The engineering material and data contained in these Bidding Documents were prepared under the
supervision and direction of the undersigned, whose seal as registered professional engineer is
affixed below.

Date of Issue: April 1, 2020

Jason Jancaitis, P.E.
Woodard & Curran, Inc. (Engineer)

HVAC & PLUMBING

Aaron Sirois, P.E.
Triple Point Engineering, LLC (Engineer)
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SECTION 03 01 05

CONCRETE REPAIR

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Repair new concrete when permitted by the Engineer and fill form tie holes per Section 03 30 20 in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 03 30 20 Concrete Placing, Curing and Finishing

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Association Of State Highway And Transportation Officials (AASHTO)

a. AASHTO T277 Standard Method of Test for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration

2. ASTM International (ASTM)

a. ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)

b. ASTM C1202 Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

c. ASTM C78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

d. ASTM C496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

e. ASTM C882 Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
f. ASTM C884 Thermal Compatibility between Concrete and Epoxy-Resin Overlay

g. ASTM G109 Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

1. Trowel-grade polymer modified portland cement repair mortar
2. Non-sag polymer modified portland cement repair mortar
3. Reinforcing steel primer

C. Notarized certificate stating that repair material meets the specified requirements and the manufacturer's current printed product literature.

D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1. Deliver products in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.
2. Store in accordance with manufacturer recommendations.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1. Take precautions to avoid damage to surface due to mixing and handling of the specified repair material near the area of Work.
PART 2 – PRODUCTS

2.01 MORTAR

A. Performance/Design Criteria

1. Mixed Properties

a. Application time: approximately 15 minutes.

b. Finishing time: 20-60 minutes.


2. Cured Properties

a. Compressive strength (ASTM C109)

   1) 1 day: 3,000 psi minimum.

   2) 28 day: 7,000 psi minimum.

b. Splitting Tensile Strength (ASTM C496)

   1) 28 day: 750 psi minimum

c. Flexural Strength (Modulus of Rupture, ASTM C78)

   1) 28 day: 2,000 psi minimum.

d. Bond Strength (ASTM C882, modified)

   1) 28 day: 2,200 psi minimum.

e. Thermal Compatibility (ASTM C884, modified)

   1) Passes test

f. Permeability (ASTM C1202, AASHTO T 277)

   1) 28 day: approximately 500 coulombs.

g. Cracked Beam Corrosion Tests (ASTM G 109, modified)

   1) Reduced corrosion rates: 63 percent versus control specimens.
B. Acceptable level of quality: equivalent to products manufactured by Sika Corporation meeting the specified performance requirements.

1. Trowel grade mortar: SikaTop 122 Plus
2. Non-sag mortar: SikaTop 123 Plus
3. Steel reinforcement primer: Sika Armatec 110 EpoCem

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GENERAL

A. Do not apply material in inclement weather or if inclement weather is imminent.

B. Condition product as recommended by the manufacturer.

3.02 SURFACE PREPARATION

A. Mechanically prepare areas to be repaired so they are clean, sound and free of contaminants. Remove loose and deteriorated concrete by mechanical means. Remove dirt, oil, grease, and bond-inhibiting materials from the surface.

B. Except where tie holes are filled, saw cut perimeter 1/8 inch minimum when a neat mortar is to be applied, and 1-inch minimum when an extended mortar is to be applied.

C. Prepare concrete substrate to obtain a minimum surface profile of 1/16 inch in depth with a new aggregate fractured surface using steel shot blasting, abrasive blasting, or water jetting (hydrodemolition). Do not use scabblers, bush hammers, or pneumatic hammers. Provide that the area to be repaired is not less than 1/8 inch in depth.

D. Prepare substrate to saturated surface dry condition with no standing water.

E. Steel Reinforcement Primer

1. Where reinforcement with active corrosion is encountered, sandblast to remove contaminants and rust, pressure wash, and apply primer.

2. Determine section loss and splice new reinforcement where there is more than 15 percent to 25 percent loss, as directed by the Engineer. If half or more of the diameter of the bar is exposed, chip out 1/2 inch minimum behind the bar.
F. Treat cracks in the substrate in the area of repair as directed by the Engineer.

3.03 MIXING AND APPLICATION

A. The following describes the specific procedures applicable for the Sika products specified in Part 2. Mix and apply in strict accordance with and adhere to limitations and cautions of manufacturer's instructions.

1. Horizontal surfaces: SikaTop 122 Plus (trowel-grade) or equal.

2. Vertical and overhead surfaces: SikaTop 123 Plus (non-sag) or equal.

B. Trowel-Grade Polymer Mortar

1. Pour entire Component A into mixing container. Add entire Component B while mixing. For extended mix, introduce 3/8 inch coarse aggregate at desired quantity. Mix to uniform consistency, maximum 3 minutes.
   a. Addition rate not to exceed 42 pounds per bag.
   b. Aggregate: non-reactive, clean, well-graded, saturated surface dry, with low absorption/high density.

2. Scrub mortar into substrate, filling pores and voids. Force material against edge of repair, working toward center. After filling repair, consolidate, then screed. Allow mortar or concrete to set to desired stiffness and finish with wood or sponge float for a smooth surface.
   a. Minimum application thickness: 1/8 inch for a neat mortar; 1 inch if extended.
   b. Maximum application thickness in a single lift: 1 inch for a neat mortar; 3 inches if extended.
   c. Where multiple lifts are required, score top surface of the preceding lift to produce a roughened surface. Allow preceding lift to reach final set prior to applying the next lift.

C. Non-Sag Polymer Mortar

1. Pour entire Component A into mixing container. Add entire Component B while mixing. Mix maximum 3 minutes to uniform consistency.
2. Scrub mortar into substrate, filling pores and voids. Force material against edge of repair, working toward center. After filling repair, consolidate, then screed. Allow mortar or concrete to set to desired stiffness and finish with wood or sponge float for a smooth surface.


   b. Maximum application thickness in a single lift: 1-1/2 inches.

   c. Where multiple lifts are required, score top surface of the preceding lift to produce a roughened surface. Allow preceding lift 30 minutes minimum to reach final set prior to applying the next lift.

D. Curing

   1. Moist cure with wet burlap and polyethylene using a fine mist of water or water based compatible curing compound. Do not use curing compounds for curing between successive lifts. Do not use solvent-based curing compounds. Commence moist curing immediately after finishing. Protect newly applied material from direct sunlight, wind, rain, and frost.

3.04 FIELD QUALITY CONTROL

   A. Provide in accordance with Division 01 General Requirements.

   B. Manufacturer Field Services

      1. Furnish the services of a qualified manufacturer’s field representative prior to commencement of application to provide instruction, demonstrate proper application and inspection procedures, and to inspect the finish of the prepared surfaces prior to application.

3.05 CLEANING

   A. Leave finished Work and Work area in a neat, clean condition without evidence of spillovers on adjacent areas.

3.06 CLOSEOUT ACTIVITIES

   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 03 11 00

CONCRETE FORMING

PART 1 – GENERAL

1.01 SUMMARY

A. Provide materials, tools, equipment and labor required for the design, preparation and cleaning, construction, and removal of all concrete formwork, and the installation of all concrete embedments furnished under other sections, necessary for the proper completion of the Work in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 03 30 20 – Concrete Placing, Curing and Finishing
2. Section 04 20 00 – Unit Masonry

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Concrete Institute International (ACI)
   a. ACI 117 Specifications for Tolerances for Concrete Construction and Materials and Commentary
   b. ACI 301 Specifications for Structural Concrete
   c. ACI 347 Guide to Formwork for Concrete

2. ASTM International (ASTM)
   a. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
   b. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

3. U.S. Army Corps of Engineers (USACE)
   a. COE CRD-C 572 Corps of Engineers Specifications for Polyvinylchloride Waterstops
1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
   A. Submit in accordance with Division 01 General Requirements.
   B. Product Data
      1. Form Ties
      2. Form Release Agent
   C. Manufacturer's Instructions
      1. Form Ties
      2. Form Release Agent
   D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS
   A. General
      1. Formwork shall conform dimensionally to the concrete Work as shown on the Drawings. To minimize the number of panel joints, formwork panels shall be of the largest practicable sizes.
2. Undamaged smooth form facing materials such as plywood, hardboard, metal, and plastic, that will produce a smooth form finish, shall be used. Formwork shall not result in fins or offsets exceeding 1/8 inch. If used, aluminum forms with un-oxidized surfaces shall be pretreated with a paste made of calcium hydroxide and water, followed by water rinsing, repeated until hydrogen bubbles do not form.

B. Form Release Agent

1. Form release agent shall be non-grain raising, non-staining, and shall not leave a residue on the concrete nor adversely affect bonding of materials to be applied.

C. Form Ties

1. General Requirements:
   a. Form ties shall be adjustable length, sized to withstand construction loads, and upon removal shall prevent concrete spalling. Ties shall have break back indentation.
   b. Plastic Cones: Form tie assembly with cone-shaped depressions at the concrete surfaces with break back ties. The portion of the tie remaining embedded in the concrete upon removal shall be equal to the depth of the cone specified.
      1) Plastic Cones: 1” diameter x 1” deep (Standard)

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 TECHNICAL REQUIREMENTS

A. The Contractor shall design, erect, shore, brace, and maintain formwork in accordance with ACI 301 to support all loads, including construction loads, until the concrete structure can support such loads.

3.02 CONSTRUCTION

A. Tolerances

1. Tolerances shall be in accordance with ACI 117.
B. Form Alignment

1. At locations where continuous surfaces are formed in successive units, forms shall be tightly fitted over the hardened concrete surface to obtain accurate surface alignment and to prevent leakage of mortar and the formation of fins, ridges, and other defects.

C. Chamfered Edges

1. Exposed concrete corners shall be formed with beveled strips to provide 3/4 inch chamfers, unless otherwise shown, specified, or directed by Engineer.

2. Where concrete walls, columns, and beams abut masonry walls, the chamfer shall be omitted.

3. Where masonry walls are flush with the face of supporting concrete curbs, the chamfer shall be omitted.

4. Chamfering by grinding is prohibited.

D. Openings

1. Form openings in concrete where required for other Work. Upon failing to form such openings, provide them in a manner approved by the Engineer at no additional cost to the Owner.

2. Except as otherwise specified, all such openings shall be filled with concrete after the Work to be installed therein is complete.

E. Cleanouts and Access Panels

1. Temporary openings shall be provided to facilitate cleaning and inspection prior to concrete placement, including at the bottom of wall forms. Cleanout openings are not permitted in exposed concrete, concrete exposed to view upon completion of the Work, whether or not it is painted, without the approval of the Engineer.

2. All refuse, sawdust, shavings, etc. shall be removed, and the forms broom cleaned before concrete placement.

F. Form Release Agent

1. Forms shall be coated with the approved form release agent before placement of reinforcing steel. Do not apply form release agent at locations of monolithic construction joints, which are construction joints with all the reinforcement continuous through the joint. Excess agent applied to the forms, and on the reinforcing steel and other surfaces requiring a concrete bond, shall be removed.
2. Forms for unexposed surfaces may be thoroughly wetted in lieu of the approved form release agent immediately before concrete is placed. However, form release agent shall be used in freezing weather.

3.03 INSTALLATION OF EMBEDDED ITEMS

A. General

1. Coordinate the setting of anchor bolts, thimbles, inserts, wall pipe, sleeves, and other embedded items. Before placing concrete, ensure that all items are accurately located and firmly secured against displacement.

2. All items shall be thoroughly cleaned and free of loose rust, mill scale, dirt, grease, etc. Wood used for removable keys shall be thoroughly dampened before concrete is placed against it.

B. Electrical Conduit

1. Electrical conduit may be embedded in concrete provided the following conditions are met.

a. Outside diameter of conduit shall not exceed 1/3 of concrete thickness.

b. Conduit shall not be placed closer than 3 diameters on center.

c. Conduit shall not significantly impair the strength of the construction.

d. Conduit shall not be embedded in structural concrete slabs less than 4 inches thick.

e. Only 2 conduits may cross at any point. The sum of the outside diameter of the crossing conduits shall not exceed 1/3 of the concrete thickness.

f. A 1-1/2 inch minimum concrete cover shall be provided for conduits in structural slabs.

g. Conduit shall not be located between bottom of reinforcing steel and bottom of slab.

h. Conduit is not permitted in beams, girders, and columns without the approval of the Engineer.

i. Aluminum conduit shall not be embedded in concrete.

j. Conduit shall be installed so that cutting, bending, or displacement of reinforcement from its proper location is not necessary.
2. Contractor shall notify Engineer of any embedded conduits not installed according the conditions specified herein a minimum of 24 hours prior to concrete placement. Noncompliant conduit placements shall be repositioned or removed to the satisfaction of the engineer and owner’s representative.

3.04 REMOVAL

A. Form Removal

1. Form removal per ACI 347, as modified.

2. Forms shall be removed while ensuring the complete safety and serviceability of the structure. Forms or shoring for slabs, beams, and other suspended members shall not be removed until members are of sufficient strength to safely support their own weight and the weight.

3. Newly unsupported portions of the structure shall not be subjected to heavy construction or material loading. Additional shores or re-shores shall be provided as required to adequately support the members during the construction period.

4. The Contractor shall be responsible for the proper removal of forms, shores, and bracing.

5. Spalling of concrete surfaces shall be prevented.

6. When forms are removed before the specified curing period (as specified in Section 03 30 20) is complete, measures shall be taken to continue curing and to continue providing thermal protection for the concrete.

7. Forms may be removed when the cumulative time during which the temperature of the air surrounding the concrete is above 50 degrees F are as follows

   a. Walls, columns, sides of beams and girders, and similar parts of the Work not supporting the weight of the concrete: 24 hours.

   b. When design superimposed load is less than the self-weight

      1) Beam and Girder Soffits

         a) Clear span less than 10 feet: 7 days

         b) Clear span 10 feet to 20 feet: 14 days

         c) Clear span more than 20 feet: 21 days
2) Slabs
   a) Clear span less than 10 feet: 4 days
   b) Clear span 10 feet to 20 feet: 7 days
   c) Clear span more than 20 feet: 10 days

c. When design superimposed load is more than the self-weight
   1) Beam and Girder Soffits
      a) Clear span less than 10 feet: 4 days
      b) Clear span 10 feet to 20 feet: 7 days
      c) Clear span more than 20 feet: 14 days

2) Slabs:
   a) Clear span less than 10 feet: 3 days
   b) Clear span 10 feet to 20 feet: 4 days
   c) Clear span more than 20 feet: 7 days

d. Alternatively to the stripping times specified, additional concrete cylinders shall be made using representative concrete, witnessed and approved by the Engineer, and tested at no additional cost to the Owner. Such specimens shall be field cured in accordance with ASTM C31 under conditions that are not more favorable than the most unfavorable conditions for the portions of the concrete that the test specimens represent. The supporting forms and shores may be removed when the concrete strength as tested per ASTM C39 is a minimum of 70 percent of the specified design strength, as determined by the field-cured cylinders according to ACI 301.

B. Tie Holes

1. Filling of form tie holes and concrete finishing are specified in Section 03 30 20.

3.05 CLEANING AND REPAIR OF FORMS

A. Parts of forms reserved for reuse shall be inspected, cleaned, and repaired. Any parts dented, deformed, or otherwise rendered unfit for reuse shall be discarded.
3.06 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.07 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 03 16 00

CONCRETE SPECIALTIES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide materials, tools, equipment, and labor necessary for construction of concrete specialties as specified, as shown on Drawings, for completion of the Work in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Post-installed expansion anchors and adhesive anchoring systems are specified in Section 05 50 00.

B. Related Requirements

1. Section 03 30 00 – Cast-In-Place Concrete

2. Section 03 30 20 – Concrete Placing, Curing and Finishing

3. Section 05 50 00 – Metal Fabrications

4. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Society for Testing and Materials (ASTM)

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

   b. ASTM A1064 Standard Specification Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

   c. ASTM C1107 Standard Specification for Packed Dry, Hydraulic-Cement Grout (Non-shrink)
d. ASTM D4832 Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

2. ICC Evaluation Service (ICC-ES)
   a. ICC-ES AC308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements

3. American Concrete Institute (ACI)
   a. ACI 355.2 Qualification of Post-Installed Mechanical Anchors in Concrete
   b. ACI 355.4 Qualification of Post-Installed Adhesive Anchors in Concrete

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

1. Non-Shrink Grout

2. Epoxy Adhesive (for drill and epoxy rebar)
   a. ICC-ES report for manufacturer’s specific product
   b. Epoxy ultimate bond strength
   c. Manufacture’s chart for embedment to develop yield strength and tensile strength of ASTM A615, grade 60, rebar sizes #3 thru #11.
   d. Storage requirements
   e. Gel and cure times as a function of temperature
   f. Installation temperature requirements for cartridges and base material
   g. Drilling method (diamond drill bit shall be prohibited)
   h. Drill bit diameter and depth of hole for rebar sizes
   i. Hole cleaning procedure and required condition of hole
j. Requirements for discarding initial discharge to ensure proper mixing

k. Hole filling procedure

l. Time period when anchor cannot be contacted or otherwise disturbed

C. Shop Drawings
   1. Reinforcement

D. Design Data and Test Reports
   1. Concrete for concrete fill and duct banks.
      a. Submittals as required in Section 03 30 00.
   2. Controlled Low Strength Material
      a. Submittals as required in Section 03 30 00.
      b. Both 28-day and 90-day compressive strength test results.

E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements for anchor installation and as follows.
   1. Install anchors by qualified personnel trained to install adhesive anchors.
   2. Adhesive anchors shall be installed in strict accordance with the Manufacturer’s Printed Installation Instructions (MPII).
   3. Each installer shall have the MPII in their possession at all times.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.
PART 2 – PRODUCTS

2.01 GROUT

A. Grout shall be non-metallic, cementitious non-shrink grout meeting ASTM C1107, grade C. Grout shall be Five Star Grout by U.S. Grout Company, Crystex or Premier by L&M Construction Chemicals, Inc., Sure-Grip High Performance Grout, by Dayton Superior, or approved equal.

2.02 DUCTBANKS

A. All underground electrical duct banks shall be concrete encased. Concrete shall be as specified in Section 03 30 00, except it shall have a 3/8 inch maximum aggregate size and a minimum 28-day compressive strength of 3,000 pounds per square inch.

B. Duct banks shall be reinforced as detailed where crossing under roads, driveways, parking areas, all areas subject to vehicular traffic, and whereas shown or specified in the Contract Documents. Reinforcement shall extend a minimum of 4 feet beyond the specified areas.

C. Coordinate red shake-on red pigmented dye, acid stains, or integral coloring as required in Section 26 05 43.

2.03 CONTROLLED LOW STRENGTH MATERIAL

A. A rigid-setting mixture of portland cement, sand, and water shall not require vibration during placement, flow without noticeable segregation, self-consolidate, and be excavatable with hand tools.

B. Sand gradation (U.S. Standard Sieve/Percent Passing)

1. 3/8-inch/100
2. No. 4/95-100
3. No. 16/45-80
4. No. 50/10-30
5. No. 100/2-10
6. No. 200/0-3

C. Cement, water, and chemical admixtures shall meet the requirements of Section 03 30 00.

D. The 28-day and 90-day compressive strengths, measured in accordance with ASTM D4832, shall be between 30-80 psi and less than 100 psi, respectively.
2.04 EPOXY ADHESIVE

A. Epoxy adhesive for installation of post-installed reinforcing bars denoted as “Drill and Epoxy” or “Drill & Epoxy” on drawings.

B. Evaluation Requirements: ICC-ES evaluation report stating product is compliant with 2015 International Building Code and approved for use to resist static, wind and earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete having a compressive strength of 2,500 psi to 8,500 psi. Evaluation reports with a listed renewal date month/year which is prior to the month/year the product is submitted for engineer’s review will be rejected.

C. Epoxy adhesive for anchoring reinforcement to concrete shall be a 2-component solid epoxy based system supplied in manufacturer's standard side-by-side cartridge and dispensed through manufacturer's standard static-mixing nozzle. Epoxy adhesive shall be:

1. Simpson Strong Tie: SET-XP or ET-HP
   a. SET-XP Compliance Report (ESR-2508)
   b. ET-HP Compliance Report (ESR-3372)

2. Hilit: HIT-RE 500 V3
   a. Compliance Report (ESR-3814)

3. Approved equal based
   a. Compliance Report to be submitted

D. Epoxy adhesive shall pass the creep test requirements of ICC-ES AC58.

E. The embedment depth shall be per the manufacturer's requirements and the ultimate strength exceeds the tensile strength of the bar, and the ultimate strength divided by a minimum factor of safety of 3.75 is at least 40 percent of the yield strength of the bar.

2.05 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 EQUIPMENT PADS

A. New concrete surfaces upon which equipment pads are to be built shall receive a scratched finish in accordance with Section 03 30 20.
B. All laitance shall be removed and the surface shall be saturated with water for a minimum of 6 hours. Excess water shall then be removed and the epoxy bonding compound applied as specified in Section 03 30 20.

C. All equipment pads shall be sized to suit the approved equipment, and reinforcement shall be as shown on the Drawings.

D. The top surface shall be level within 1/8-inch. All exposed faces shall be formed with smooth forms and shall be smooth and free of sands streaks, bug holes, and honeycomb. All exposed surfaces shall have a smooth, even surface with all exterior corners chamfered. Exposed faces of pads shall receive a sack-rubbed finish as specified in Section 03 30 20.

E. All anchor bolts, dowels, sleeves, and other fittings required for the equipment shall be built in.

3.02 GROUTING

A. Grouting is required for structural, mechanical, and electrical items, and shall be in accordance with the manufacturer's recommendations.

B. Concrete surfaces to receive grout shall be cleaned of all contamination and debris. Surface roughening shall be required if laitance or poor concrete is evident.

C. Grout placement shall be rapid and continuous such that grout completely fills the space to be grouted, absent of air pockets.

D. Grout may be placed by gravity or pumped. When practical, grout shall be placed from one side and made to flow to the open side to prevent the formation of air pockets.

3.03 EXISTING CONCRETE

A. Where equipment pads are to be constructed, grouting is to be performed, and concrete fills are to be placed against existing concrete, the following surface preparation shall be required.

1. The existing concrete surface shall be cleaned of all contamination and debris, and roughened by steel shot blasting, abrasive sand blasting, or water jetting. Use of scabblers, scarifiers, bush hammers, and pneumatic hammers is not permitted.

2. The existing concrete surface shall be water-saturated for a minimum of 6 hours, after which the excess water shall be removed immediately prior to placement of new concrete or grout.
3. In areas where equipment pads are to be constructed and concrete fills are to be placed, apply epoxy-bonding compound specified in Section 03 30 20 to prepared concrete surface prior to concrete placement.

3.04 DUCTBANKS

A. There shall be a minimum of 4 inches of concrete between the outside of a duct and surrounding soil. There shall be not less than 3 inches of concrete between adjacent ducts.

B. All ductbank concrete placements shall be continuous between manholes and handholes, and between manholes, handholes, and structures.

C. Where ducts pass through a foundation wall, the concrete encasement shall extend through the wall and be flush with inside face per the details on the Drawings. Watertight construction joints shall be provided.

3.05 EPOXY ADHESIVE

A. Installation: Per manufacturer’s installation instructions and as listed in the product ICC-ES Evaluation Report

B. Drilled and epoxied rebar shall be installed in concrete having a minimum age of 21 days at time of installation.

C. All cartridges shall have the expiration date clearly visible. Material past its expiration date shall not be used, and shall be immediately removed from the Site.

D. Diamond drill bits are not permitted. Hammer drills shall be used. Hole diameter size per manufacturer’s installation instructions.

E. The initial material extruded from each cartridge shall be discarded in accordance with the manufacturer’s instructions to ensure that all material is properly mixed.

F. Depth stop shall be used to ensure correct drilling depth. Drilled holes shall be blown out with air, thoroughly wire brushed with a repeated back and forth movement, blown out, thoroughly wire brushed, and blown out again. Adhesive shall be injected, starting from the bottom of the hole and slowly withdrawn as filling progresses to prevent air pockets.

G. Rebar shall remain completely undisturbed between the manufacturer's specified gel time and the full cure time. Zero load shall be applied during this time.
3.06 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Manufacturer’s Field Services

1. Epoxy Adhesive
   a. Except where specified to be performed by personnel certified by an applicable program such as the ACI/CRSI Adhesive Anchor Installer Certification program or equivalent, as approved by the Engineer, the Contractor shall furnish the services of a competent manufacturer's field representative who shall be present at the Work Site prior to beginning installation in order to instruct the Contractor and the Engineer on proper installation and inspection procedures. Such instruction shall include a full and complete demonstration.

   b. Installation of anchors horizontally or upwardly inclined to resist sustained tension loads shall be continuously inspected by the Engineer’s special inspector approved for that purpose. The special inspector shall furnish a report to the Engineer that the Work covered by the report has been performed and that the materials and installation procedures conform to the Contract Documents and the Manufacturer’s Printed Installation Instructions (MPII).

   c. Proof loading: performed where required per ACI 355.4.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 03 20 00

CONCRETE REINFORCING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide materials, tools, equipment, and labor necessary for the fabrication and installation of reinforcement (except installation only of reinforcement for masonry construction which is included in Section 04 20 00, Unit Masonry) in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. 04 20 00 – Unit Masonry

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Concrete Institute (ACI)
   a. ACI 117 Specifications for Tolerances for Concrete Construction and Materials and Commentary
   b. ACI SP-66 ACI Detailing Manual

   a. ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   b. ASTM A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars

3. American Welding Society (AWS)
   a. AWS D1.4 Structural Welding Code – Reinforcing Steel
4. Concrete Reinforcing Steel Institute (CRSI)
   a. CRSI 10MSP Manual of Standard Practice

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
   A. Submit in accordance with Division 01 General Requirements.
   B. Product Data
      1. Certified mill reports, including chemical and physical analyses
      2. Dowel bar splicers and dowel inserts
   C. Shop Drawings
      1. Reinforcement Drawings: Comply with ACI SP-66, and include the following information
         a. Sizes, dimensions, and locations for reinforcement and supports
         b. Bending diagrams and schedules
         c. Splices
         d. Cover and clearances
         e. Class designation and details of bar supports
         f. Pertinent reinforced concrete details with dimensions and elevations
         g. Items furnished by other trades or under other sections of the Specification that are to be cast in concrete where interference with reinforcement may occur
         h. Reinforcement shall be shown on wall elevations with required sections, on beam elevations with required sections, on plan views of slabs with required sections. Provide plan details where walls intersect.
   D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.
   B. Fabricate reinforcement in accordance with ACI 117.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Deliver reinforcement in bundles with tags indicating size, length, and identification mark.
   C. Store materials off the ground to prevent soiling and to facilitate subsequent inspection and handling.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 STEEL REINFORCEMENT
   A. General: Steel reinforcement shall include all bars, anchorages, stirrups, dowels, ties, tie-wire, chairs and other steel supports, and spacers as noted on the Drawings, specified, and as required for the proper completion of the Work.
   B. Materials
      1. Reinforcement bars shall be formed from new billet steel conforming to ASTM A615, Grade 60 except as otherwise specified.
   C. Tie Wire
      1. 16-gauge minimum
      2. FS QQ-W-461 annealed black
   D. Bar Supports
      1. Chairs, bolsters, spacers and other supports to properly position reinforcement shall conform to the bar support recommendations of CRSI 10MSP, and shall be of adequate strength and design to prevent displacement of reinforcement and discoloration of concrete.
      2. Supports shall be Class 1 - plastic protected.
3. Supports for bottom reinforcement of slabs on soil shall be chairs with integral plates, or precast concrete blocks not less than 4-inches square with a compressive strength equal to that of the surrounding concrete. Precast blocks may only be used to support reinforcement not more than 3-inches from the bottom of the slab.

E. Fabrication

1. Steel reinforcement shall be fabricated to the sizes, shapes and dimensions shown on the Drawings, details and schedules. All bending shall be in accordance with CRSI 10MSP. All steel shall be bent cold and shall not be bent or straightened in a manner that will injure the metal. Bars with kinks or bends not so detailed shall not be used.

2. Bends for stirrups and ties shall be made around a pin having a diameter not less than 4 times the diameter of the bar. Bends for other bars shall be made around a pin having a diameter not less than 6 times the diameter of the bar, except for bars larger than 1-inch, the pin shall be not less than 8 times the diameter of the bar.

F. Dowel Bar Splicers and Dowel Inserts (DBS/DI)

1. Dowel bar splicers shall be a 2-component threaded rebar splice system. The internally threaded component shall be forged from Grade 60 deformed rebar material free of external machining or welding. It shall contain an integral flange with nailing holes and be threaded with Unified National Coarse (UNC) or UN (unified) threads to a depth equal to the nominal diameter of the threads plus 1/4 inch. The externally threaded splice component shall be fabricated from Grade 60 deformed rebar material and supplied with rolled threads corresponding with the internally threaded component. The root diameter of the threads shall provide a minimum cross sectional area equal to the cross sectional area of the nominal bar size. Manufacturer testing shall indicate ultimate tension failure occurring in the nominal bar diameter, not at the mechanical splice.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Reinforcement

1. Tolerances shall conform to ACI 117.
2. Placement
   a. Reinforcement shall be accurately positioned both horizontally and vertically, and shall be properly secured and sufficiently rigid to prevent displacement during concrete placement.
   b. Reinforcement shall be securely tied at intersections with tie wire or clips in a manner that will keep all metal away from exposed concrete surfaces.

3. Splices
   a. Reinforcement splices shall be as shown on the Drawings. Where not shown, splices shall be located away from areas of maximum stress, and shall be approved by the Engineer.
   b. Welding shall only be permitted by written approval of the Engineer, and shall be in accordance with AWS D1.4.

4. All reinforcement within an area of a continuous concrete placement shall be installed, supported, and secured before beginning the concrete placement.

5. Reinforcement Adjustment
   a. Adjust to within allowable tolerances to avoid interference with other reinforcement, conduits, or embedded items.
   b. Reinforcement shall not be moved beyond allowable tolerances without the Engineer's approval.
   c. Reinforcement shall not be heated, bent or cut without approval Engineer's approval.

B. All reinforcement shall be entirely free from flaking rust, loose mill scale, grease, dirt, etc. that might reduce its bond with the concrete.

C. Concrete cover for reinforcement shall conform to the dimensions shown on the Drawings.

D. Notify Engineer at least 24 hours before placing concrete. Reinforcement within the area of 1 day's concrete placement shall be tied in place and observed by Engineer prior to commencing concrete placement.
3.02 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.03 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes
1. Provide cast-in-place concrete in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements
1. Section 03 16 00 – Concrete Specialties
2. Section 03 30 20 – Concrete Placing, Curing and Finishing

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards
1. American Concrete Institute International (ACI)
   a. ACI 117 Specifications for Tolerances for Concrete Construction and Materials and Commentary
   b. ACI 301 Specifications for Structural Concrete
2. ASTM International (ASTM)
   a. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
   b. ASTM C33 Standard Specification for Concrete Aggregates
   c. ASTM C40 Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
   d. ASTM C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
   e. ASTM C94 Standard Specification for Ready-Mixed Concrete

g. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete

h. ASTM C150 Standard Specification for Portland Cement

i. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

j. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

k. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete

l. ASTM C295 Standard Guide for Petrographic Examination of Aggregates for Concrete

m. ASTM C494 Standard Specification for Chemical Admixtures for Concrete


o. ASTM C586 Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)

p. ASTM C595 Standard Specification for Blended Hydraulic Cements

q. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

r. ASTM C989 Standard Specification for Slag Cement for Use in Concrete and Mortars

s. ASTM C1105 Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction

t. ASTM C1116 Standard Specification for Fiber-Reinforced Concrete

u. ASTM C1157 Standard Specification for Hydraulic Cement

w. ASTM C1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction

x. ASTM C1567 Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

y. ASTM C1602 Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete

z. ASTM E329 Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

1. Test Reports

a. Provide reports by testing agencies meeting ASTM E329.

2. Design Data for Each Concrete Mixture

a. Submit for mix designs for each concrete mixture specified in the Concrete Mix Design Schedule, located at the end of this Section. Submitted mix designs shall use the same, or similar, names as indicated in the Concrete Mix Design.

b. Submit at minimum 14 days before initial placement of concrete.

c. Proportions for all ingredients, 28-day design compressive strength, water to cementitious materials ratio, admixture dosages, slump, and air content.

d. Test data supporting proportions based upon laboratory trial batches or field test records per ACI 301 Section 4, Concrete Mixtures.

1) Field test data used to determine the standard deviation used for establishing the required average design strength shall be from within the previous 12 months, per ACI 301.
2) Field test data documenting that the proposed concrete proportions will produce an average compressive strength equal to or greater than the required average compressive strength shall be from within the 12 months.

3) Laboratory trial batch data shall be from within the previous 24 months.

3. Cement: Certified mill reports, not older than 90 days.

4. Supplementary cementitious materials: Source and test reports for actual material to be used in the Work, not older than 90 days.
   a. Fly ash
   b. Ground granulated blast-furnace slag

5. Aggregate
   a. Data not older than 90 days, except test data for soundness, abrasion, and alkali reactivity - not older than 1 year.
   b. Fine and coarse aggregate data, except as noted
      1) Sources
      2) Specific gravity
      3) Sieve analyses per ASTM C33 (including fineness modulus of fine aggregate)
      4) Organic impurities for fine aggregate per ASTM C40
      5) Potential alkali reactivity (not required if a cement containing less than 0.60 percent alkalis is used or if mix design uses 50% ground-granulated blast furnace slag by weight of cementitious material, per ASTM C1260, ASTM C1293, or ASTM C1567)
      6) Soundness per ASTM C88
      7) Abrasion for coarse aggregate per ASTM C131 and ASTM C535

6. Product Data and Instructions
   a. Admixtures
B. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 SOURCE
   A. Provide concrete supplied from a single commercial ready-mix plant, mixed and delivered in accordance with the requirements of ASTM C94, except if plant does not exist within a reasonable distance from Site, furnish material for on Site batching and store per Article 1.07.

2.02 CONCRETE MATERIALS
   A. Concrete mixture design
      1. Per ACI 301, Section 4, Concrete Mixtures.
      2. 28-day design compressive strength: 5,000 pounds per square inch, except as otherwise specified.
      3. Water to cementitious materials ratio: not to exceed 0.40 except as otherwise specified.
      4. Provide designs of required strength, water to cementitious materials ratio, slump, and workability for placing conditions and specified finishes without segregation.
      5. Slump
         a. Per ASTM C143.
         b. Specified Slump Range: 3 inches to 5 inches
c. Specified Slump Range (mixes with mid-range water reducer):
   2 inches to 4 inches, before admixture is added
   Maximum 6 inches, after admixture is added

d. Specified Slump range (mixes with high-range water reducer)
   2 inches to 4 inches, before admixture is added
   Maximum 8 inches, after admixture is added

B. Cement: per ASTM C150, Type II or ASTM C595 IP(MS), IS (less than 70)(MS).
   Do not use ASTM C595 cements that contain ASTM C1157 cement. If equivalent alkali content is greater than 0.60 percent (and percent by weight of cementitious material is not 50% ground-granulated blast furnace slag), submit aggregate reactivity testing as required by Article 2.02.D.3.

C. Supplementary cementitious materials

   1. Fly ash (optional)
      a. ASTM C618, Class F
      b. Maximum loss of ignition: 3.0 percent
      c. Not less than 15 percent or more than 25 percent of weight of cement plus fly ash
      d. Maximum available alkalis: 5 percent

   2. Ground-granulated blast furnace (GGBF) slag (optional)
      a. ASTM C989
      b. Activity classification: Grade 100 or 120
      c. Not less than 25 percent or more than 50 percent of weight of cementitious material

   3. Fly ash plus GGBF slag
      a. Maximum 50 percent of total cementitious materials
      b. Fly ash portion maximum 25 percent of total cementitious materials
      c. Minimum portland cement: 337 pounds per cubic yard of concrete
D. Aggregate

1. Meet ASTM C33, as amended herein. Evidence of a satisfactory service record in lieu of testing for alkali reactivity is not permitted.

2. Do not use crushed hydraulic cement concrete for aggregate.

3. Aggregate reactivity testing: per ASTM C1260. Do not use aggregate having a 14 day expansion greater than 0.10 percent (considered potentially reactive), except if tested per ASTM C1567, the 14 day expansion is not greater than 0.10 percent, or if tested per ASTM C1293, the 2-year expansion is not greater than 0.04 percent, or if cement containing less than 0.60 percent alkalis is used per ASTM C33. In lieu of the above, Alkali-Silica Reactivity (ASR) mitigation may be by substitution of a minimum 25% fly ash or 50% GGBF slag for cement by weight.

4. Fine aggregates: Sand or screenings of gravel or crushed stone, well graded from fine to coarse; clean and free from soft particles, clay, loam and organic matter, with the volume removed by sedimentation not more than 3 percent.

   a. Organic impurities testing: per ASTM C40. Color of the supernatant liquid above the test Sample, not darker than organic plate No. 3.

   b. Grading

<table>
<thead>
<tr>
<th>U.S. Standard Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 3/8 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>80 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>50 - 85</td>
</tr>
<tr>
<td>No. 30</td>
<td>25 - 60</td>
</tr>
<tr>
<td>No. 50</td>
<td>5 -30</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
</tr>
</tbody>
</table>

   c. Not more than 45 percent retained between any 2 consecutive sieves listed above. Fineness modulus, not less than 2.3 nor more than 3.1.
5. Coarse Aggregates: Crushed stone or washed gravel of clean, hard, durable, uncoated particles, free from dust, dirt, or other deleterious substances, and free from thin, flat, or elongated particles.
   
a. Nominal maximum aggregate size for slabs poured on ground, at least 15 inches thick, except where clear spacing between reinforcing bars is less than 2 inches: 1-1/2 inches.
   
b. Nominal maximum aggregate size at all other locations, except as specified otherwise or approved: 3/4 inch.
   
c. Nominal maximum aggregate sizes per grading in Table 2 of ASTM C33: No. 467 (1-1/2 inches), No. 57 (1 inch), No. 67 (3/4 inch), No. 7 (1/2 inch), and No. 8 (3/8 inch).

E. Admixtures

1. Air-entraining admixture
   
a. Per ASTM C260 and chloride free
   
b. Provide air entrainment, except as noted below, per manufacturer's directions and this Specification to produce the following total entrained air content determined per the procedure in ASTM C173 or ASTM C231.

<table>
<thead>
<tr>
<th>Nominal Maximum Size Coarse Aggregate (inches)</th>
<th>Air Content By Volume (percent plus or minus 1.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>7.5</td>
</tr>
<tr>
<td>1/2</td>
<td>7.0</td>
</tr>
<tr>
<td>3/4</td>
<td>6.0</td>
</tr>
<tr>
<td>1</td>
<td>6.0</td>
</tr>
<tr>
<td>1-1/2</td>
<td>5.5</td>
</tr>
</tbody>
</table>

   c. Maximum air content for interior concrete slabs to be hard-troweled: 3.0 percent.

2. Mid-range water reducing agents: per ASTM C494, Type A, and with consideration of the air entraining effect of the water reducing agent.

3. Water reducing-retarding agents: For use when ambient temperature above 70 degrees F, replace water reducing agent in whole or part with water reducing-retarding agent meeting ASTM C494, Type D. Use amounts to produce concrete with set time equal to that at 70 degrees F without the retarder.
4. Set accelerator: Non-chloride type conforming to ASTM C494, Type C or E where allowed under Section 03 30 20.

5. High-range water reducing agent: ASTM C494, Type F or G (added in plant or field).

F. Water

1. Meet ASTM C1602.

2. Fresh and free from oil, acid, salt, alkali, sewage, organic matter, and other deleterious substances.

3. The amount of water carried on the aggregate and the effect of admixtures is included in the water content. Provide that water carried on the aggregate is determined periodically by test and the amount of free water on the aggregate subtracted from water added to the mixture.

4. Residual, wash, or other water in drums: Completely discharged prior to concrete batching (drums backed out).

5. Maximum amount of water required to produce a plastic mixture of the strength and water to cementitious materials ratio specified and the required density, uniformity and workability. Consistency of mixture required for the specific placing conditions and methods.

6. Slump adjustment: Not made at wash down, slump rack, or by any other means prior to arrival at point of delivery at the Site.

7. Water added after arrival at Site: Accurately metered and recorded on the batch ticket.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Advise testing laboratory and field observers minimum 24 hours in advance of placing concrete to allow for scheduling observation and testing.

C. Assist testing laboratory and Engineer in obtaining and handling Samples at the Site and other sources of material.
D. Provide space and electrical power at the Site for facilities to be provided by Owner’s testing agency for proper initial curing and storage of concrete test cylinders to be lab-cured as required by ASTM C31 for 48 hours after casting. For cylinders to be field-cured: per Section 03 30 20.

E. Testing agency to store cylinders to be lab-cured at 60 degrees F to 80 degrees F in an environment preventing moisture loss from the specimens such as storage in wooden boxes, and placement in damp sand pits. Shield specimens from direct sunlight and radiant heating devices. Control storage temperature by use of heating and cooling devices as necessary and record temperature with a maximum-minimum thermometer.

3.02 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
# CONCRETE MIX DESIGN SCHEDULE

The following table provides a list of concrete mixtures required for the project. The concrete supplier shall submit a concrete mix design for each of the concrete mixtures listed in accordance with “Part 1.05 Submittals” of this specification.

<table>
<thead>
<tr>
<th>Concrete Mixture</th>
<th>Min Comp Strength (psi)</th>
<th>Max W/C Ratio</th>
<th>Air Entrained</th>
<th>Description of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Mix Design w/ air</td>
<td>5,000 at 28 days</td>
<td>0.40</td>
<td>Yes</td>
<td>Use for all concrete, unless noted otherwise, including: Pile caps, grade beams, concrete beams, columns, and floor slabs.</td>
</tr>
<tr>
<td>Duct Banks &amp; Mud Mat</td>
<td>3,000 at 28 days</td>
<td>0.55</td>
<td>Yes</td>
<td>Per Section 03 16 00</td>
</tr>
<tr>
<td>Controlled Low- Strength Material</td>
<td>See Spec</td>
<td>N/A</td>
<td>See Spec</td>
<td>Per Specification 31 00 00</td>
</tr>
</tbody>
</table>
SECTION 03 30 20

CONCRETE PLACING, CURING, AND FINISHING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide placing, curing and finishing of cast-in-place concrete in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Concrete sampling and field testing by an independent technician certified in accordance with the requirements of ACI Concrete Field Testing Technician – Grade 1 certification program, or the requirements of ASTM C1077.

B. Related Requirements

1. Section 03 11 00 – Concrete Forming
2. Section 03 16 00 – Concrete Specialties
3. Section 03 30 00 – Cast-In-Place Concrete

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Concrete Institute International (ACI)
   a. ACI 117 Specifications for Tolerances for Concrete Construction and Materials and Commentary
   b. ACI 301 Specifications for Structural Concrete
   c. ACI 306.1 Standard Specification for Cold Weather Concreting
   d. ACI 308.1 Standard Specification for Curing Concrete
   e. ACI 350.1 Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures
f. ACI 306R Cold Weather Concreting

2. ASTM International (ASTM)
   a. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
   b. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
   c. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   d. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
   e. ASTM C144 Standard Specification for Aggregate for Masonry Mortar
   f. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete
   g. ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete
   h. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
   i. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
   j. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
   k. ASTM C404 Standard Specification for Aggregates for Masonry Grout
   l. ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
   m. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
   n. ASTM C1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
CONCRETE PLACING, CURING, AND FINISHING

B. Definitions

1. Construction joint refers to a monolithic construction joint in which the surface between successive placements is prepared to enhance bond and shear transfer and reinforcement is continuous.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data and Manufacturer’s Instructions

1. Delivery Tickets

a. Provide duplicate delivery tickets at time of delivery for each truckload of concrete delivered

b. Serial number of ticket

c. Date and Project location
d. Name and location of ready mixed concrete plant

e. Truck number, time loaded, cubic yardage delivered

f. Dispatcher's name

g. Mixture design, cement type, and admixtures with brand names

h. Types and quantities of cement, fly ash and/or slag (if included in approved mix design) and admixtures. Quantities of water and fine and coarse aggregate including moisture content, and nominal maximum aggregate size

i. Water added subsequent to plant batching, if any. (Only applicable if total water per mixture design is not added at plant. Addition of water such that the water content of the approved mixture design is exceeded will be strictly prohibited.)

j. Concrete temperature upon delivery

k. Unloading time and location

2. Curing Paper

3. Epoxy Bonding Compound

4. Evaporation Retardant

5. Cure and Seal Compound

6. Curing Compound

7. Preformed Joint Filler

C. Source and Field Quality Control Submittals

1. Methods to be used to protect concrete placed during cold weather. The Engineer's review shall not constitute approval as the Contractor shall be responsible for the protection of concrete placed during cold weather.

2. Methods to be used to protect concrete placed during hot weather. The Engineer's review shall not constitute approval as the Contractor shall be responsible for the protection of concrete placed during hot weather.

D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.
   B. Concrete sampling and testing per Article 3.10.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Protection
      1. Provisions shall be made for maintaining new concrete in a continuously moist condition for at least seven days after placement
      2. Fresh concrete shall be protected from freezing, premature drying, flowing water, and mechanical injury
      3. Concrete shall not be placed while rain, sleet, or snow is falling unless acceptable protection is provided. Precipitation shall not be allowed to enter into the concrete mix or damage concrete surfaces

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 PREFORMED JOINT FILLER
   A. Preformed joint filler: Conform to ASTM D4819, closed cell polyethylene foam isolation joint material, 1/2” thick unless noted otherwise on drawings. Joint filler shall be Deck-O-Foam by W.R. Meadows, or approved equal.

2.02 CURE AND SEAL COMPOUND
   A. Cure and Seal Compound: Conform to ASTM C309, Type 1 Class A & B, and ASTM C1315, Type 1 Class A, AASHTO m148 Type 1 Class A & B with minimum 25 percent solids, non-yellowing, non-staining, and UV light resistant.
   B. Cure and Seal compound shall meet the following requirements.
      1. NCHRP 244 Series IV – Reduction in absorbed Chloride > 85%
      2. ASTM E96 Water Vapro Permeability – 94%
      3. ASTM C457 Depth of Penetration – 0.18-0.21
      4. ASTM C642 Water Absorption Reduction in Hardened Concrete – 89%
5. Equal to CERTI-VEX Guard Clear Aim by VEXCON Chemicals, Inc

2.03 CURING PAPER

A. Curing Paper: Shall consist of two layers of kraft paper cemented together and reinforced with fiber and conform to ASTM C171, for regular or white waterproof paper. Regular shall be used if ambient temperatures are below 60 degrees F.

2.04 EPOXY BONDING COMPOUND

A. Epoxy Bonding Compound: Conform to ASTM C881, contain 100 percent solids, and be moisture tolerant. Sikadur 32 Hi-Mod or Sikadur 32 Hi-Mod LPL, by Sika Corporation; Sure-Bond (J-58, or J-58 LPL), by Dayton Superior; or approved equal shall be provided.

B. Where larger placements require open times greater than 2 hours: Sika Armatec 110 EpoCem or approved equal for larger placements.

2.05 EVAPORATION RETARDANT

A. Evaporation Retardant: water-based polymer liquid placed on fresh concrete to control the rate of evaporation and extend workability. E-CON as manufactured by L&M Construction Chemicals, Inc.; SikaFilm by Sika Corporation; MasterKure ER 50 by Master Builders; or approved equal.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 CONCRETE PLACEMENT AND JOINTING

A. Tolerances: Tolerances shall conform to all requirements of ACI 117 except as modified.

B. Cold Weather Requirements

1. Cold weather concreting provisions shall be followed during cold weather: any and all periods when for more than three consecutive days the average daily outdoor temperature drops below 40 degrees F. (The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight.) When temperatures higher than 50 degrees F occur during more than half of any 24-hour duration, the period shall not be regarded as cold weather.
2. When freezing temperatures may occur during periods not defined as cold weather, concrete surfaces shall be protected against freezing for at least the first 24 hours after placing.

3. Concrete shall not be placed on frozen subgrade. Insulate or heat subgrade to ensure temperature above 32 degrees F when concrete is placed.

4. All embedment’s having a cross sectional area of 1.0 square inch or greater, and including #9 reinforcing bars, shall be at a temperature not less than 10 degrees F at time of concrete placement.

5. Thermal protection must be provided immediately after concrete placement. Procedures for covering, insulating, housing, and/or heating concrete shall be prearranged. Except when supplemental heat is provided, the R-value of the insulation shall be per the recommendations of chapter 9 of ACI 306R.

6. Accelerating admixtures shall be approved at the Engineer's discretion, however those containing calcium chloride shall not be permitted.

7. When combustion heaters are used, flue gases shall be vented to the exterior of enclosures.

8. Concrete shall be placed and maintained at the following minimum concrete placement temperatures (measured at concrete surface):
   a. Sections of less than 12-inch minimum dimension: 55 degrees F
   b. Sections of 12 to 36 inches minimum dimension: 50 degrees F

9. The concrete placement temperature shall not be higher than the minimum concrete placement temperature by more than 20 degrees F.

10. The minimum concrete temperature as mixed shall be: 5 degrees F higher than the minimum concrete placement temperature when the air temperature is above 30 degrees F; 10 degrees F higher when the air temperature is between 0 and 30 degrees F; and 15 degrees F higher when the air temperature is less than 0 degrees F.

11. The temperature shall be monitored at the surface of the concrete, including at corners and edges, which are more vulnerable to freezing. The concrete surface temperature and the corresponding outside air temperature shall be recorded a minimum of twice per each 24 hour period.

12. Concrete shall be maintained at the minimum specified temperatures for a protection period of 6 days. When an approved accelerating admixture is used the protection period may be reduced to 4 days.
13. Slabs, regardless of air content, shall not be exposed to freezing temperatures when exposed to rain, snow or other water sources, prior to reaching a compressive strength of 3,500 psi. For hard-troweled slabs (which have a maximum air content of 3.0 percent) see Article 3.07, paragraph D.3 for additional requirements.

14. Concrete shall be cooled gradually at the end of the protection period. The maximum allowable temperature drop at the concrete surface during the first 24 hours after the protection period shall be: 50 degrees F for concrete sections of less than 12 inch minimum dimension; and 40 degrees F for concrete sections of 12 to 36 inch minimum dimension.

C. Hot Weather Requirements

1. The temperature of the concrete when placed shall not exceed 90 degrees F. When the air temperature is 90 degrees F and above, procedures to cool mixture ingredients may be warranted. These include: providing shaded storage for aggregate, frequent sprinkling or fog spraying of coarse aggregate, and using chilled batch water and/or ice. Forms and reinforcement shall be sprinkled with cold water just prior to concrete placement. When possible, placement of slabs should be scheduled after walls and roof structure are in place in order to minimize problems associated with direct sunlight and/or drying winds. Newly placed concrete shall be protected from the direct sunlight.

2. Records shall be maintained of: time and location of concrete placement, air temperature, weather conditions, relative humidity, and concrete temperature as delivered and after placement.

3. When the air temperature is 90 degrees F and above: the time between the addition of water to cement or cement to aggregate (whichever occurs first) and the time of concrete placement shall not exceed 60 minutes, except upon approval of the Engineer when all tests for air content, slump and temperature are acceptable.

D. Placing

1. Concrete shall be handled from the truck to the place of final deposit as rapidly as practicable by methods preventing segregation and/or loss of ingredients.

2. The time between the addition of water to cement, or cement to aggregates (whichever occurs first), and the placement of concrete shall not exceed 90 minutes. When air temperature is 90 degrees F and above, this time shall be reduced to 60 minutes. These times may be exceeded only upon approval of the Engineer, and only if all tests for air content, slump, and temperature are also acceptable.
3. Water shall be removed from all forms and excavations and the Work shall be kept dry during placement. No water shall be thrown on, allowed to flow over, or rise upon the concrete until it is thoroughly set.

4. Prior to placement of slabs on soil, the subgrade shall be moist with no free water and no muddy or soft spots.

5. The concrete shall be directly deposited as close as possible to its final location, and shall be deposited in such manner so as to maintain a homogeneous, plastic, approximately horizontal surface.

6. Where concrete may contact soil while being placed, free fall shall be limited to a maximum of 3 feet. Concrete that has been contaminated by soil and/or other foreign matter shall be rejected. The accumulation of concrete on the forms and/or on reinforcement above the level of placement shall be avoided. The splashing of concrete upon formwork that is set for a subsequent concrete placement shall be prevented due to the resulting marks on the finished concrete.

7. Re-tempering of concrete and concrete placement against partially hardened concrete shall not be permitted. A concrete placement, once started, shall be carried out as a continuous operation until the placement of the entire section between construction joints is complete.

E. Runways: Runways shall be provided for wheeled concrete handling equipment which shall not be wheeled over reinforcement. Runways shall not be supported upon reinforcement that is part of the Work.

F. Chuting

1. Minimum slope shall be 3 horizontal to 1 vertical and maximum slope shall be 2 horizontal to 1 vertical. Between these limits, the slope shall be that which will prevent segregation and ensure continuous flow.

2. A baffle shall be provided at the end of the chute to prevent segregation. If the end of the chute is more than 3 feet above the surface of deposit, a spout shall be used. The spout shall be kept full of concrete with the end kept as near as practical to the surface of deposit.

3. The chute shall be steel or steel lined, and sections shall have the same slope throughout. Aluminum chutes are not permitted.

4. The chute shall be thoroughly flushed with water before and after each use, the water discharged outside the forms.
G. Pumping: The inside diameter of pipes and hoses used to convey the concrete shall be a minimum of three times the maximum size aggregate of the mixture. In order to minimize altering the concrete properties, long vertical sections at the end of the pump line shall be avoided. A horizontal hose run, a hose loop, or a slide gate at the end of the hose may be used to reduce loss of entrained air.

H. Compaction

1. Provide at least one standby vibrator, and at least one for each three in use.

2. Concrete may be deposited in one or multiple layers. Each layer shall be compacted by mechanical internal vibrating equipment supplemented by hand spading, rodding, and tamping as required. Depth of each layer shall not exceed the smaller of 36 inches and depth that can be properly vibrated with equipment used. When deposited in multiple layers, the vibrator shall penetrate the previous layer approximately 6 inches. Ensure initial setting of previous layer does not occur prior to placement of subsequent layer.

3. Vibrators shall be relocated frequently, and over-vibration resulting in segregation shall be prevented. Vibrators shall not be used to move concrete within the forms. Concrete shall be thoroughly consolidated around reinforcement, embedments, and into the corners of the forms.

4. Where internal vibration is impractical, the use of form vibrators will be considered, and will be allowed only with the Engineer's written approval. When allowed, the vibrator shall be placed so that motion is horizontal.

I. Construction Joints

1. Construction joints shall be located where shown on the Drawings, or, if not shown, locations shall be approved by Engineer.

2. Horizontal construction joints: laitance shall be removed immediately after initial set and the surface shall roughened in an acceptable manner that exposes the aggregate uniformly and doesn't leave laitance or loose aggregate. After the concrete has set to a degree that precludes laitance removal by shovels or scrapers, the Contractor shall remove it, and create a roughened surface, by water jetting or other effective method. The use of pneumatic hammers is not permitted.

3. Vertical construction joints: the surface shall be thoroughly cleaned of laitance by water jetting, or by wire brushing followed by air blasting.

4. Before concrete is placed against set concrete, the surface shall be thoroughly wetted with standing water removed. Horizontal construction joints shall be in a saturated surface dry condition: saturated for a minimum of 6 hours, with standing water removed.
5. Where noted on the Drawings, and as approved by the Engineer where an unplanned interruption within a concrete placement has occurred, epoxy-bonding compound shall be used in accordance with the manufacturer's instructions.

6. Reinforcement shall be continuous at construction joints unless otherwise shown on the Drawings.

J. Existing Concrete

1. Where concrete is placed against existing concrete, the following surface preparation shall be required.

2. The existing concrete surface shall be cleaned of all contamination and debris, and roughened by steel shot blasting, abrasive (sand) blasting, or water jetting (hydrodemolition). Use of scabblers, scarifiers, bush hammers, or pneumatic hammers is not permitted.

3. The existing concrete surface shall be water-saturated for a minimum of six hours, after which the excess water shall be removed immediately prior to placement of new concrete.

4. Apply epoxy-bonding compound to prepared concrete surface prior to concrete placement.

3.02 CURING AND PROTECTION

A. Temperature

1. When the ambient temperature falls below 40 degrees F or rises above 95 degrees F, a record shall be kept of concrete temperatures and of protection given to concrete during placement and curing.

2. Temperature of in-place concrete shall be the surface temperature of the concrete. Surface temperature may be determined by placing temperature sensors in contact with concrete surfaces or between concrete surfaces and covers used for curing, such as insulation blankets or plastic sheeting.

B. Curing

1. Provide curing per ACI 308.1 except as modified.

2. During cold weather, as previously defined, the application of water shall not be required. Curing shall be accomplished by the use of curing paper, curing compounds, cure and seal compounds, or other approved methods. Thermal blankets are not an approved curing method and shall be used in conjunction with curing provisions previously stated.
3. Provisions shall be made for maintaining new concrete in a continuously moist condition for a minimum of 7 days. Curing shall commence as soon as possible after final finishing when it will not mar, erode, or stain the concrete surface.

4. Curing shall be accomplished by the use of curing paper, curing compounds (except as noted below), wet methods (ponding, fog spray, damp sand or burlap, sprinkling, soaker hoses) or other methods.

5. Water used for curing shall be no more than 20 degrees F cooler than the concrete surface temperature.

6. Concrete slabs to receive a coating or bonded finish, including chemical hardeners, that aren't wet cured, shall be covered with curing paper as specified, laid with side joints lapped 4 inches and end joints lapped 6 inches. Paper shall be applied no earlier than 24 hours and no later than 30 hours after finishing the slab and shall be left in place at least seven days. (Wet methods shall be used for the first 24-30 hours.) The slab surface shall be maintained in a wet condition beneath the paper at all times. Joints shall be taped and paper shall be weighted to prevent displacement. Tears during the first 7 days after a slab is completed shall be immediately repaired.

7. Curing paper shall also be used to protect newly poured concrete floors from damage. Where heavy tools and/or equipment may be used, provide additional protection as required. Only light traffic will be permitted until 7 days after concrete placement. Slabs shall be protected from damage for the Contract duration.

8. All above concrete grade concrete shall receive cure and seal compound:
   a. Concrete that is sack-rubbed finished:
      1) Step 1: wet cure or formwork shall remain in place for the specified 7-day curing period.
      2) Step 2: Concrete shall receive sack-rubbed finish
      3) Step 3: Apply cure and seal compound
   b. Concrete not specified to have sack-rubbed finish:
      1) Apply cure and seal compound per manufacturer’s instructions, immediately after finish work or after formwork has been removed.
9. The use of a curing compound or cure and seal compound on surfaces to receive applied toppings, chemical hardeners, water repellents, coatings, or a rubbed or bonded finish will not be allowed. Where used, curing compound shall be applied immediately following the disappearance of the surface water sheen after the final finishing pass for slabs, and immediately upon removal of forms for formed concrete. Apply two coats per manufacturer’s installation instructions. Apply each coat uniformly with no gaps in coverage. If applied by spray, provide additional spray tank and spray nozzles as required to provide uninterrupted application of product. Cure and seal compounds have high solid content and shall be applied by trays and rollers, if application by spray tanks is not completed in a timely manner and to the satisfaction of the engineer.

10. Soaker hoses shall be used at tops of walls and columns before forms are removed. Wood forms shall be kept continuously wet in hot weather.

3.03 DEFECTIVE CONCRETE

A. The Engineer may direct the Contractor to remove and replace, at no additional cost to the Owner, concrete Work that is not formed as shown and/or specified in the Contract Documents, or that contains a defective surface.

B. Upon the Engineer's approval, minor imperfections may be patched as specified herein.

3.04 REPAIR OF SURFACE DEFECTS AND PATCHING

A. After form removal, all form ties shall be cut off, all fins and irregularities removed, and all defective areas, holes, honeycombs, cavities and irregularities shall be repaired where surface finish defects exceed the finish tolerances of Section 3.05

B. Exposed patchwork shall match adjacent finish and shall include a sack rubbed finish to blend repair into adjacent surfaces and cured and protected as specified for concrete.

C. Filling Form Tie Holes: Tie holes shall be filled solid with non-shrink grout, specified in Section 03 16 00, in the same manner as specified under patching above.

3.05 FINISH OF FORMED SURFACES

A. General

1. Concrete surfaces "exposed to view" shall be defined as those exposed to view upon completion of the Work, whether or not a painted finish is specified. Surfaces which will be covered by fill, such as exterior faces of walls, shall not be considered exposed to view.
Surface tolerance classes indicated herein are specified in ACI 117, and include abrupt surface irregularities that are measured within 1-inch of the irregularity, and gradual surface irregularities measured as the maximum gap between the concrete and the near surface of a 5-foot straight-edge, measured between contact points.

B. Surface Finish – 2.0 (SF-2.0)

1. SF-2.0 shall be provided for formed surfaces not exposed to view.
2. Patch voids larger than 3/4-inch wide or 1/2-inch deep.
3. Remove projections larger than 1-inch
4. Fill Tie holes
5. Surface tolerance Class D, with formed surface irregularities not more than 1-inch.

C. Surface Finish – 3.0 (SF3.0)

1. SF-3.0 shall be provided for formed surfaces exposed to view.
2. Patch voids larger than 1/2-inch wide or 1/4-inch deep.
3. Remove projections larger than 1/8-inch.
4. Fill tie holes
5. Surface tolerance Class C, with formed surface irregularities not more than 1/2-inch.
6. Provide sack-rubbed finish.

D. Grout-cleaned rubbed finish (Sack-Rubbed)

1. All interior and exterior concrete surfaces that are exposed to view shall receive a grout-cleaned rubbed finish and shall have a smooth and even surface, free of bug holes, when completed, unless specifically noted otherwise on Drawings.
2. Wet the surface and apply a thin coat of medium consistency neat cement slurry to the concrete surface by means of bristle brushes to provide a bonding coat. Before the slurry has dried or changed color, grout comprising one-part cement to 1 1/2 parts sand meeting ASTM C144 or ASTM C404, with sufficient water to produce the consistency of thick paint, shall be applied and scrubbed into voids, with excess removed. The cement shall be that used in the concrete mix adjusted with white cement as necessary to match color of exposed concrete. Grout shall be applied with slightly damp pads of coarse burlap approximately 6 inches square used as a float and shall be well scrubbed into the surface to provide a dense mortar.

3. The mortar shall be allowed to partially harden for 1 to 2 hours depending upon weather conditions. Work in direct hot sunlight shall be avoided. In hot dry conditions the concrete shall be kept damp during this period with a fine fog spray. Grout shall not be allowed to remain on the surface too long as it will become very difficult to remove. Grout shall not be left on the concrete overnight.

4. After the grout has hardened sufficiently, all that can be removed with a trowel shall be.

5. The surface shall then be allowed to dry thoroughly, and be rubbed vigorously with clean, dry burlap to completely remove any dried grout. There should be no visible film of grout remaining after rubbing.

6. The entire rubbing operation shall be completed in a single working day. Sufficient time shall be allowed for this.

7. On the following day, the concrete shall again be wiped clean with dry burlap to remove dust. The use of burlap containing old hardened mortar may be used since it will act as a mild abrasive. After this treatment, no build-up film should remain on the surface, but if it does, a fine abrasive stone shall be used to remove it without breaking through the surface film of the parent concrete. Do not work up a lather.

8. After application of the surface grout, the surface shall be thoroughly washed down with stiff brushes and the concrete maintained in a continuously damp condition for at least three days above 50 degrees F by the periodic application of a fine fog spray, the use of damp fabric covered with polyethylene or other methods.

3.06 FINISHING OF RELATED UNFORMED SURFACES

A. Tops of exposed walls and similar unformed surfaces shall be struck off smooth and hand steel troweled to produce a smooth hard level surface. Line and elevation shall be pre-established by means of preset wood screeds, which shall be removed during the troweling operation.
B. After troweling is completed and after the curing period, the surface shall be dry honed to a smooth non-directional surface texture satisfactory to the Engineer.

3.07 FINISH OF SLABS

A. General

1. The evaporation retardant specified may be used in accordance with manufacturer recommendations to control plastic shrinkage cracking and as an aid in slab finishing operations. Conditions that may warrant its use include: high temperature, low humidity, high winds, and direct sunlight.

2. Loss of bleed water and surface drying shall be allowed to proceed naturally. Means to accelerate drying such as applying dry cement, sand, or other materials shall be prohibited.

B. Floor Flatness and Floor Levelness

1. Elevated floor slabs constructed on formwork and all concrete tank base slabs shall be true to the gradient and elevation shown on the Drawings. Flat Slabs shall be level with a tolerance of 3/8 inch in 10 feet. Sloped slabs shall be true to the gradient shown, within a tolerance of 3/8 inch in 10 feet. Slabs shall be pitched to drains as indicated on the Drawings.

C. Floated Finish

1. Slabs to receive a seamless floor finish or roofing, and all tank bottom slabs, shall receive a floated finish. Floating shall also precede a troweling, where a troweled finish is required as specified below. After consolidating, screeding, and leveling, the slab shall not be worked further until it is ready for floating.

2. Floating shall begin when the water sheen has disappeared, and when the slab has stiffened sufficiently to allow proper operation of a power-driven float. Hand floating with wood, aluminum or magnesium floats shall be used at locations inaccessible to the power-driven float.

3. Surface trueness shall be verified at this stage with a 10-foot straightedge applied in multiple angles. High spots shall be cut down and low spots filled so that the finished surface is true. The slab shall then be immediately refloated to a uniform, smooth, granular texture.

D. Troweled Finish

1. All interior slabs left exposed shall receive a troweled finish.
2. The surface shall be finished with power floats as specified above for floated finish, followed by power trowels, and finally hand trowels. The first power troweling shall produce a smooth surface relatively free of defects but which may contain trowel marks. Subsequent trowel shall be by hand after the surface has sufficiently hardened. The surface shall be thoroughly consolidated by the hand troweling, and final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The finished surface shall be free of trowel marks and uniform in texture and appearance.

3. Interior concrete slabs to be hard-troweled shall have a maximum air content of 3.0 percent. After the curing period, they shall be protected from freezing temperatures for a minimum of 8 weeks. Thereafter, and for the duration of the Contract, if such slabs might be subject to freezing temperatures, they shall be fully sheltered from rain, snow and all other water sources.

4. Subsequent trowels shall be by hand after the surface has sufficiently hardened. The surface shall be thoroughly consolidated by the hand troweling, and final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The finished surface shall be free of trowel marks and uniform in texture and appearance.

E. A broom finish shall be provided for all exterior slabs, sidewalks, platforms, ramps, exterior stairs and as specified herein or shown on the Drawings. After floating, and between initial and final set, the surface shall be given a coarse transverse scored texture by drawing a broom across the surface.

F. Raked finish: after consolidating, screeding and leveling, the surface shall be roughened with stiff brushes or raked before final set. At sloped surfaces scratches shall be made parallel to the direction of slope, to facilitate subsequent cleaning.

3.08 CLEANING CONCRETE

A. Cleaning during progress of the Work shall not be permitted. Cleaning shall not commence until the structure is entirely completed.

B. Rust and other stains and discolorations shall be removed with a non-etching cleaning agent used in accordance with the manufacturer's instructions. Cleaning of all surfaces to receive a painted finish is also required.

C. Rust stains may be removed by applying a bleaching agent such as oxalic acid. Acid etching, sandblasting, or cleaning by other methods may be used as approved by Engineer.
3.09 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1. During the progress of the Work, an independent, accredited and certified testing laboratory shall conduct concrete testing as specified herein, including the preparation and testing of concrete cylinders. All testing shall be paid for by Contractor.

2. Field technicians in charge of sampling concrete; testing for slump, unit weight, air content, and temperature; and making and curing test specimens shall be certified in accordance with the requirements of ACI Concrete Field Testing Technician – Grade 1 certification program, or the requirements of ASTM C1077.

3. Scheduling: Contractor to advise testing laboratory and field technician(s) a minimum 24 hours in advance of placing concrete to allow for scheduling observation and testing.

4. Test Cylinder Storage: Provide space and electrical power at the Site for temperature controlled storage of concrete laboratory test cylinders to be standard cured per Specification 03 30 00. Temperature controlled storage containers to be provided by testing agency.

B. Field Testing and Sampling Procedures

1. Concrete samples shall be taken in accordance with ASTM C172 for slump, entrained air, unit weight, and strength tests.

2. Entrained air content and slump requirements are listed in Specification 03 30 00.

3. Air Content: Test in accordance with ASTM C173 or ASTM C231. Prior to pumping initial delivery of concrete each day, air content and slump shall be verified at point of delivery. Thereafter, pumped concrete shall be sampled and tested for air content at the point of placement, as opposed to at the point of delivery. Upon the Engineer's approval: once the slump loss and the loss of entrained air due to pumping is established, correlated acceptance limits at the point of delivery, where sampling and testing may then be performed, shall be made applicable. When the pump line configuration is changed significantly, sampling and testing shall again be performed at the point of placement until new acceptance limits at the point of delivery may be determined.

4. Slump: Measured in accordance with ASTM C143 at the point of delivery.

5. Temperature shall be measured in accordance with ASTM C1064 at point of delivery.
6. Test Cylinders: Concrete cylinders shall be prepared in accordance with ASTM C31 and be 4 inches diameter by 8 inches tall. Refer to Article 3.10, part D for number of cylinders required.
   a. Lab-Cured (Standard Cured) Cylinders: Filed cured in temperature controlled storage per Specification 03 30 00. Cylinders shall be transported to the testing lab within 48 hours of forming, but not sooner than 8 hours after final set.
   b. Field Cured Cylinders: Cured in the field under conditions that are not more favorable than the most unfavorable conditions for the portions of the concrete that cylinders represent.

C. Laboratory Testing of Test Cylinders
   1. Cylinders shall be tested for compressive strength in accordance with ASTM C39
   2. Test concrete cylinders per Section 3.10, Part D.
   3. The compressive strength shall be the average strength of three cylinder breaks per ASTM C39 and tested at 28-days.
   4. Test Results: Submit test results to Engineer and concrete supplier within 24 hours of laboratory testing.

D. Field and Laboratory Testing Frequency
   1. Minimum field testing frequency for each day concrete is delivered and placed at Project Site shall be as follows.
      a. Take concrete test cylinders at frequency specified from truckload determined by technician, Contractor, or Engineer
      b. 1st truck load: Test air content, slump, and temperature.
      c. 2\textsuperscript{nd} and 3\textsuperscript{rd} truck load: No testing unless noted otherwise.
      d. 4\textsuperscript{th} truck load: Test air content, slump, and temperature
      e. 5\textsuperscript{th} and 6\textsuperscript{th} truck load: No testing unless noted otherwise
      f. 7\textsuperscript{th} truck load: Test air content, slump, and temperature.
      g. Repeat test frequency for additional truckloads of concrete delivered during each day of concrete placement.
h. Concrete temperature shall be tested for each truckload of concrete during cold weather or hot weather as defined within this specification.

i. Contractor, Owner’s representative, or Engineer shall increase testing frequency as required to verify mix designs, address workability concerns, and to ensure all concrete placed complies with specifications.

2. Lab-Cured (Standard Cure) Cylinders

a. Lab-cured cylinders are required for all concrete on the project and shall be in addition to field-cured cylinders, where provided.

b. One set of 5 cylinders shall be prepared for each 100 cubic yards, or fraction thereof, of each different mix placed in each single day; or for each 5,000 square foot of slab or wall surface area placed each day.

c. Test one cylinder at 7 days, three at 28 days, and reserve one cylinder for 56-days.

d. Test 56-day cylinder as needed or requested by Contractor or Engineer.

3. Field-Cured Cylinders

a. Contractor is responsible for taking additional field-cured test cylinders to verify concrete compressive strength prior to tightness testing concrete tanks, backfilling concrete basement walls, or early removal of formwork.

b. One set of 3 field-cured cylinders shall be prepared for each 100 cubic yards, or fraction thereof, of the concrete placed in each single day.

c. Test field cured cylinders at 14 days or as requested by Contractor or Engineer.

E. Acceptance Criteria and Additional Testing Requirements

1. Concrete strength shall be evaluated in accordance with ACI 301 Section 1.6.5, "Evaluation of concrete strength tests", and Section 1.6.6, "Acceptance of concrete strength."
2. Construction will be considered potentially deficient if concrete fails to meet any requirements that affect the strength and durability of the structure, including but not necessarily limited to:

   a. Low strength concrete per ACI 301, Section 1.6.5, "Evaluation of concrete strength tests", and Section 1.6.6, "Acceptance of concrete strength"

   b. Water-to-cementitious materials ratio higher than that of the specified mix

   c. Reinforcing steel size, quantity, strength, position or arrangement that does not meet the requirements of the Contract Documents

   d. Reinforced concrete that differs from the dimensions or locations shown on the Drawings

   e. Curing that does not meet the requirements of the Contract Documents, including premature formwork removal

   f. Hot or cold weather concreting that doesn't meet the requirements of the Contract Documents

   g. Mechanical damage from accidents or fire

   h. Poor construction practices

F. The Engineer may order load and/or core tests in accordance with ASTM C42. Such testing shall be paid for by the Owner if the concrete is proven to meet the requirements specified.

3.10 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 03 41 26

PRECAST CONCRETE WET WELL & VALVE VAULT

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide precast concrete wet well & valve vault structures in accordance with this Section and the applicable reference standards listed in Article 1.03.

2. Tightness testing of concrete structures in accordance with ACI 350.1 and concrete structure leak repairs. Contractor is responsible for all costs associated with testing and completing all repairs to successfully pass the testing requirements of ACI 350.1. Contractor’s construction schedule shall account for sufficient time to perform testing and leak repairs prior to backfilling concrete structures.

B. Related Requirements

1. Section 03 01 05 Concrete Repair
2. Section 03 30 00 Cast-in-Place Concrete
3. Section 05 50 00 Metal Fabrications
4. Section 43 21 40 Submersible Pumps

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Association of State Highway and Transportation Officials (AASHTO)
   a. AASHTO HB-17 Standard Specifications for Highway Bridges
   b. AASHTO T111 Standard Method of Test for Mineral Matter or Ash in Asphalt Materials

2. American Concrete Institute International (ACI)
3. **ASTM International (ASTM)**

b. ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
c. ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
d. ASTM C33 Standard Specification for Concrete Aggregates
e. ASTM C144 Standard Specification for Aggregate for Masonry Mortar
f. ASTM C150 Standard Specification for Portland Cement
g. ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes
h. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete
i. ASTM C478 Standard Specification for Precast Reinforced Concrete Manhole Sections
j. ASTM C494 Standard Specification for Chemical Admixtures for Concrete
k. ASTM C857 Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
l. ASTM C890 Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
m. ASTM C990 Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
n. ASTM D113 Standard Test Method for Ductility of Bituminous Materials
o. ASTM D1227 Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
p. ASTM D217 Standard Test Methods for Cone Penetration of Lubricating Grease
q. ASTM D4 Standard Test Method for Bitumen Content
r. ASTM D6 Loss on Heating of Oil and Asphalitic Compounds
s. ASTM D71 Standard Test Method for Relative Density of Solid Pitch and Asphalt (Displacement Method)
4. Federal Specifications (FED)
   a. FED SS-S-210A Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Shop Drawings

   1. Precast Concrete Structures, including construction details, dimensions, reinforcement, placement, openings, etc.

   2. Shop drawings shall be signed and sealed by a licensed Professional Engineer in the project state.

C. Certificate of Design

   1. Certificate of design (design calculations) for precast concrete structures (including anti-flotation slabs) shall be signed and sealed by a Professional Engineer registered in the state where Project is located having a minimum 5-years’ experience in the design of similar structures. The shop drawings and design calculations shall certify that precast structures have been designed to withstand all forces including soil, traffic, and hydrostatic loads, including the anti-flotation slabs whether provided separately or as a monolithic unit. Anti-flotation calculations shall not include friction due to soil and shall have a minimum factor of safety of 1.15. Design calculations shall be submitted a minimum of 2 weeks prior to scheduled manufacture.

D. Concrete Mix Design

   1. Submit a concrete mix design that will be used for the precast concrete. Mix design submittal shall include all products that are to be used in the mix; including, but not limited to, cement mill report, aggregate data, water reducer product, air entraining product, etc. Refer to Specification 03 30 00 Cast-in-Place Concrete for all product requirements.

      a. If the Submitted cement mill report contains 0.60% equivalent alkali content or greater, aggregate reactivity testing shall be submitted. Aggregate reactivity testing shall be per Section 03 30 00 Cast-in-Place Concrete, Article 2.02.D.3.

E. Product Data

   1. Joint Sealant
2. Manhole Steps
3. Aluminum Hatch Covers
4. Anchorage Hardware

F. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE
A. Provide in accordance with Division 01 General Requirements.
B. The materials covered by this Specification are intended to be standard materials of proven ability as manufactured by reputable concerns. Materials shall be designed and constructed in accordance with Industry Practice, and shall be installed in accordance with the manufacturer's recommendations. The Specifications call attention to certain features, but do not purport to cover all details entering into the construction of the materials.
C. Tightness Test Concrete Structures per Article 3.06.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Provide in accordance with Division 01 General Requirements.
B. Products shall be shipped, stored, and handled in a manner consistent with the written recommendations of the manufacturer so as not to degrade quality, serviceability, and appearance. Any unit found to be defective, either before or after installation, shall be removed from the Project Site and replaced with a sound unit.

1.08 SITE CONDITIONS
A. Existing Conditions: per Division 01 General Requirements.

1.09 WARRANTY
A. The precast concrete manufacturer shall provide a warranty on the complete precast concrete structures, for a period of 1-year after the Owner's acceptance, (Certificate of Substantial Completion) or one year after the precast structure is put into operation, whichever comes first. Any defects found during the warranty period will be reported to the Contractor by the Owner. Defects shall include, but not be limited to, any concrete cracks, any leaks, any concrete spalling, etc. Any material or craftsmanship defects not associated with faulty installation, operation or maintenance found during the warranty period will be corrected by the Contractor at no cost to the Owner.
PART 2 – PRODUCTS

2.01 PRECAST CONCRETE STRUCTURES

A. General

1. Precast structures shall have the inside dimensions as shown on the Drawings.

2. Any concrete fill that is required shall meet the requirements set forth in Specification 03 30 00.

B. Precast Materials

1. Concrete

   a. Concrete compressive strength shall be 5,000 psi after 28 days.

   b. Minimum concrete thickness shall be 6 inches.

   c. Portland cement shall be Type II conforming to ASTM C150.

   d. Fine aggregate shall consist of natural sand conforming to ASTM C33.

   e. Coarse aggregate shall consist of 1/2-inch maximum, well-graded crushed stone conforming to ASTM C33.

   f. Air entrainment admixture shall conform to ASTM C260. The air-entrained content shall be not less than 4 percent or greater than 7 percent.

   g. A super plasticizer shall be used and shall conform to ASTM C494 Type F or G. Concrete shall be placed at a slump of between 5 and 8 inches.

   h. A Crystalline Waterproofing Additive shall be used when selected as a product option. The system shall cause the concrete to become sealed against the penetration of liquids from any direction, and shall protect the concrete, surface to surface, from deterioration due to harsh environmental conditions. The Waterproofing Additive shall be Xypex Admix C-100, as manufactured by XYPEX Chemical Corporation, Richmond, B.C., Canada, or approved equal.

   i. The precast concrete manufacturer shall conduct concrete strength tests on 4” x 8” cylinders. An adequate number of tests shall be performed to certify and ensure the strength meets or exceeds the design strength. Concrete strength test results for all specific precast structures supplied must be made available in written reports, per PCI standards, at the request of the review engineer.

   j. The cement used shall contain less than 0.60% equivalent alkalis. If the Submitted cement mill report contains 0.60% equivalent alkali
content or greater, aggregate reactivity testing shall be submitted. Aggregate reactivity testing shall be per Section 03 30 00 Cast-in-Place Concrete, Article 2.02.D.3.

2. Reinforcement
   a. Wire fabric shall conform to the requirements of ASTM A1064.
   b. Reinforcing bars shall be new billet steel, deformed, conforming to the requirements of ASTM A615, Grade 60.
   c. Minimum clear concrete cover to reinforcement shall be 1-1/2 inches.
   d. Reinforcing steel minimum yield stress shall be 60 ksi.
   e. All reinforcement shall be free from loose rust, oil, and contamines which reduce bond. Any foreign material shall be removed by suitable means prior to installation.

C. Design Loads

1. The Precast Pump Station shall be designed to support its own weight, snow loads, seismic loads, as well as the minimum superimposed loads tabulated below. All additional equipment shall be accounted for in the design of the elements.

   Top Slab
   - Live Load – AASHTO H20
   - Live Load – 300 psf

   Exterior Walls
   - Hydrostatic Soil Pressure
   - Hydrostatic Groundwater Pressure
   - AASHTO H20 Vehicle Surcharge

   Base Slab
   - Buoyancy Pressure

2. Vehicle Loads
   a. Except as otherwise specified, the design shall meet the requirements of AASHTO HB-17, including a H20 vehicle loading.
   b. A lateral vehicle surcharge load in compliance with AASHTO shall be applied.

3. Lateral Pressure
   a. The equivalent lateral fluid/soil pressure shall be applied to the full height of the structure. The minimum groundwater height shall be at the top of the structure. The specified lateral vehicle surcharge load shall be added to this load.
4. Buoyancy / Anti-Flotation
   a. The structure shall be designed with a factor of safety of 1.15 against buoyancy/anti-flotation with the design flood elevation at the top of the structure. Frictional resistance and weight of mechanical equipment in this calculation is not permitted. Where the structure is composed of successive vertical segments, the weight of the segments shall provide the same factor of safety for buoyancy, or stainless steel mechanical connections shall be used to connect the segments together. The design shall include positive anchorage to a reinforced concrete anti-buoyancy slab of the required size.
   b. If the Engineer determines, at his sole discretion, that the pre-caster's buoyancy/anti-flotation calculations are incorrect, the Engineer shall direct the Contractor to implement specific measures to counteract buoyancy to the Engineer's satisfaction. All costs associated with such measures shall be borne entirely by the Contractor and at no additional cost to the Owner.

5. Water & Wastewater Structures Design Load
   a. Except where higher loads are specified, water and wastewater structures shall be designed for the loads prescribed in ASTM C890.

6. Utility Structures Design Load
   a. Except where higher loads are specified, utility structures shall be designed for the loads prescribed in ASTM C857.

D. Openings
   1. All wall penetrations shall be formed utilizing hole-formers for manhole boots or galvanized threaded couplings with waterstops for electrical connection.
   2. Field drilled cores shall not be permitted. All wall penetrations shall be cast into the precast concrete wet well and dry well.
   3. All cast wall openings for ductile iron, PVC shall incorporate adjustable rubber manhole boots for a watertight seal.
   4. The structural design shall take into account discontinuities in the structure produced by openings. All slabs and walls shall be fully reinforced on both surfaces with minimum reinforcing of #5 @ 12” each way. Additional reinforcing shall be provided around all openings.

E. Joints
   1. The precast concrete structures shall be comprised of the least number of sections to keep the joints to a minimum.
2. Concrete sections shall be provided with bell and spigot, or tongue-in-groove ends to ensure proper connection of the joints.

3. Each joint shall be sealed with two (2) butyl rubber sealant strips. A compatible primer shall be applied as recommended by the manufacturer. Sealant shall be Conseal CS-102 (CS-202 when the temperature during installation is less than 30 degrees F) by Concrete Sealants, Inc., Kent Seal #2 by Hamilton Kent, Pro-Stik by Press-Seal Gasket Corporation, or approved equal, and shall be applied in accordance with the manufacturer's recommendations. Sealant properties shall be as follows
   a. AASHTO T111: 30 percent minimum ash content
   b. ASTM C990
   c. ASTM D4: 50 percent minimum hydrocarbon content
   d. ASTM D6: 2 percent maximum volatile matter
   e. ASTM D71: specific gravity between 1.15 - 1.50
   f. ASTM D113: 5.0 minimum
   g. ASTM D217: 55-100 mm at 77 degrees F
   h. FED SS-S-210A: No deterioration, no cracking and no swelling after 30 days immersion in 5 percent solutions of HCl, H2SO4, NaOH, KOH, and H2S.

4. Also, at each joint, provide E-Z Wrap joint wrap (or approved equal), 9-inch wide, rubberized backing as manufactured by Press Seal Gasket Co., Fort Wayne, IN. applied to exterior.

2.02 WATERPROOFING
   A. Waterproof all exterior below grade surfaces with HLM 1300S by Sonneborn or equal; 55 mils thick. Waterproofing is to be field applied only. To be done only after fiber reinforcement has been applied at joints. To be applied to a well dried surface and only under manufacturers recommended ambient conditions.

   B. All surfaces of the precast structures shall be smooth, even, and free from roughness, irregularities and other defects. The surfaces shall be suitable for receiving exterior treatments as specified elsewhere herein.

2.03 DAMPPROOFING
   A. Dampproofing shall be Hydrocide 700 Mastic as made by Sonneborn, Karnak 920 Anti Hydro Mastic Emulsion, or approved equal, conforming to ASTM D 1227.

   B. All surfaces of the precast structures shall be smooth, even, and free from roughness, irregularities and other defects. The surfaces shall be suitable for receiving exterior treatments as specified elsewhere herein.
2.04 MANHOLE STEPS
   A. Manhole steps shall be of steel reinforced copolymer polypropylene conforming to ASTM C478, cast-in-place or installed utilizing inserts approved by the Engineer.
   
   B. All steps shall be 12 inches on center with abrasive step surface and safety edge, drop front design, 1-inch diameter and 16 inches wide. Metal items embedded in concrete shall be painted with a zinc chromate primer.
   
   C. See Specification 05 50 00 for further requirements.

2.05 PIPE CONNECTIONS
   A. Pre-molded elastomeric sealed joints shall be used at the joints between the pipe and precast sections. Pre-molded elastomeric sealed joints shall be A-Lok, Res-Seal, Press-Wedge II, Lock Joints Flexible Manhole Sleeve, Kor-N-Seal Joint Sleeve, or equal.

2.06 ALUMINUM HATCHES
   A. Furnish and install hatches of the size indicated on the Drawings and in the locations shown on the Drawings. Confirm hinge locations for pump removal with Engineer prior to fabrication and prior to field installation. Refer to Specification 05 50 00 Metal Fabrications for any other requirements.

2.07 ANCHORAGE HARDWARE
   A. Hardware for fastening the precast structure to the anti-buoyancy slab, and to fasten precast segments together for buoyancy shall be stainless steel and as specified in Section 05 50 00 Metal Fabrications.

2.08 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PRECAST STRUCTURES
   A. Precast structures shall be installed as shown on the Drawings. Precast sections shall be installed so that the entire structure is vertically plumb and aligned, and when not so, shall be removed and replaced. All erection holes shall be filled solid with non-shrink grout. The Contractor shall furnish and use suitable slings, hooks, and cables for the proper handling of the sections.

3.02 APPLICATION OF DAMPPROOFING
   A. Application of dampproofing shall be in accordance with the manufacturer's recommendations.
B. Application shall not be permitted in spaces exposed to inclement weather or when air temperatures are below 40 degrees F, or are expected to go below 40 degrees F within 24 hours after application.

C. Dampproofing can be applied to green or slightly damp surfaces.

D. Apply dampproofing at a rate of 4 to 6 gallons per 100 square feet. If applying 2 coats, each coat shall be 2 to 3 gallons per 100 square feet. First coat must be allowed to dry prior to the application of the second coat. Coating must be continuous and free from breaks and pinholes.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.05 CLEANING

A. Upon completion of all construction, and prior to final acceptance, all debris shall be removed from precast structures.

3.06 TIGHTNESS TESTING OF CONCRETE STRUCTURES

A. General:

1. The Contractor shall individually test each precast wet well for water tightness before backfilling operations, except where backfilling is necessary in order to construct tank:

   a. List Each Tank to be Tested

2. Testing shall be in accordance with ACI 350.1, Section 2- “Hydrostatic tightness test for open or covered containment structures”.

   a. Testing Criteria: Volume loss shall not exceed 0.10 percent net liquid loss per day

B. Testing Sequence and Schedule:

1. Contractor shall submit tank basin testing sequence and testing schedule for Engineer’s review.

2. Prior to submitting testing sequence and testing schedule, Contractor shall request and obtain test documentation forms prepared by Engineer. Forms will be provided to Contractor within 14-calender days of request.

C. Documentation:
1. Contractor shall document test results for each tank test basin using Engineer’s documentation forms.

D. Failed Test:

1. If any basin fails Part 1: Qualitative Criteria or Part 2: Quantitative Criteria per ACI 350.1, the Contractor shall correct the problem and retest at Contractor’s expense.

E. Structure Leak Repairs:

1. Contractor shall repair leaks per the direction of the Engineer. Any costs associated with leak repairs shall be by the Contractor at no additional cost to the Owner.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

B. Submit signed and completed concrete tank tightness testing forms for each precast structure required to be tested.

END OF SECTION
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SECTION 04 20 00

UNIT MASONRY

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide services, material, and equipment necessary to complete the masonry work shown on the Drawings and as required to complete the Work in accordance with this Section and applicable reference standards listed in Article 1.03.

   a. Furnishing and installing concrete masonry units (CMU).
   b. Furnishing and installing masonry joint reinforcement, ties, and anchors.
   c. Furnishing and installing cavity wall insulation, which is specified in Section 07 21 00.
   d. Furnishing and installing bond beam lintels for openings required for Work specified under other sections.
   e. Building into masonry-embedded items such as anchors, anchor bolts, inserts, flashing, steel and concrete lintels, etc. furnished and located by the Contractor.
   f. Building into masonry door and window frames, louvers, vents, conduits, etc., furnished and set by the Contractor.
   g. Furnishing and installing membrane wall flashing, and other specified items.

B. Products Installed But Not Supplied Under This Section

1. Deformed steel reinforcement as specified in Section 03 20 00.
2. Metal door frames as specified in Section 08 11 00.
3. Fiberglass door frames as specified in Section 08 16 15
4. Aluminum windows as specified in Section 08 51 13
C. Related Requirements

1. Section 03 11 00 – Concrete Forming
2. Section 03 20 00 – Concrete Reinforcing
3. Section 07 21 00 – Thermal Insulation
4. Section 07 92 00 – Joint Sealants
5. Section 08 11 00 – Metal Doors and Frames
6. Section 08 16 15 – Fiberglass Doors and Frames
7. Section 08 51 13 – Aluminum Windows

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Concrete Institute International (ACI)
   a. ACI 530.1 Specification for Masonry Structures

2. ASTM International (ASTM)
   a. ASTM A82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
   b. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   c. ASTM A951 Standard Specification for Steel Wire for Masonry Joint Reinforcement
   d. ASTM C90 Loadbearing Concrete Masonry Units
   e. ASTM C140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
   f. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
   g. ASTM C144 Standard Specification for Aggregate for Masonry Mortar
   h. ASTM C150 Standard Specification for Portland Cement
   i. ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes
1. ASTM C270 Standard Specification for Mortar for Unit Masonry
2. ASTM C404 Standard Specification for Aggregates for Masonry Grout
3. ASTM C476 Standard Specification for Grout for Masonry
4. ASTM C494 Standard Specification for Chemical Admixtures for Concrete
5. ASTM C1329 Standard Specification for Mortar Cement
6. ASTM C1384 Standard Specification for Admixtures for Masonry Mortars

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. A letter from the masonry Contractor indicating that they have reviewed the reinforcement Shop Drawings for the masonry Work

C. Product Data

1. Brochures for all items furnished, including, but not limited to
   a. Anchors and fasteners
   b. Grout ingredients
   c. Masonry Units: CMU
   d. Metal accessories
   e. Reinforcement supports/spacers
   f. Mortar ingredients
   g. Joint reinforcement and wall ties

D. Samples

1. Samples for all items furnished. Mortar Sample for each mortar specified.

E. Design Data

1. Mortar mix designs in accordance with the proportion Specification of ASTM C270 for each mortar mix.

2. Grout mix designs in accordance with the proportion Specification of ASTM C476.
F. Material Certificates
   1. Certifications shall be signed, dated, and notarized, and for the Work of this specific Project. New certifications shall be submitted any and all times there is a change in material or material Supplier.
   2. Anchors and Fasteners
   3. Grout Ingredients
   4. Masonry Units: CMU
   5. Metal Accessories including reinforcement supports and spacers
   6. Mortar Ingredients
   7. Joint Reinforcement and Wall Ties

G. Hot Weather and Cold Weather Construction Procedures
   1. The Engineer's review shall not constitute approval, as the Contractor shall be responsible for all Work performed during hot and cold weather.

H. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Prior to commencement of Work, a Sample panel shall be constructed.
   1. Only materials and procedures approved for the Work shall be used.
   2. The Sample panel shall be approved by the Engineer prior to the commencement of the Work. It will be the standard of comparison for masonry work built of the same materials, and shall not be destroyed until the Work is complete and accepted by the Engineer
   3. The Sample panel shall be approximately 8 feet long by 4 feet tall and shall be constructed in the presence of the Engineer or his designated representative. The panel shall include two exterior corners with 2-foot returns. One corner and return shall show the CMU backup. The second corner and return shall show the CMU field, and exterior corner layout
   4. The Sample panel shall be full cavity wall construction, showing proposed bond mortar color, joint ties, insulation, back-up CMU, weeps through wall flashing, cavity drainage material, and workmanship.
1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Cement, lime, and all other cementitious materials shall be delivered to the Site in unbroken packaging that is plainly labeled with brand and manufacturer, and stored in dry, weather tight enclosures. They shall be stored and handled in a manner to prevent contamination by foreign materials, water, and dampness.

C. Masonry units shall be handled with care in order to prevent chipping and other damage. Damaged units shall not be used in exposed Work.

D. Materials stored on newly constructed floors shall be placed such that the load does not exceed 50 pounds per square foot.

E. CMU shall be shipped with each pallet wrapped in polyethylene plastic film. The wrapping shall not be removed until the CMU is to be placed in the wall to prevent moisture absorption.

F. CMU left exposed, or is otherwise allowed to pick up moisture, will be rejected and shall be removed from the Site.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. Gauges

1. Wire gauge standard shall be United States Steel Wire. Sheet gauge standard shall be U.S. Standard.

B. Materials

1. Cement shall be portland cement conforming to ASTM C150, Type I or Type II. Alternatively, for mortar, the cement may be mortar cement as specified.

2. Hydrated Lime shall conform to ASTM C207, Type S, and shall not contain air-entrainment additives.

3. Aggregates for mortar shall conform to ASTM C144.

4. Aggregates for grout shall conform to ASTM C404.

5. Water shall be clean, fresh, and potable.
6. Concrete Masonry Units (CMU)

a. CMU shall be supplied by a single manufacturer that is capable of providing all types, sizes, shapes, and textures described below.

b. CMU shall conform to ASTM C90. CMU shall be lightweight with a concrete density of less than 105 pounds per cubic foot. Surfaces shall be smooth and dense. The minimum CMU net section compressive strength shall be 1900 pounds per square inch (psi) (average of 3 units) and 1700 psi (individual unit) measured in accordance with ASTM C140.

   1) \( f'm = 2000 \text{ psi, where } f'm = \text{specified compressive strength of masonry at age 28 days.} \)

c. Bond beam units, lintel units and all other special shapes shall be furnished as required, and the exposed face shall closely match that of the stretcher units.

d. Stretcher units of 6 inches and greater nominal thickness shall be 2-core units. Stretcher units of 4 inch nominal thickness shall be 3-core units. Open-ended units shall be permitted in order to facilitate positioning units at vertical reinforcement.

e. The minimum fire rating for CMU of 8 inches and greater nominal thickness shall be 2 hours. The minimum fire rating for CMU of 6 inches and less nominal thickness shall be 1 hour.

7. Joint Reinforcement and Wall Ties

a. Masonry joint reinforcement and wall ties shall be factory fabricated from cold-drawn steel wire conforming to ASTM A82, galvanized after fabrication in accordance with ASTM A153.

b. Joint reinforcement shall conform to ASTM A951 and shall be fabricated of W1.7, 9-gauge, 0.148-inch diameter wire in a ladder-type configuration. Smooth cross wires, at a maximum spacing of 16 inches, shall be welded to deformed longitudinal wires. The out-to-out dimension of the longitudinal wires shall be approximately 2 inches less than the nominal thickness of the wythe. Prefabricated corners shall be used. Joint reinforcement shall be supplied in flat sections 10 feet to 20 feet in length.

c. For exterior cavity walls, joint reinforcement shall be fabricated as specified above and contain adjustable 2-piece, W2.8, 3/16 inch diameter, eye-and-pintle ties spaced not more than 24 inches on center. The eye section shall be welded to the joint reinforcement and shall extend 1/4 inch beyond the face of the wall insulation.
8. CMU Anchors
   a. Wire components shall be hot dip galvanized per ASTM A153. Sheet metal components and components fabricated from steel plate shall be hot dip galvanized per ASTM A153 Class B.
   b. Anchors where CMU bearing or shear walls (i.e. structural walls) intersect each other shall be strap anchors, 1/4 inch by 1-1/2 inch by 24 inches, including a 2-inch long 90-degree bend at each end to form a Z-shape. They shall be #344 Rigid Partition Anchor as manufactured by Hohmann & Barnard, Inc.
   c. Anchors where CMU partition walls (i.e. nonstructural walls) intersect each other shall be prefabricated tee joint reinforcement or 16-gauge by 1/2 inch mesh galvanized hardware cloth. Provide hardware cloth 6 inches wide for walls of 8 inch or greater nominal thickness, and 2 layers of hardware cloth, 3 inches wide for walls less than 8-inch nominal thickness. (Isolation joints shall be provided where CMU partition walls intersect structural CMU walls.)
   d. Anchors at steel members shall be Model #359FH weld-on ties with #VBT Vee Byna-Ties by Hohmann & Barnard, Inc., or equal.
   e. Anchors at heads of CMU partitions shall be PTA 422, all as manufactured by Hohmann & Barnard, Inc., or equal.
   f. Dovetail slots to anchor CMU to concrete shall be 18-gage, furnished in 10-ft lengths equal to #305 dovetail slots manufactured by Hohmann & Barnard, Inc., or equal.
      1) CMU Dovetail Anchors: For anchoring ends of CMU walls to concrete shall be 1” wide x 12-gage x 8” long #303 SV seismic-notch anchor with 3/16” dia x 9” long VBT-Vee Byna-Tie each manufactured by Hohmann & Barnard, Inc., or equal.
      2) Dovetail slots and dovetail anchors shall be manufactured by same manufacturer and shall be compatible.

9. Wire mesh. For use under all knockout block bond beams, and for bonding where noted, shall be 16-gauge, 1/2 inch mesh galvanized hardware cloth.

10. Membrane wall flashing shall be a full 5-ounce copper sheet permanently bonded between 2 layers of textured, woven, high tensile strength glass fiber fabric with a ductile asphalt compound.

11. Compressible filler shall be PolySeal compressible polyurethane foam saturated with polybutylene as made by Sandell Manufacturing Co., or equal. In general, material shall be twice as wide as joint to be filled. Depth to be equal to width if not noted.


14. CMU Lintels
a. CMU lintels shall be provided where shown on the Drawings and above all openings required by other trades.
b. They shall be formed of U-shaped channel bond beam units with solid bottoms.
c. Unless indicated otherwise, they shall be reinforced with a minimum of 2, #5 bars, and filled solid with grout. Reinforcement shall extend a minimum of 40 times the diameter of the bar past the face of openings, except it shall terminate 2 inches from control joints.
d. Exposed Work shall be of the same material and texture as the adjoining masonry.
e.Lintels may be built on the ground or assembled in place. Lintels built on the ground shall be allowed to set at least 6 days before being moved and shall have at least 8 inches of bearing at each end when placed, with the reinforcement extended as noted above.

15. CMU Bond Beams
a. CMU bond beams shall be provided where shown on the Drawings.
b. They shall be constructed of knockout web (not low web) bond beam units with open bottoms.
c. Unless indicated otherwise, they shall be reinforced with a minimum of 2, #5 bars, and filled solid with grout. Wire mesh shall be placed in the bed joint to contain the grout.
d. Exposed Work shall be of the same material and texture as the adjoining masonry.

16. Mortar
a. Aggregate shall be measured in a damp, loose condition.
b. Except as noted below, mortar for concrete masonry shall conform to ASTM C270, Type S, consisting of the following proportions by volume.
   1) 1 part Type S mortar cement, 2-1/4 to 3 parts aggregate, or
2) 1/2 part portland cement, 1 part Type N mortar cement, 2-1/4 to 3 times the sum of the cement volumes, parts aggregate, or

3) 1 part portland cement, 1/4 to 1/2 part hydrated lime, 2-1/4 to 3 times the sum of the cement and lime volumes, parts aggregate

c. Integral Type Waterproofing: Use in all exterior mortar and shall be metallic stearate type, Hydrocide Powder by Sonneborn Contech; Omicron Mortar Proofing by Master Buildings Inc.; Integral Waterpeller or equal.

17. Grout

a. Conform to ASTM C476 for fine grout, and meet either the specified compressive strength or proportion requirements.

b. If by proportion (by volume)

1 part portland cement, 0 to 1/10 part hydrated lime, 2-1/4 to 3 times the sum of the cement and lime volumes parts fine aggregate (with aggregate measured in a damp, loose condition).

18. Weeps and Cavity Vents

a. Full head joint weeps and cavity vents shall be formed using Hohmann & Barnard QV Quadro Vent, Advanced Building Products Mortar Maze Cell vents, or equal.

19. Cavity Drainage Material

a. Cavity drainage material shall be 2-inch thick free drainage mesh; made from polyethylene strands and shaped to avoid being clogged by mortar droppings. Mortar net as manufactured by Mortar Net USA or equal. Provide at all through wall flashings.

20. Metal Flashing (Drip Edge)

a. Metal flashing shall be 26-gauge stainless steel Type 304 as manufactured by Keystone Flashing Co., Cheney Flashing Co., Hohmann & Barnard, or equal.

b. Two-piece cap flashing shall be 16 ounce copper with 4 inch flat return in-wall and 5 inch cap flashing insert as manufactured by Keystone Flashing Co., Cheney Flashing Co., Ryerson, or equal.
21. **Self-Adhered Wall Flashing**
   
a. Self-adhered wall flashing shall be a 40-mil membrane comprising a polyethylene or polyvinyl chloride (PVC) membrane integrally bonded to a rubberized asphalt adhesive.

b. Provide primer and rubberized asphalt mastic for sealing edges


### 2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

### PART 3 – EXECUTION

#### 3.01 TECHNICAL REQUIREMENTS

A. Masonry materials and construction shall conform to ACI 530.1 except as modified by the Contract Documents.

#### 3.02 INSTALLATION

A. Inspection

1. Examine all areas scheduled for Work to determine whether existing masonry or other conditions will adversely affect execution of the Work including meeting specified tolerances. Report any such conditions to the Engineer.

B. Workmanship

1. Masonry shall be constructed level, square, plumb and true within the following tolerances.

   a. Dimensions

      1) Cross section and elevation: minus 1/4 inch, plus 1/2 inch

      2) Mortar joint thickness (except glass block)

         a) Bed joints: minus 1/8 inch, plus 1/8 inch

         b) Head and collar joints: minus 1/4 inch, plus 3/8 inch
3) Mortar joint thickness for glass block
   a) Bed joints: minus 1/16 inch, plus 1/8 inch
   b) Head joints: minus 1/8 inch, plus 1/8 inch

4) Grout space and cavity width, except for walls passing framed construction: minus 1/4 inch, plus 3/8 inch

b. Elements
1) Variation from level
   a) Bed joints within 10 feet: minus 1/4 inch, plus 1/4 inch
   b) Bed joints maximum: minus 1/2 inch, plus 1/2 inch
   c) Top surface of bearing walls, in 10 feet: minus 1/4 inch, plus 1/4 inch
   d) Top surface of bearing walls, maximum: minus 1/2 inch, plus 1/2 inch

2) Variation from plumb
   a) In 10 feet: minus 1/4 inch, plus 1/4 inch
   b) In 20 feet: minus 3/8 inch, plus 3/8 inch
   c) Maximum: minus 1/2 inch, plus 1/2 inch

3) True to a line
   a) In 10 feet: minus 1/4 inch, plus 1/4 inch
   b) In 20 feet: minus 3/8 inch, plus 3/8 inch
   c) Maximum: minus 1/2 inch, plus 1/2 inch

4) Alignment of columns and walls (bottom versus top)
   a) Bearing walls: minus 1/2 inch, plus 1/2 inch
   b) Nonbearing walls: minus 3/4 inch, plus 3/4 inch
c. Location of elements
   1) Indicated in plan
      a) In 20 feet: minus 1/2 inch, plus 1/2 inch
      b) Maximum: minus 3/4 inch, plus 3/4 inch
   2) Indicated in elevation
      a) In story height: minus 1/4 inch, plus 1/4 inch
      b) Maximum: minus 3/4 inch, plus 3/4 inch

2. The tolerance for the placement of reinforcement in walls and other flexural members when the distance from the centerline of reinforcement to the opposite face of masonry "d" is not more than 8 inches shall be plus or minus 1/2 inch. For "d" greater than 8 inches but not more than 24 inches, the tolerance shall be plus or minus 1 inch. For "d" greater than 24 inches, the tolerance shall be plus or minus 1-1/4 inches. Tolerances shall be considered in conjunction with the cover requirements specified.

3. Elevations shall be checked by instrument as often as necessary to maintain the tolerances specified.

4. Anchors, ties, wall plugs, accessories and other items to be built into the Work shall be installed as the masonry work progresses. Cutting and fitting of masonry, including that required to accommodate the Work of others, shall be done with masonry saws or other approved methods which provide cuts that are straight and true.

5. Mortar shall be used within 2 hours of initial mixing. Pigmented mortar shall not be re-tempered. No mortar shall be used after it has begun to set.

6. Grout shall be placed within 1-1/2 hours of introduction of water into the mix, and before initial set. Grout shall not be re-tempered by the addition of water.

7. During erection, walls shall be kept dry by covering the top with a strong, waterproof membrane at the end of each day or shutdown. Partially completed walls shall be covered at all times when Work is not in progress. Cover shall extend a minimum of 2 feet down both sides and shall be securely held in place.

8. Unfinished Work shall be stepped back for joining with new Work.
9. Hollow concrete masonry units shall be protected against wetting prior to use and shall be dry when laid. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Any unit disturbed after mortar has stiffened shall be removed and re-laid with fresh mortar. Vertical cells to be filled with grout shall be aligned to provide a continuous unobstructed opening.

C. CMU Construction

1. Interior, single wythe exterior and backup CMU shall be laid in full running bond. Mortar joints at CMU shall be 3/8 inch thick. Units shall be laid with full mortar coverage on horizontal and vertical face shells. Webs shall also be bedded in all courses where adjacent to cells or cavities filled with grout and shall be bedded in the starting course on solid foundation walls or floors. Remove mortar protruding more than 1/2 inch into cells or cavities to be filled with grout. Corners shall interlock: alternating courses shall overlap in running bond. Intersecting walls shall not interlock.

2. Joint reinforcement shall be placed so that the longitudinal wires are located over face-shell mortar beds and are fully embedded in the mortar for their entire length. Joint reinforcement shall have a minimum clear cover of 5/8 inch when exposed to earth or weather and 1/2 inch otherwise. Reinforcement shall be lapped a minimum of 6 inches. Reinforcement shall be placed in the second and in each alternate course. At openings, reinforcement shall be provided in the first course above and below the opening, extending at least 2 feet beyond the opening on each side. Joint reinforcement shall be interrupted at all control and isolation joints.

3. Intersecting bearing or shear walls shall be joined by strap anchors, 1/4 inch by 1-1/2 inch by 24 inches, including a 2-inch long, 90 degree bend at each end to form a Z-shape. The strap anchors shall be spaced at 4 feet maximum.

4. Intersections where partition walls intersect interior nonbearing shear walls or partition walls, shall be joined at vertical intervals of not more than 16 inches by prefabricated tee joint reinforcement or by 16-gauge by 1/2 inch mesh galvanized hardware cloth.

5. Steel bar reinforcement shall be completely embedded in grout. Place reinforcement in grout spaces prior to grouting. Pushing reinforcement into grout shall be strictly prohibited. Fasten reinforcement together and provide hot-dip galvanized bar supports and spacers to prevent reinforcement displacement beyond the permitted tolerances. Where units are placed where vertical reinforcement projects, the block shall be either positioned into place over the top of the vertical bar, or open-ended units shall be provided. The clear distance between parallel bars shall not be less than the nominal diameter of the bar, nor less than 1 inch. In columns and pilasters, the clear distance between vertical bars shall not be less than 1 and 1/2 times...
the nominal bar diameter, nor less than 1-1/2 inches. Steel reinforcement shall be positioned as follows.

a. The thickness of grout between the reinforcement and the masonry units shall not be less than 1/4 inch

b. Where masonry wythe contains a single row of reinforcement, it shall be positioned at the center of the units, equidistant from each masonry face

c. Where masonry wythe contains 2 rows of reinforcement, each masonry face shall be reinforced. The clear cover shall be 2 inches at each face, with zero negative tolerance.

d. Splice lengths for bar reinforcement shall conform to the following
   1) #4: 2 feet – 0 inches
   2) #5: 2 feet – 6 inches
   3) #6: 3 feet – 6 inches
   4) #7: 5 feet – 0 inches

6. Grout

a. At the time of placement, the grout shall have a slump between 8 inches and 11 inches as determined by ASTM C143.

b. Grout lifts shall not exceed 5 feet. Grout pours shall meet the height limitations of ACI 530.1. The level of grout for each grout pour shall be stopped 1-1/2 inches from the top of the masonry.

c. Grout shall be consolidated in place between grout lifts by vibration or other approved methods to ensure complete filling of cells.

d. For grout pours exceeding 5 feet, clean-outs are required at the base of each grout pour.

D. Weep Vents

1. Weep vents at the bottom of all cavity walls shall be spaced at 32 inches on center immediately above flashing. Weep vents over all openings shall be similar, except spaced at 16 inches on center.
E. Insulation

1. All exterior walls shall be insulated. The backup CMU shall be erected first, and the wire reinforcement installed as the Work progresses. Joints of the backup CMU wall shall be struck off smooth and level. The insulation shall be placed between wall ties, with long ends horizontal and ends and edges butted. Insulation shall be adhered to the wall with mastic adhesive that is recommended by the insulation manufacturer.

F. Cutting and Fitting

1. Wherever possible, full units shall be used in lieu of cut units. Where cut units are required to accommodate the design, cutting shall be done by masonry mechanics using power masonry saws, except that cutting of units in unexposed Work may be accomplished with masonry hammers and chisels. Wet-cut units shall be dried to the same surface-dry appearance as uncut units before being placed in the Work. Cut edges shall be clean, true, and sharp. Openings to accommodate pipes, conduits, and other accessories shall be neatly formed so that framing or escutcheons required will completely conceal the cut edges. Insofar as practicable, all cutting and fitting shall be accomplished while masonry work is being erected.

G. Penetrations

1. Conduits, pipes, and sleeves in masonry shall be no closer than 3 diameters on center.

H. Flashing

1. Where flashing is to be laid on or against masonry, the surface of the masonry shall be smooth and free from projections. Flashing shall be continuous and installed in accordance with the details shown on Drawings and manufacturer's recommendations. Flashing shall be installed with 1/2 beds of mortar above and below the flashing. Joints shall be lapped 4 inches, and the contact surface coated with fibrated asphalt mastic made for use with the flashing. Membrane flashing at masonry openings shall be extended a minimum of 8 inches beyond the opening. The flashing ends shall be turned up to form a pan.

2. Self-adhered wall flashing is to be applied only when surface temperatures are above 25 degrees F. Substrate must be smooth, clean, dry, and sound, without any sharp protrusions. Apply primer to substrate where recommended by flashing manufacturer. Seal all top termination edges with a bead of flashing mastic.
I. Tooling

1. Mortar joints, which have become thumbprint hard, shall be tooled with a round jointer. The jointer shall be slightly larger than the width of the mortar joint so that complete contact is made along the edges of the units, compressing and sealing the surface of the joint. Joints in unexposed surfaces shall be cut flush.

J. Caulking Recesses

1. Outside joints around the perimeter of exterior door, louver and window frames shall be cleaned out, ready for placement of caulking specified elsewhere.

K. Pointing and Cleaning

1. At the completion of the Work, holes in joints of masonry surfaces to be exposed, except weep holes, shall be filled with mortar and suitably tooled. Masonry walls shall be dry brushed at the end of each day's Work, and after final pointing and shall be left clean and free from mortar spots and droppings. Defective joints shall be repointed.

L. Repointing

1. Joint Preparation

   a. Tools: Use of power chisels, or any other power tool, which might damage masonry, is not permitted. Provide chisels sized for narrow mortar joints.

   b. Removal of old mortar: Hand tools shall be sized for joints of less dimension than actual. Contractor shall exercise all necessary diligence to avoid abrading joint faces at the outer edge of the arris, and to not chip edges or otherwise widen joints at the arris. Use only chisels of constant rectangular shape for cutting. Cold chisels or other tapered end cutting tools will not be permitted.

      1) Remove old mortar to a depth of 1-1/2 times the thickness of the joint, or 3/4 inch, whichever is greater.

      2) Remove mortar from both surfaces of the adjacent masonry and square out at the back of the joint.

      3) Remove all loose mortar, even if it is deeper than the depths indicated, to reach sound, existing mortar.
c. Thoroughly rinse raked joints with water to remove fine particles. Do not use compressed air. Clean and rinse joints sufficiently before filling the joints and allow evaporation of any freestanding water in the joints.

2. Pre-hydrated Mortar Preparation

a. Mix sand, cement and hydrated lime thoroughly for at least 3 minutes before adding any water, and until the even color of the mixed materials indicates that they have been thoroughly distributed throughout the mass.

b. After mixing dry ingredients, then mix again adding only enough water to produce a damp workable mix, which will retain its form when pressed into a ball. After 1 to 2 hours, add sufficient water to bring it to the proper consistency that is somewhat drier than conventional masonry mortars.

c. Clean mixing equipment thoroughly after each use to prevent hardened or partially hardened lumps of mortar from contaminating a new batch.

d. No additional substances shall be added to the mortar without the written permission of the Engineer.

e. Use mortar within 20 minutes of mixing. Do not add water (re-temper) in the attempt to make the mortar workable.

3. Joint Moistening

a. If the joints have dried since being rinsed, moisten again with a fine water spray. Allow no freestanding water to be present.

4. Joint Filling

a. Apply mortar from mortarboard to joint with pointing tool sufficiently narrow to enter the joint, and to achieve good compaction.

b. Apply mortar in layers not exceeding 3/8 inch in depth. Apply first layers to deepest voids only, to enable applying each subsequent layer to a uniform depth.

c. Apply each layer fully compacted into the joint and allow to become thumbprint hard prior to the application of the next layer.

5. Joint Finishing

a. Tool final layer of mortar to match existing joints after it has become thumbprint hard, to slightly exceed depth of recess of adjacent sound joints. Mortar joints shall be tooled so that the arris stands free of the joint face. No feathering of mortar edges will be permitted. Rod and caulk cracks where required with sealant.
b. Expose aggregate of mortar joints to match adjacent sound joints by applying water with a stiff bristle brush just after mortar has set, but before it has dried.

c. Remove excess mortar from masonry just after it has set, but before it has dried to prevent smearing. As needed, use natural bristle brush or wood paddle with water. Use of muriatic acid or any acid based masonry cleaners is prohibited.

M. Final Cleanup

1. At the conclusion of masonry work, remove all scaffolding and equipment used in the Work, clean up all debris, refuse, and surplus material, and remove from the premises. Remove Sample panel from premises after acceptance of the Work by the Engineer.

3.03 ENVIRONMENTAL CONDITIONS

A. Masonry work shall not be performed when climatic conditions or the limitations of the facilities furnished by the Contractor prevent setting and curing of mortar joints or obtaining proper bond.

B. Hot weather: When the ambient temperature exceeds 100 degrees F, or exceeds 90 degrees F with wind velocity exceeding 8 mph, the hot weather procedures of ACI 530.1 shall be implemented.

C. Cold weather: When the ambient temperature is below 40 degrees F, the cold weather procedures of ACI 530.1 shall be implemented. Admixtures shall meet ASTM C1384 or ASTM C494, Type C, and shall not be used without the Engineer's written approval. Type III cement may be substituted for Type I and Type II cement in masonry grout.

D. Masonry not constructed in accordance with the protective measures listed above will be considered defective and rejected.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 04 43 13
STONE MASONRY VENEER

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Natural thin stone veneer for exterior vertical surfaces.

B. Related Requirements

1. Section 03 11 00 – Concrete Forming
2. Section 03 20 00 – Concrete Reinforcing
3. Section 07 21 00 – Thermal Insulation
4. Section 07 92 00 – Joint Sealants

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Concrete Institute International (ACI)
   a. ACI 530.1 Specification for Masonry Structures
2. American National Standards Institute (ANSI)
   a. ANSI A118.4 – Specifications for Latex-Portland Cement Mortar
3. ASTM International (ASTM)
   a. ASTM C144 Standard Specification for Aggregate for Masonry Mortar
   b. ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes
   c. ASTM C270 Standard Specification for Mortar for Unit Masonry
   d. ASTM C503 Standard Specification for Marble Dimension Stone
e. ASTM C568 Standard Specification for Limestone Dimension Stone
f. ASTM C615 Standard Specification for Granite Dimension Stone
g. ASTM C616 Standard Specification for Quartz Based Dimension Stone
h. ASTM C629 Standard Specification for Slate Dimension Stone
i. ASTM C847 Standard Specification for Metal Lath

4. Portland Cement Association

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. A letter from the masonry Contractor indicating that they have reviewed the reinforcement Shop Drawings for the masonry Work

C. Product Data: Submit manufacturer's product data on stone, mortar products, and sealant products, including:
   1. Surface preparation and installation instructions.
   2. Storage and handling instructions.

D. Shop Drawings:
   1. Submit manufacturer’s shop drawings, including plans, elevations, sections, and details, indicating layout, dimensions, anchorages, and jointing methods.

E. Samples:
   1. Submit mortar color samples.
   2. Submit 2 manufacturer’s full-size samples of natural thin veneer stone for each pattern specified.

F. Warranty: Submit manufacturer’s standard warranty for natural thin veneer stone.
G. Design Data

1. Mortar mix designs in accordance with the proportion Specification of ASTM C270 for each mortar mix.

2. Grout mix designs in accordance with the proportion Specification of ASTM C476.

H. Material Certificates

1. Certifications shall be signed, dated, and notarized, and for the Work of this specific Project. New certifications shall be submitted any and all times there is a change in material or material Supplier.

2. Anchors and Fasteners

3. Grout Ingredients

4. Masonry Units: CMU

5. Metal Accessories including reinforcement supports and spacers

6. Mortar Ingredients

7. Joint Reinforcement and Wall Ties

I. Hot Weather and Cold Weather Construction Procedures

1. The Engineer's review shall not constitute approval, as the Contractor shall be responsible for all Work performed during hot and cold weather.

J. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Prior to commencement of Work, a Sample panel shall be constructed.

1. Only materials and procedures approved for the Work shall be used.

2. The Sample panel shall be approved by the Engineer prior to the commencement of the Work. It will be the standard of comparison for stone masonry veneer Work built of the same materials, and shall not be destroyed until the Work is complete and accepted by the Engineer.
3. The Sample panel shall be approximately 4 feet long by 4 feet tall and shall be constructed in the presence of the Engineer or his designated representative. The panel shall include two exterior corners with 2-foot returns.

4. Do not proceed with remaining Work until workmanship, color, and sheen are approved by the Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

C. Storage:
   1. Store materials in accordance with manufacturer’s instructions.
   2. Store materials in manufacturer’s unopened packaging until ready for installation.
   3. Store stone materials on pallets on dry, level surface and cover with tarps. Do not stack pallets.
   4. Store mortar under cover to prevent contamination by foreign materials, water, and dampness where air temperature is maintained between 40 degrees F and 110 degrees F.

D. Materials shall be handled with care in order to prevent chipping and other damage. Damaged units shall not be used in exposed Work.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 NATURAL THIN STONE VENEER

A. Manufacturers
   2. Stoneyard
   3. Glen Gery
   4. Or equal
B. Pattern: Ledgestone

C. Colors: Colors shall be selected by the Engineer. Submit the manufacturer’s full range of colors for selection by the Engineer.

D. Dimensions:
   1. Height: 1 inch to 4 inches
   2. Length: 3 inches to 8 inches
   3. Nominal thickness: 3/4 inch to 1-1/2 inches

E. Sill
   1. Minimum 2-1/4 inch thickness
   2. Sill shall be a single segment with mitered corners around column

2.02 ACCESSORIES

A. Expanded Metal Lath: ASTM C847; galvanized, self-furring

B. Lath Anchorage: Tie wire, nails, screws, and other metal supports; galvanized; type to suit application and to rigidly secure materials in place

C. Concrete Bonding Agent: Latex type.

D. Joint Sealants and Joint Fillers: As specified in Section 07 92 00.

2.03 MORTAR

A. Mortar:
   1. Cement: ASTM C270
   2. Lime: ASTM C207
   3. Sand: ASTM C144, natural or manufactured
   4. Color Pigments: ASTM C979, mineral oxide
   5. Water: Potable
   6. Pre-Packaged Latex-Portland Cement Mortar: ANSI A118.4

B. Bonding Agent: Acrylic additive

C. Sealer: Water-based silane or siloxane masonry sealer, clear
D. Mortar Mix:

1. Jointless Dry-Stack Installation:
   a. Mix mortar in accordance with ANSI A118.4
   b. Add color pigments in accordance with pigment manufacturer’s instructions.

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine all areas scheduled for Work to determine whether existing conditions will adversely affect execution of the Work including meeting specified tolerances. Report any such conditions to the Engineer.

B. Do not begin surface preparation or installation until unacceptable conditions are corrected.

C. Do not begin installation until backing structure is plumb, bearing surfaces are level, and substrates are clean and properly prepared.

D. Verify location and secure installation if shelf angles are required.

3.02 SURFACE PREPARATION

A. Prepare surfaces in accordance with manufacturer’s instructions.

B. Clean surfaces thoroughly before installation.

C. Prepare surfaces using methods for achieving best results for substrate under project conditions.

D. Prepare for Installation Over Formed Concrete Surface:

1. Metal Lath:
   a. Install metal lath in accordance with ASTM C1063.
   b. Apply metal lath with long dimension perpendicular to supports and with joints lapped a minimum of 1 inch.
   c. Secure laps with tie wire where they occur between supports.
2. Fastening Metal Lath:
   a. Attach lath to concrete using galvanized concrete nails at maximum 6 inches on center vertically and 16 inches on center horizontally.
   b. Stop lath 1 inch from finished edges.
3. Foundation weep screed:
   a. Install foundation weep screed 1 inch above finished grade.

E. Application of Base Coat Stucco:
1. Apply scratch coat in accordance with PCA Plaster/Stucco Manual.
2. Apply scratch coat to nominal thickness of 1/2 inch to 3/4 inch over metal lath surfaces.
3. If weather is hot or surface is dry, dampen previous coat before applying mortar and thin stone veneer.
4. If scratch coat is done in advance, use notch trowel to create texture for better bond. Smooth surface is not acceptable for bond.

F. Prepare for Installation of Thin Veneer Stone:
1. Coordination: Coordinate placement of reinforcement, anchors, accessories, flashings, weep holes, and other moisture-control products specified in other sections.
2. Cleaning: Clean built-in items of loose rust, ice, mud, and other foreign matter before incorporating into wall.
3. Prime or galvanize ferrous metal built into wall.
4. Temporary Bracing:
   a. Provide temporary bracing as required during installation of masonry.
   b. Maintain bracing in place until building structure provides permanent support.

3.03 DRY-STACK INSTALLATION

A. Install thin veneer stone and mortar in accordance with manufacturer’s instructions and ACI 530.1/ASCE 6/TMS 602.

B. Maintain masonry courses to uniform dimensions. Form vertical and horizontal joints of uniform thickness.
C. Pattern Bond

1. Lay out Work in advance and distribute color range of stone uniformly over total Work area.
2. Lay stone with face exposed.
3. Take care to avoid a concentration of any 1 color to any 1 wall surface.
4. Maintain squared and uniform profile.
5. Do not use stacked vertical joints.

D. Placing and Bonding

1. Dampen substrate as required to reduce excessive suction.
2. Use thin-set mortar in accordance with ANSI A118.4 for exterior dry stack installation.
3. Apply mortar to thickness of 1/4 inch to back of stone.
4. Press firmly to seat each stone as placed.
5. Work from bottom up, laying corner pieces first.
6. Remove excess mortar as Work progresses.
7. Do not shift or tap veneer stone after mortar has achieved initial set. Where adjustment is required, remove mortar and replace.
8. Isolate top of veneer stone from horizontal structural framing members and slabs or decks with compressible joint filler and sealant as specified in Section 07 92 00.

E. Joints:

1. Lay stone with reasonably uniform joints, as stone allows.
2. Remove excess mortar as stone is pressed into position.
3. Use non-corrosive stone shims as required to maintain joint thickness.

F. Control and Expansion Joints:

1. Keep joints open and free of debris.
2. Coordinate control joints as specified in Section 07 92 00 for sealant performance.
G. Sealant Recesses:
   1. Provide open joints 3/4 inch deep and 1/4 inch wide, where masonry meets doors, windows, and other exterior openings.
   2. Coordinate sealant joints as specified in Section 07 92 00 for sealant performance.

H. Cutting and Fitting:
   1. Cut and fit thin veneer stone for chases, pipes, conduits, sleeves, grounds, and other penetrations and adjacent materials.
   2. Coordinate with other Work to provide correct size, shape, and location.

I. During progress of the Work, cover top of unfinished stone masonry for protection from weather.

3.04 CLEANING

   A. Keep face of stone free of mortar as Work progresses.
   B. If residual mortar is on face of stone, allow to dry partially and brush mortar off surface and sponge off residue.
   C. When Work is completed and mortar has set for 2 to 3 days, clean surface from top to bottom using mild masonry detergent acceptable to natural thin veneer stone manufacturer.
   D. Do not use harsh cleaning chemicals or methods that could damage stone.
   E. Do not use metal brushes or acids for cleaning.

3.05 PROTECTION

   A. Protect installed natural thin veneer stone to ensure that, except for normal weathering, stone will be without damage or deterioration at time of Substantial Completion.
   B. Touch-up, repair, or replace damaged stone before Substantial Completion.

3.06 ENVIRONMENTAL CONDITIONS

   A. Masonry Work shall not be performed when climatic conditions or the limitations of the facilities furnished by the Contractor prevent setting and curing of mortar joints or obtaining proper bond.
B. Hot weather: When the ambient temperature exceeds 100 degrees F or exceeds 90 degrees F with wind velocity exceeding 8 mph, the hot weather procedures of ACI 530.1 shall be implemented.

C. Cold weather: When the ambient temperature is below 40 degrees F, the cold weather procedures of ACI 530.1 shall be implemented. Admixtures shall meet ASTM C1384 or ASTM C494, Type C, and shall not be used without the Engineer's written approval. Type III cement may be substituted for Type I and Type II cement in masonry grout.

D. Masonry not constructed in accordance with the protective measures listed above will be considered defective and rejected.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.08 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 05 50 00
METAL FABRICATIONS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide the following metal fabrications in accordance with this Section and applicable reference standards listed in Article 1.03.

   a. Railings and components including mounting brackets
   b. Grating and grating supports not attached to structural steel
   c. Frames for miscellaneous openings
   d. Hatches
   e. Miscellaneous steel items
   f. Anchor bolts
   g. Expansion Bolts
   h. Adhesive Anchors
   i. Stairs
   j. Manhole-type rungs
   k. Steel bollards
   l. Embedded metal items not receiving structural steel
   m. Equipment supports not attached to structural steel

2. Epoxy adhesive for installing drilled and epoxy rebar is specified in Section 03 16 00.

B. Related Requirements

1. Section 03 11 00 – Concrete Forming
2. Section 03 16 00 – Concrete Specialties
3. Section 04 20 00 – Unit Masonry
4. Section 09 90 00 – Painting and Coating
1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Concrete Institute (ACI)
   a. ACI 355.2 Qualification of Post-Installed Mechanical Anchors in Concrete
   b. ACI 355.4 Qualification of Post-Installed Adhesive Anchors in Concrete Elements

2. American Institute of Steel Construction (AISC)
   a. AISC 303 Code of Standard Practice for Steel Buildings and Bridges

3. American National Standards Institute (ANSI)
   a. A14.3 American National Standard for Ladders-Fixed-Safety Requirements

4. American Welding Society (AWS)
   a. AWS D1.1 Structural Welding Code - Steel
   b. AWS D1.2 Structural Welding Code - Aluminum
   c. AWS D1.6 Structural Welding Code - Stainless Steel

5. ASTM International (ASTM)
   a. ASTM A6 Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
   b. ASTM A36 Standard Specification for Carbon Structural Steel
   c. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   d. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   e. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
f. ASTM A239 Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles

g. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

h. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts

i. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

j. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

k. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

l. ASTM A992 Standard Specification for Structural Steel Shapes

m. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

n. ASTM B211 Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire


p. ASTM D6386 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

q. ASTM F436 Hardened Steel Washers

r. ASTM F959 Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

s. ASTM F1136 Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners

t. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
u. ASTM F1852 Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

v. ASTM F2329 Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

w. ASTM F2833 Standard Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type

x. ASTM F3125 Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch and Metric Dimensions

6. ICC Evaluation Services (ICC-ES)
   b. ICC-ES AC308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

7. National Association of Architectural Metal Manufacturers (NAAMM)
   a. AMP 500 Metal Finishes Manual
   b. MBG 531 Metal Bar Grating Manual
   c. MBG 533 Welding Specification for Fabrication of Steel, Aluminum, & Stainless Steel Bar Grating

8. Research Council on Structural Connections (RCSC)
   a. Specification for Structural Joints Using High-Strength Bolts

1.04 ADMINISTRATIVE REQUIREMENTS

   A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

   A. Submit in accordance with Division 01 General Requirements.
B. Shop Drawings
   1. Details of connections, copes, splices, holes, hardware, finish, and other pertinent information
   2. Anchor bolt embedment Drawings
   3. Indicate welds by standard AWS symbol

C. Product Data
   1. Expansion Bolts
      a. ICC-ES Compliance Report
      b. Allowable and ultimate load tables per embedment depths
      c. Capacity reduction factors for bolt spacing and edge distances
      d. Installation Instructions including bolt torque
   2. Adhesive Anchors
      a. ICC-ES Compliance Report
      b. Allowable and ultimate load tables per embedment depths
      c. Storage requirements
      d. Gel and cure times as a function of temperature
      e. Installation temperature requirements
      f. Drilling method (diamond drill bit shall be prohibited)
      g. Drill bit diameter and depth of hole for each size anchor
      h. Hole cleaning procedure and required condition of hole
      i. Dual-nozzle instructions to ensure proper mixing
      j. Hole Filling procedure
      k. Time period anchor cannot be contacted or disturbed

D. Samples and Mockups: as specified in Article 1.06.

E. Manufacturer Instructions

F. Source and Field Quality Control Submittals
G. Certificates
   1. Mill test reports for structural shapes, bolts, nuts, and washers
   2. Welding certifications for welding procedures and personnel

H. Closeout and maintenance material submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE
A. Provide in accordance with Division 01 General Requirements.
B. Samples
   1. Railings indicating weld, splicing, and finish

1.07 DELIVERY, STORAGE, AND HANDLING
A. Provide in accordance with Division 01 General Requirements.
B. Assemble and ship ASTM F1852 and galvanized ASTM F3125 bolt assemblies in the same container. Do not re-lubricate ASTM F1852 tension-control bolt assemblies.

C. Carefully unload material and equipment and stack to prevent deformation and damage. Store items on substantial pallets, dunnage, or other supports and spacers, free from the earth and properly drained, preventing splattering with dirt and other foreign matter.

D. Store material and equipment to permit easy access for inspection and identification. Protect from deterioration and maintain markings.

E. Provide protective storage for fastener components. Protect fastener components removed from protective storage from dirt and moisture in closed containers at the location of installation. Do not clean or modify fastener components from as-delivered condition. Do not use fastener components accumulating rust or dirt and remove from the Site.

1.08 SITE CONDITIONS
A. Existing Conditions: per Division 01 General Requirements.
PART 2 – PRODUCTS

2.01 GENERAL

A. Make field measurements prior to fabrication to ensure proper fit. Report discrepancies in existing conditions that require detail changes to Engineer prior to fabrication.

B. Assemble built-up Work in sections in the shop as much as practicable and match mark components for field assembly.

C. Bolt holes (including those for attaching wood blocking and other components): by fabricator and not made or modified by burning.

D. Gauges

1. For iron sheets and steel: U.S. Standard
2. For non-ferrous products: Brown & Sharpe
3. For wire: United States Steel Wire

E. Weld carbon steel per ANSI/AWS D1.1, with electrodes with a tensile strength of 70 ksi.

F. Fusion weld aluminum by the inert gas-shielded arc method per ANSI/AWS D1.2. Use alloy rods similar to alloy being welded where appearance match is required. Alloy 4043 rods may be used where appearance is not a factor and anodizing is not required.

G. Weld stainless steel per AWS D1.6

H. Steel

1. Comply with AISC 303
2. Steel mill material tolerances: per ASTM A6
3. Steel W-shapes: ASTM A992 (50 ksi yield strength)
4. Steel channels and angles: ASTM A992 (50 ksi yield strength) ASTM A572 grade 50, or ASTM A36
5. Other steel shapes, plates and bars: ASTM A36
6. Steel pipe: ASTM A53, Grade B
7. Hollow structural shapes: ASTM A500, Grade B.
I. Bolts: ASTM F3125 Grade A325 Type I, heavy-hex, hot-dipped galvanized per ASTM F2329 at exterior applications and/or where indicated on Drawings

J. Nuts: ASTM A563, heavy-hex

K. Washers: ASTM F436 hardened steel

L. Tension-control bolt assemblies: ASTM F1852 Type I, heavy-hex

M. Direct tension indicators: ASTM F959, Type 325, compressible washer type

N. Threaded rods: ASTM A36

O. Aluminum items: Fabricated from bars, plates, pipes, rolled and extruded shapes conforming to the following alloy designation unless otherwise specified.
   1. Standard structural shapes: Rolled 6061-T6 per ASTM B308
   2. Rolled rod and bar: 6061-T6 per ASTM B211
   3. Sheets, Plates, Checkered Plates: 6061-T6 per ASTM B209
   4. Bolts: 2024-T4
   5. Nuts: 6061-T6
   6. Washers: Alclad 2024-T4

P. Stainless steel items: Type 316 (Type 316L if welded)

2.02 ALUMINUM RAILING

A. Aluminum railing: All-welded construction formed of 1-1/2 inch round aluminum pipe.

B. Furnish railing in the largest practical sections with the locations and details of field connections indicated on Shop Drawings. Close exposed ends of railing members. After fabrication, clean, lightly circumferentially brush, caustic etch and clear anodize (0.4 mil minimum thickness) railings in accordance with NAAMM AMP 500, M31C22A31.

C. Welds: Continuous at intersections and ground smooth on all exposed areas. Use radius corners only, do not use mitered corners. Where intersections occur, shape and cut pieces to fit with no distortion of the circular shape.
D. Posts
   1. Schedule 80, alloy 6061-T6, single un-spliced pipe length
   2. Spacing: Maximum 5-feet on centers measured along the rail

E. Rails
   1. Schedule 40, alloy 6061-T6
   2. Top rails
      a. Continuous wherever possible with single un-spliced length attached to minimum of 3 posts.
      b. At platforms and other level runs: 42 inches from the top of rail to floor, tank wall or other horizontal surface unless otherwise specified.
      c. On stair flights: 42 vertical inches from the top of rail to a line connecting the toes of the treads.
   3. Lower rails
      a. Single, un-spliced length between posts
      b. At level runs and at stairs: Approximately half the height of the top rail

F. Toeboard: Extruded aluminum toeboard 4-inches high, mechanically clamped to posts except where specifically shown to be omitted on Drawings. Do not weld, drill or screw directly to the posts.

G. Provide expansion joints at each railing and toe plate, allowing 1/2 inch of joint movement at each location and space at intervals of maximum 24 feet. Provide internal aluminum slip sleeve fastened securely to one side and extend a minimum of 2 inches beyond each side of the joint. Locate within 6 inches of posts.

H. On stairs: Provide additional (third) rail forming a handrail, bracketed off the vertical posts at height of 34 inches from the upper surface to a line connecting the toes of the treads. Provide 3-inch minimum clearance from posts and obstructions.

I. Completed railing structure and anchorage: Capable of withstanding the loads prescribed by the building code at Project location.

J. Mount railing posts into flanged cast or extruded aluminum sleeve brackets, and secure with stainless steel set screws. Support wall mounted railing with cast brackets and fasten with stainless steel expansion or toggle bolts.

K. Furnish removable railings where indicated on the Drawings, and mounted so that when the railing is removed, it is separated from the mounting bracket.
2.03 ALUMINUM GRATINGS AND FRAMES

A. Manufacturers: IKG Industries, Klemp Corporation, Ohio Gratings, Inc., or equal.
   1. Grating: I-bar swage locked with 1/4 inch flanged bars at 1-3/16 inches on center and cross bars at 4 inches on center per NAAMM AMP 500, NAAMM MBG 531, and NAAMM MBG 533.
   2. Supporting members: Aluminum of the size and shape per Drawings.
   3. Grating: Alloy 6063-T6 bearing bars and alloy 6063-T5 cross bars with mill finish.
   4. Straps, bolts, ties, and accessories: Aluminum
   5. Band grating with 1/4 inch thick band of width equal to the full depth of grating, welded on at the ends of all sections and at openings.
   6. Where not shown, provide suitable supporting members as required when span of grating changes direction.

B. Fasteners: manufacturer's standard clips using micarta between the aluminum and dissimilar materials. Provide one fastener at each section corner, and a minimum of one additional fastener for each intermediate support.

C. Coat portions of aluminum to be embedded in, or in contact with, concrete with heavy bodied bituminous paint.

D. Limit grating sections to a size that can be removed by one person.

2.04 STEEL FRAMES FOR MISCELLANEOUS OPENINGS

A. Fabricate from structural shapes and plates in sizes per Drawings.

B. Accurately square, miter, butt, or cope frames. Weld flush and grind smooth.

C. Stops: Plug-welded and ground smooth.

D. Seal weld joints exposed to weather.

2.05 EXPANSION BOLTS (INTO CONCRETE)

A. General: Torque controlled expansion anchor suitable for seismic loads and cracked concrete applications.
B. Material:

1. AISI 316 stainless steel anchor body, nut, washer, and expansion sleeve, unless noted otherwise

C. Evaluation Requirements: ICC-ES evaluation report stating product is compliant with 2015 International Building Code and approved for use to resist static, wind and earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete having a compressive strength of 2,500 psi to 8,500 psi. Evaluation reports with a listed renewal date month/year which is prior to the month/year the product is submitted for engineer’s review will be rejected.

D. Approved expansions bolts:

1. Simpson Strong-Tie: Strong-Bolt 2
   a. Compliance Report (ESR-3037)
2. Hilti: Kwik Bolt TZ
   a. Compliance Report (ESR-1917)
3. Powers: Power-Stud + SD6
   a. Compliance Report (ESR-2502)

2.06 ADHESIVE ANCHORS (INTO CONCRETE)

A. General: Epoxy adhesive for installing post-installed bolts into concrete denoted as Adhesive Anchors on Drawings.

B. Evaluation Requirements: ICC-ES evaluation report stating product is compliant with 2015 International Building Code and approved for use to resist static, wind and earthquake (Seismic Design Categories A through F) tension and shear loads in cracked and uncracked normal-weight concrete having a compressive strength of 2,500 psi to 8,500 psi. Evaluation reports with a listed renewal date month/year which is prior to the month/year the product is submitted for engineer’s review will be rejected.

C. Epoxy adhesive for anchoring reinforcement to concrete shall be a 2 component solid epoxy based system supplied in manufacturer's standard side-by-side cartridge and dispensed through manufacturer's standard static-mixing nozzle. Epoxy adhesive shall be:
1. Simpson Strong Tie: SET-XP or ET-HP
   a. SET-XP Compliance Report (ESR-2508)
   b. ET-HP Compliance Report (ESR-3372)
2. Hilti: HIT-RE 500 V3
   a. Compliance Report (ESR-3814)
3. Powers: PE1000+
   a. Compliance Report (ESR-2583)

D. Epoxy adhesive shall pass the creep test requirements of ICC-ES AC308.

E. Hardware: From same manufacturer as epoxy adhesive for a complete anchoring system.

   1. Threaded Steel Rods: Continuously threads (all-thread).
   2. Material: AISI 316 stainless steel threaded steel rods, nut and washers, unless noted otherwise.

2.07 ADHESIVE ANCHORS (INTO MASONRY)

A. General: Adhesive anchor system for installing post-installed threaded steel rods to grouted and ungrouted CMU, solid and hollow brick walls, and unreinforced multiple wythe brick walls denoted as “Adhesive Anchors” on drawings.

   1. All products shall be furnished by the same manufacturer including steel threaded rods, mesh screen tubes, adhesive, and installation equipment.

B. Evaluation Requirements: ICC-ES evaluation report stating product is compliant with 2015 International Building Code and approved to anchor building components to hollow (ungrouted) and fully grouted concrete masonry walls to resist static, wind, and earthquake loads.

C. Adhesive for anchoring reinforcement to masonry shall be furnished in a side-by-side cartridge and dispensed through manufacturer's standard static-mixing nozzle. Adhesive system shall be:

   1. Simpson Strong Tie: SET-XP or ET-HP
      a. SET Compliance Report (ESR-1772)
      b. ET-HP Compliance Report (ESR-3638)
2. HIT-HY 270  
   a. Compliance Report (ESR-4143)  
3. Powers: AC100+ Gold  
   a. Compliance Report (ESR-3200)  

D. Epoxy adhesive shall pass the creep test requirements of ICC-ES AC58.  

E. Hardware: From same manufacturer as epoxy adhesive for a complete anchoring system.  

   1. Threaded Steel Rods: Continuously threads (all-thread).  
   2. Material: AISI 316 stainless steel threaded steel rods, nut and washers, unless noted otherwise.  
   3. Screen Tubes/ threaded insets: Manufacturer’s standard screen tubes or threaded inserts.  

2.08 ALUMINUM HATCH COVERS  

A. Performance characteristics:  

   1. Cover: Cover shall be reinforced to support a minimum live load of H20 with a maximum deflection of 1/150th of the span. Manufacturer shall provide structural calculations stamped by a professional engineer registered in the project state upon request of the Engineer.  


C. Styles, types and sizes: Per Drawings, and of single manufacturer. Sizes indicated on drawings is the required clear opening. Contractor shall box-out openings per manufacturer instructions to account for hatch frame thickness.  

   1. Type JAL-H20 and JDAL-H20: Single leaf and double leaf, respectively, watertight, self-draining type  
      a. Door leaf: 1/4-inch thick aluminum diamond pattern plate reinforced with aluminum stiffeners, capable of withstanding live load of 300 pounds per square foot and H20 vehicular loading. Equip each door leaf with minimum 2 hinges with stainless steel pins, compression spring operators enclosed in telescopic tubes to afford easy operation.  
      b. Provide automatic hold-open arm with vinyl grip handle to release cover for closing.  
      c. Equip with snap lock and removable handle.
d. Channel frame: 1/4-inch thick aluminum with anchor flange around the perimeter. Except where connected to a drainage system per Drawings, provide extension from frame drainage coupling to drain to area below.

e. Mechanically attach a continuous EPDM debris gasket to frame. Provide 1-1/2 inch drainage coupling in channel frame.

f. Hardware: Stainless steel with factory mill finish.

g. Bituminous coating applied to areas to be embedded in concrete.

h. Where not connected to a drainage system per Drawings with extensions to the drainage coupling to allow drainage to the area below.

D. Fall protection

1. Equip hatch covers with fall protection grating system of fiberglass or aluminum construction and 316 stainless steel hardware, with live load capacity of 300 psf.

2. Safety color: Orange or yellow

3. Provide with spring-loaded lifting handle and aluminum or stainless-steel hold open arm and release handle, and automatic lock at 90-degree open position.

4. Provide capability for locking with padlock in the closed position.

E. Padlocks: Provide one (1) lock equal to Master No. 5 for each hatch provided and one spare lock. All locks keyed to Owner’s standard.

2.09 MISCELLANEOUS STEEL ITEMS

A. Fabricate and furnish miscellaneous steel items, galvanized angles, relieving angles, plates, channels, and all required fastenings per Drawing details. Miscellaneous steel items shall be galvanized as specified.

2.10 ANCHOR BOLTS

A. ASTM F1554 Grade 36 steel, galvanized except where stainless steel specified, headed and threaded.

B. Type 316 stainless steel: to attach aluminum and in all submerged locations – including washers and nuts.

C. Sizes: per Drawings
2.11 ALUMINUM STAIRS
   A. Per Drawing details and furnished with stainless steel bolts, nuts, and washers
   B. Grating stairway treads: 1-bar type with extruded aluminum corrugated nosing
      1. Furnish treads with 3-inch by 3/16-inch carrier plates welded to the ends of
         tread, punched for bolting to stringers.
      2. Bar size: as recommended by the manufacturer for the length of the tread,
         and approved by Engineer
   C. Solid stairway treads and risers: 1/4-inch non-slip aluminum safety tread or
      diamond plate, fabricated for fastening to angle supports welded to stringers.
   D. Railings: per Article 2.02

2.12 MANHOLE-TYPE RUNGS
   A. Steps: Alloy 6061-T6. Coat portions to be embedded in concrete with a coat of zinc
      chromate paint.
   B. Expected level of quality for manhole-type rungs Part No. F-14-2-D as
      manufactured by Washington Aluminum, or similar as made by Neenah Foundry,
      Flockhart Foundry or equal.

2.13 STEEL BOLLARDS
   A. Pipe: ASTM A53, 6 inches nominal diameter, schedule 40, galvanized
   B. Length: To allow bollards to extend 4 feet above and below grade, except as
      otherwise shown on the Drawings

2.14 SHOP COATING
   A. Prepare ferrous items and paint per Section 09 90 00, except where otherwise
      specified.
   B. Do not prime paint galvanized steel not specified to be painted, stainless steel
      surfaces embedded in concrete or masonry (except for partially embedded
      components, extend priming 2 inches into the embedment), and surfaces to be field
      welded.
   C. Coat items specified as galvanized by the hot-dip process per ASTM A123, ASTM
      A153, or ASTM A653, as applicable, in molten zinc, to produce a continuous
      coating of uniform thickness of weight required by the referenced standards.
1. Coating: Commercial quality, free from injurious defects, flux and uncoated spots, and per ASTM A239: capable of enduring not less than 4 immersions in copper sulfate without penetration of the coating.

2. Identify galvanized items with a stamp showing the name of the galvanizer, the weight of the coating, and applicable ASTM compliance.

D. Galvanized steel specified to be painted

1. Do not quench.

2. Phosphatize and prepare to be painted per ASTM D6386

3. Prime with paint compatible with the finish paints specified in Section 09 90 00.

2.15 SOURCE OF QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 DISSIMILAR MATERIAL

A. Keep aluminum surfaces from direct contact with metals other than stainless steel by painting the dissimilar metal with a coating of zinc chromate paint or provide non-absorptive tape between dissimilar metals.

B. Paint aluminum with a coat of bituminous paint where aluminum is embedded in, or comes in contact with, concrete, masonry or by-products of these materials.

3.02 STEEL CONNECTIONS

A. Comply with RCSC Specifications for Structural Joints Using ASTM F3125 Grade A325 or A490 Bolts.

B. Design bolted connections as N-type bearing connections, installed snug-tight.

C. Minimum size: 3/4 inch

D. Minimum number of bolts per connection: 2

E. Where bolts are specified to be installed loose or finger tight, snug up the connection to ensure that plies are in contact. Then back off the nut between 1/2 and 1 turn to permit intended movement of the connection. Provide double nuts on bolts to prevent loosening.

F. Weld steel per AWS D1.1. Grind exposed welds smooth.

3.03 INSTALLATION

A. Verify elevations of concrete and masonry bearing surfaces and locations of anchor rods, bearing plates, and other embedments. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen surfaces prior to setting plates.

B. Set bearing plates using leveling nuts or galvanized leveling plates, and grout with non-shrink grout as specified in Section 03 16 00. Promptly grout leveling plates after set and checked for line, levelness and elevation.

C. Grout bearing plates after framing is plumb when leveling nuts are used.

D. Concrete embedments: installed under Section 03 11 00.

E. Bar rack components to be fastened to concrete: Install from field measurements of cast concrete.

F. Use stainless steel hardware when anchoring aluminum and in submerged locations.
G. Steel lintels and masonry embedments: installed under Section 04 20 00.
H. Steel bollards: encased in concrete and filled inside of pipe per Section 03 30 00.

3.04 BOLTS

A. Install bolts snug tight. Install bolt at least flush with the outer face of the nut. Cut off bolts projecting more than 5/8 inch beyond the nut in exposed Work as close to nut as possible and as directed.

B. All joint surfaces shall be free of loose mill scale, burrs, and foreign material. Enough bolts shall be brought to a snug tight condition to insure that the parts of the joint are properly compacted, i.e., brought into full contact with each other. Snug tight shall be defined as the tightness attained by a few impacts of an impact wrench or the full effort of a worker using an ordinary spud wrench. Following the initial tightening, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall be tightened an additional 1/3 turn if bolt length is up to and including four bolt diameters, or a 1/2 if longer.

C. Provide required cutting, fitting, drilling, and tapping. Do not use thermal cutting during installation and erection. Do not make or modify bolt holes by burning.

3.05 ADHESIVE BOLTS

A. Installation: Per manufacturer’s installation instructions and as listed in the product ICC-ES Evaluation Report

B. Drilled and epoxied bolts shall be installed in concrete having a minimum age of 21 days at time of installation.

C. All cartridges shall have the expiration date clearly visible. Material past its expiration date shall not be used and shall be immediately removed from the Site.

D. Diamond drill bits are not permitted. Hammer drills shall be used.

E. Drill Holes:
   1. Diameter: Per manufacturer’s instructions
   2. Embedment: Manufacturer’s standard embedment for anchor size, unless noted otherwise on drawings. Depth stop shall be used to ensure correct drilling depth.
   3. Installation Torque: Per manufacturer’s instructions.
F. The initial material extruded from each cartridge shall be discarded in accordance with the manufacturer’s instructions to ensure that all material is properly mixed.

G. Drilled holes shall be blown out with air, thoroughly wire brushed with a repeated back and forth movement, blown out, thoroughly wire brushed, and blown out again. Adhesive shall be injected, starting from the bottom of the hole and slowly withdrawn as filling progresses to prevent air pockets.

H. Installed bolt shall remain completely undisturbed between the manufacturer's specified gel time and the full cure time. Zero load shall be applied during this time.

### 3.06 EXPANSION BOLTS


B. Drill Holes
   
   1. Diameter: per manufacturer’s instructions.
   
   2. Embedment: Manufacturer’s standard embedment for anchor size, unless noted otherwise on drawings. Depth stop shall be used to ensure correct drilling depth

C. Installation Torque: per manufacturer’s instructions.

### 3.07 ALUMINUM GRATINGS, SUPPORTS, AND NECESSARY ACCESSORIES

A. Components embedded in concrete: installed under Section 03 11 00.

### 3.08 FIELD TOUCH UP

A. Where galvanized steel is field cut and locations where galvanized coating is removed: Touch up steel surface with zinc rich paint meeting ASTM A780 and containing a minimum of 65 percent zinc at locations.

### 3.09 CLEANING

A. Immediately after installation, round or chamfer sharp edges and grind burrs, jagged edges and surface defects smooth. Remove weld splatter.

### 3.10 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
3.11 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 06 10 00
ROUGH CARPENTRY

PART 1 – GENERAL

1.01 SUMMARY
A. Section Includes
1. Provide materials, tools, equipment and labor required to furnish, fabricate
and complete the rough carpentry work in accordance with this Section and
applicable reference standards listed in Article 1.03.
2. Items to be embedded in concrete and masonry shall be furnished under this
section, but installed under Division 03, Concrete, or Division 04, Masonry.

1.02 PRICE AND PAYMENT PROCEDURES
A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES
A. Reference Standards
1. ASME International (ASME)
   a. ASME B18.2.1 Square and Hex Bolts and Screws (Inch Series)
   b. ASME B18.6.1 Wood Screws (Inch Series)
2. ASTM International (ASTM)
   a. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on
      Iron and Steel Hardware
   b. ASTM A563 Standard Specification for Carbon and Alloy Steel
      Nuts
   c. ASTM D2559 Standard Specification for Adhesives for Bonded
      Structural Wood Products for Use Under Exterior Exposure
      Conditions
   d. ASTM E84 Standard Test Method for Surface Burning
      Characteristics of Building Materials
   e. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36,
      55, and 105-ksi Yield Strength
   f. ASTM F1667 Driven Fasteners: Nails, Spikes, and Staples
3. American Wood Protection Association (AWPA)
   a. AWPA U1 Use Category System: User Specification for Treated Wood
4. ICC-Evaluation Services
   a. ESR-1539 Power-Driven Staples and Nails
5. National Institute of Standards and Technology (NIST)
   a. NIST PS 1 DOC Voluntary Product Standard PS 1-07, Structural Plywood
   b. NIST PS 20 American Softwood Lumber Standard

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in Accordance with Division 01 General Requirements.

B. Product Data
   1. Engineered Wood Products: including manufacturer's load tables
   2. Building Paper
   3. Metal Framing Anchors
   4. Wood Treatment Data: including chemical treatment manufacturer's instructions for storage, handling, installation and finishing
   5. Water-Borne-Treated Products: include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to Project Site
   6. Warranty of chemical treatment manufacturer for each type of treatment

C. Material Certificates
   1. For dimension Lumber, indicating species and grade for each use, and compliance with minimum specified allowable unit stresses per values approved by the American Lumber Standards Committee.
   2. For each type of preservative-treated wood product include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
3. For fire-retardant-treated wood products include certification by treating plant that treated material complies with specified standard.

4. Certificates of inspection stating species and grades of plywood used for roof and wall sheathing.

1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and plywood; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.
   C. For lumber and plywood pressure-treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 LUMBER GENERAL
   A. Furnish lumber manufactured to comply with NIST PS 20 and with applicable grading rules of inspection agencies certified by ALSC Board of Review.
   B. Inspection Agencies:
      1. RIS - Redwood Inspection Service
      2. SPIB - Southern Pine Inspection Bureau
      3. WCLIB - West Coast Lumber Inspection Bureau
      4. WWPA - Western Wood Products Association
      5. NELMA - Northeastern Lumber Manufacturers Association
      6. NSLB - Northern Softwood Lumber Bureau
      7. NLGA - National Lumber Grades Authority
C. Each piece of lumber shall factory-marked with grade stamp of inspection agency indicating grade, species, and moisture content at time of surfacing and milling.

D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by NIST PS 20 for moisture content specified for each use.
   1. Provide dressed lumber, S4S, unless otherwise indicated.
   2. Provide lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.

2.02 DIMENSION LUMBER

A. For structural framing (2 to 4 inches nominal thickness) provide the following (size factors NOT included):
   1. Allowable bending stress of 575 psi minimum (661 psi under repetitive member use); allowable compressive stress parallel to the grain of 825 psi minimum; and a modulus of elasticity of 1,100,000 psi minimum. These values are for No. 2 Eastern Softwoods graded under NELMA or NSLB. Other species and grades meeting these properties are acceptable.

B. Top sill plate shall meet the specifications for dimension lumber. Bottom sill plate shall meet the specifications for miscellaneous lumber.

2.03 BOARDS

A. Exposed Boards: 15 percent maximum moisture content: Eastern White Pine, Idaho White, Lodgepole, Ponderosa, or Sugar Pine; D Select (Quality), grade per NELMA, NLGA, WCLIB, or WWPA. Exposed boards shall be pre-primed.

B. Concealed Boards: 15 percent maximum moisture content: Hem-Fir (North), Spruce-Pine-Fir (South), Spruce-Pine-Fir; Construction or 2 Common, grade per NELMA, NLGA, WCLIB, or WWPA.

2.04 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber for support and attachment of other construction, including bottom sill plate, nailers, blocking, furring, and similar members. Provide 19 percent maximum moisture content at time of dressing & shipment; Hem-Fir, Hem-Fir (North), Spruce-Pine-Fir; Construction or No. 2 grade per NELMA, NLGA, WCLIB, or WWPA.

B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
2.05 ENGINEERED WOOD PRODUCTS

A. General

1. Provide engineered wood products for which current model code evaluation/research reports provide evidence of compliance for the indicated application and the building code of Project state.

B. Plywood Sheathing

1. All sheathing shall conform to NIST PS 1 and shall be factory marked.

2. Roof sheathing: 5/8 inch APA Rated Sheathing, 32/16, C-D Grade; Exposure 1 Durability; ply clips as required

3. Wall sheathing: 1/2 inch APA Rated Sheathing, C-D Grade, Exposure 1 Durability

2.06 BACKING PANELS

A. Plywood panels for mounting electrical or telephone equipment: provide fire-retardant-treated plywood panels with grade designation, NIST PS 1 A-C, Exterior, not less than 3/4 inch.

2.07 FASTENERS

A. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Provide fasteners with a hot-dip zinc coating per ASTM A153 or of Type 304 stainless steel. Where in contact with pressure-treated wood, use hot-dip galvanized or Type 316 stainless steel, and as noted. Use Type 316 stainless steel where stainless steel framing anchors are used.

B. Nails, Brads, and Staples: ASTM F1667. Nails shall be common nails, except as otherwise noted.

C. Power Driven Fasteners: ESR-1539

D. Wood Screws: ASME B18.6.1

E. Lag Bolts: ASME B18.2.1

F. Anchor Bolts: Steel bolts complying with ASTM F1554, Grade 36; with ASTM A563 hex nuts and where indicated, flat washers.
2.08 METAL FRAMING ANCHORS

A. Provide metal framing anchors of type, size, metal, and finish indicated that comply with requirements specified including the following.

1. Provide products for which current model code evaluation/research reports provide evidence of compliance for the indicated application and the building code of Project state.

2. Provide products for which manufacturer publishes allowable design loads that are determined from empirical data or by rational engineering analysis and that are demonstrated by comprehensive testing performed by a qualified independent testing laboratory.

3. Where in contact with pressure-treated wood, provide stainless steel or hot-dip galvanized steel with minimum G185 coating (1.85-ounce zinc per square foot).

2.09 PRESERVATIVE TREATED WOOD

A. Where lumber or plywood is indicated as pressure-treated, preservative-treated, or is specified herein to be treated, comply with applicable requirements of AWPA U1 Commodity Specifications A-Sawn Products for lumber, and F-Wood Composites for plywood.

B. Pressure-treat items with water-borne preservative chemicals, legal for use in the Project state, with a minimum chemical preservative retention of 0.25 per cubic foot. After treatment, kiln-dry lumber and plywood to a maximum moisture content, of 19 percent for lumber and 15 percent for plywood. Discard materials that are warped or that do not comply with requirements for untreated materials.

C. Treat indicated items and: bottom wood sill plate, sleepers, blocking, furring, stripping, and similar members in contact with masonry or concrete.

2.10 FIRE-RETARDANT TREATED WOOD

A. Pressure treated fire-retardant wood shall have a flame spread rating of 25 or less when tested in accordance with ASTM E84. Fire retardant shall be listed in AWPA U1 Commodity Specifications H-Fire Retardant Treated Products, and shall be Pyro-Guard, as manufactured by Hoover Treated Wood Products, Inc., or Fire-Pro, as manufactured by Osmose, Inc. Lumber shall be kiln dried after treatment to a moisture content of 19 percent. All treated wood shall be identified with UL and Timber Products Inspection Stamps and shall include identification of treating manufacturer, name of fire-retardant treatment, wood species, flame spread and smoke developed index, and drying method used after treatment.
2.11 BUILDING PAPER

A. Nonwoven non-perforated, spun bonded polypropylene weather membrane with micro porous coating, Tyvek by DuPont, Typar by BBA Fiberweb, Weather Trek by Valeron, or approved equal. Provide compatible sealing tape.

2.12 SILL SEAL

A. Flexible polyethylene foam gasketing strip, 1/4 inch thick by 5-1/2 inch wide. Styrofoam Sill Seal by Dow, Reflectix Sill Sealer by Reflectix Inc., Slex Sill Sealer by Protecto Wrap, or equal

2.13 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION - GENERAL

A. Discard pieces with defects that impair quality of rough carpentry construction and that are too small to use in fabricating rough carpentry with minimum joints or optimum joint arrangement.

B. Set rough carpentry to required levels and lines, with members plumb and true to line and cut and fitted.

C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.

E. Countersink nail heads on exposed carpentry work and fill holes.

F. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

3.02 SILL PLATES

A. The bottom sill plate attached to the concrete foundation shall be pressure-treated. The top sill plate that is attached to the bottom sill plate shall not be pressure-treated, and shall comply with the Specifications for Dimension Lumber.
B. Prior to bolting to the foundation, 2 by 6 sill plates shall be nailed together with 2 rows of 10D galvanized common nails spaced 9 inches on center. Adjacent nails within each row shall be driven from opposite sides. Rows shall be spaced approximately 2-1/2 inches apart and not greater than 3 inches apart. Nail edge distance shall be approximately 1-1/2 inches and not less than 1 inch. Where sill plate segments terminate at the same location, nail rows shall terminate 2-1/2 inches from the end; alternatively, sill plates shall be spliced with a minimum stagger of 4 feet.

C. Bottom sill plate shall be isolated from concrete with specified sill seal.

3.03 WOOD NAILERS AND BLOCKING

A. Install wood nailers and blocking where shown and where required for attachment of other work. Form to shapes as shown and as required for true line and level of work to be attached. Coordinate location with other work involved.

B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated.

3.04 FURRING

A. Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finished work.

B. Firestop furred spaces on walls at each floor level and at ceiling line of top story, with wood blocking or noncombustible materials, accurately fitted to close furred spaces.

3.05 FRAMING – GENERAL

A. Anchor and nail as shown, and to comply with the following

1. ESR-1539

2. Published requirements of manufacturer of metal framing anchors

B. Do not splice structural members between supports.

C. Firestop concealed spaces of wood frame walls and partitions at each floor level and at the ceiling line of the top story. Where firestops are not automatically provided by the framing system used, use closely fitted wood blocks of nominal 2 inch thick lumber of the same width as framing members.
3.06 ROOF SHEATHING

A. Configuration of panel sheets shall be as shown on the Drawings. Panel sheets shall span perpendicular to supporting members.

B. Blocking: Continuous at ridge; as shown on the Drawings at eaves; additional continuous blocking where shown on the Drawings

C. Nailing: As shown on Drawings

D. Panels shall be placed with 1/16 inch clearance at end joints and 1/8 inch clearance at side joints

3.07 WALL SHEATHING

A. Blocking at all panel edges

B. The bottom of the wall sheathing shall be nailed to upper sill plate

C. 8d Nailing: 6 inches on center at panel edges, 12 inches on center at intermediate supports

D. Panels shall be placed with 1/16 inch clearance at end joints and 1/8 inch clearance at side joints

3.08 BUILDING PAPER

A. Apply building paper horizontally with 2 inch overlap and 6 inch end lap; fasten to sheathing with galvanized staples or roofing nails. Cover upstanding flashing with 4 inch overlap. Tape vertical seams.

3.09 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.10 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 06 17 53

SHOP FABRICATED WOOD TRUSSES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide metal-plate-connected wood trusses in accordance with this Section and applicable reference standards listed in Article 1.03.

2. The Work of this section comprises all materials, tools, equipment and labor required to furnish, fabricate and install the metal-plate-connected wood trusses as shown on the Drawings, specified herein, and evidently required to complete the Work.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. AMERICAN FOREST & PAPER ASSOCIATION (AF&PA)
   a. AF&PA T101 - National Design Specification (NDS) for Wood Construction

2. American Lumber Standards Committee (ALCS)

3. ASME INTERNATIONAL (ASME)
   a. ASME B18.2.1 - Square and Hex Bolts and Screws (Inch Series)
   b. ASME B18.6.1 - Wood Screws (Inch Series)

4. ASTM INTERNATIONAL (ASTM)
   a. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   b. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   c. ASTM F1667 - Driven Fasteners: Nails, Spikes, and Staples
5. ICC-EVALUATION SERVICES
   a. ESR-1539 - Power-Driven Staples and Nails

6. NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)
   a. NIST PS 20 - American Softwood Lumber Standard

7. TRUSS PLATE INSTITUTE (TPI)
   a. TPI 1 - National Design Standard for Metal Plate Connected Wood Truss Construction; Commentary and Appendices

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
   A. Submit in accordance with Division 01 General Requirements.

1. Shop Drawings
   a. Lumber species and group, size, and stress grade for each truss component
   b. Span, pitch, configuration, and spacing for each truss
   c. Size, material, finish, locations of connector plates
   d. Bearing details: Truss connectors for each location where trusses are supported by other trusses
   e. Design loads, load combinations, and allowable and actual stresses
   f. Permanent bracing requirements and details
   g. Shop Drawings shall be stamped by a professional Engineer licensed in the Project state

2. Product Data
   a. Lumber, hardware, metal connector plates, and fasteners
   b. Wood Treatment Data: including chemical treatment manufacturer's instructions for storage, handling, installation, and finishing

3. Material Certificates
   a. Certificates of inspection stating species, grade, and percent moisture content of all lumber used in truss fabrication
b. Certification by treating plant, stating type of preservative solution, pressure process used, net amount of preservative retained, and compliance with applicable standards

c. Water-Borne-Treated Products: include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to Project Site.

d. Warranty of chemical treatment manufacturer for each type of treatment

4. Manufacturer's Instructions

a. Requirements for handling, storage, erection, temporary and permanent bracing, and connections

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Truss manufacturer shall be a member of the Truss Plate Institute (TPI) and shall comply with TPI quality control procedures for the manufacturer of connector plates published in TPI 1.

C. Manufacturer shall comply with applicable requirements of TPI 1.

D. Manufacturer shall comply with applicable requirements of AF&PA T101.

E. A Professional Engineer licensed in the Project state, who is experienced in the design of wood trusses similar to those used in the Work, with a successful record of in-service performance, shall be responsible for the truss designs, and shall sign and stamp the Shop Drawings.

F. Connector plates and wood trusses shall each be provided by a single manufacturer

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Comply with manufacturer's instructions and TPI recommendations for handling and storing trusses. Avoid damage from improper handling which can induce stresses the trusses are not designed to resist.

C. Stack trusses off the ground. Protect from rain and snow inside a well-ventilated enclosure.

D. Coordinate delivery and erection of trusses to avoid lengthy on-Site storage.

E. Remove defective or damaged trusses from the Site and replace at no additional cost to the Owner.
1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 METAL CONNECTOR PLATES

A. Fabricate connector plates from hot-dip galvanized steel sheet complying with ASTM A653, grade A, G60. Minimum-coated metal thickness is 0.036 inches.

B. Acceptable Manufacturers

1. Alpine Engineered Products, Inc.
2. Truswal Systems Corporation
3. MiTek Industries, Inc.
4. Or equal

2.02 LUMBER

A. Each piece of lumber shall be factory marked with grade stamp of inspection agency indicating type, grade, species, and moisture content at time of surfacing and milling, and grading agency.

B. Lumber shall comply with NIST PS 20 and with applicable grading rules of inspection agencies certified by the American Lumber Standards Committee (ALCS) Board of Review. Machine stress rated (MSR) lumber grades shall be used except that visual graded lumber may be used for web members.

C. Inspection Agencies

1. SPIB - Southern Pine Inspection Bureau
2. WCLIB - West Coast Lumber Inspection Bureau
3. WPA - Western Wood Products Association

D. Provide dressed lumber, S4S, manufactured to sizes required by NIST PS 20. Lumber shall have 19 percent maximum moisture content at time of dressing and shipment for dimension lumber, except as otherwise indicated.
2.03 PRESERVATIVE TREATED WOOD

A. Where trusses are indicated as pressure-treated or preservative-treated, comply with applicable requirements of AWPA C2.

B. Pressure-treat lumber with water-borne preservative chemicals, legal for use in the Project state, with a minimum chemical preservative retention of 0.25 per cubic foot. After treatment, kiln-dry lumber to a maximum moisture content of 19 percent. Discard warped lumber that doesn't comply with requirements for untreated lumber.

2.04 BRACING

A. Sway bracing, lateral bracing, and runners shall be provided as recommended by the truss manufacturer. Permanent truss diagonal web bracing shall be coordinated with web lateral bracing as required by the truss designer.

2.05 FASTENERS

A. Provide fasteners of size and type indicated, with a galvanized coating per ASTM A153, or AISI Type 304 stainless steel.

B. Nails, brads, and staples shall conform to ASTM F1667

C. Power driven fasteners shall conform to ESR-1539

D. Wood screws shall conform to ASME B18.6.1

E. Lag bolts shall conform to ASME B18.2.1

2.06 METAL FRAMING ANCHORS

A. Provide metal framing anchors of type, size, and finish indicated, that comply with requirements specified including the following

1. Current model code evaluation/research reports that provide evidence of compliance for the indicated application and the building code of Project state

2. Manufacturer published allowable design loads that are determined from empirical data or by rational engineering analysis, and that are demonstrated by comprehensive testing performed by a qualified independent testing laboratory

3. Galvanized anchors shall be manufactured from ASTM A653, Grade A, G60 zinc coated by the hot-dip process on continuous lines prior to fabrication
4. Truss tie-downs (hurricane ties) shall be as indicated on the Drawings

5. Acceptable manufacturers
   a. Alpine Engineered Products, Inc.
   b. Simpson Strong-Tie Company, Inc.
   c. United Steel Products Company, Inc.
   d. Or equal

2.07 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints with wood-to-wood bearing in assembled units.

B. Assemble truss members using jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with specified tolerances.

C. Fabricate metal connector plates to size, configuration, thickness, and anchorage required to withstand design loads.

D. Metal connector plates shall be accurately located and securely fastened to each side of wood members.

E. Finished trusses shall conform to the following tolerances
   1. Overall length and height of each truss shall be accurate within 1/4 inch
   2. Chord members shall be straight between panel points within 1/4 inch
   3. Camber shall be measured with the truss supported at its normal bearing points and supporting its own weight and shall be within 1/8 inch. Trusses shall be designed such that there is no camber when subjected to full dead load.

F. Ends of chords shall be cut to exact design length and bevel. Bearing surfaces shall be flat and square across. Foreign matter shall be cleaned from bearing surfaces.

2.08 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Erect and brace trusses to comply with applicable requirements of TPI standards specified herein.

B. Trusses shall not be altered in the field, except for minor modifications as approved by the Engineer. Trusses that do not fit shall be returned to the fabricator and replaced with properly sized trusses.

C. Trusses shall be erected with the plane of the truss webs vertical and parallel to each other. Trusses shall be accurately located at the proper design spacing.

D. Trusses shall be hoisted into place by means of lifting equipment suited to sizes and types of trusses. Care shall be taken not to damage truss members or joints by out-of-plane (weak axis) bending and other causes.

E. Trusses shall be securely anchored at all bearing points. Toe nailing truss bottom chords to wall top plates at bearing locations shall be prohibited due to the likelihood for splitting the truss chord.

F. Install permanent bracing to ensure trusses maintain design spacing along their span and properly withstand all design loads.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.03 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 06 20 00

FINISH CARPENTRY

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide the following finish carpentry in accordance with this Section and applicable reference standards listed in Article 1.03:

a. Exterior trim
b. Interior trim

B. Related Requirements

1. Section 07 92 00 – Joint Sealants
2. Section 09 90 00 – Paints and Coatings

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Hardboard Association (AHA)
   a. AHA A135.6 Hardboard Siding

2. American National Standards Institute (ANSI)
   a. ANSI A208.1 Mat-Formed Wood Particle Board
   b. ANSI B18.2.1 Square and Hex Bolts and Screws Inch Series
   c. ANSI B18.2.2 Hex Nuts and Hex Jam Nuts

3. American Wood-Preservers' Association (AWPA)
   a. AWPA C1 All Timber Products - Preservative Treatment by Pressure Processes
   b. AWPA C2 Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
   c. AWPA C20 Structural Lumber Fire-Retardant Treatment by Pressure Processes
4. APA - THE ENGINEERED WOOD ASSOCIATION (APA)
   a. APA E445S Performance Standards and Qualification Policy for Structural-Use Panels (APA PRP-108)

5. ARCHITECTURAL WOODWORK INSTITUTE (AWI)
   a. AWI Qual. Stds. AWI Quality Standards

6. ASME INTERNATIONAL (ASME)
   a. ASME B18.2.2 Square and Hex Nuts

7. ASTM INTERNATIONAL (ASTM)
   a. ASTM A687 Standard Specification for High-Strength Nonheaded Steel Bolts and Studs
   b. ASTM D2898 Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
   c. ASTM F547 Nails for Use with Wood and Wood-Base Materials

8. NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)
   a. NELMA Grading Rules Standard Grading Rules for Northeastern Lumber

   a. PS20 American Softwood Lumber Standard

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product data for wood items and trim
C. Samples for hardwood interior window trim and treated exterior composite trim

D. Certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified

E. Certificates of compliance unless materials bear certification markings or statements

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Deliver lumber, plywood, trim, and millwork to job Site in an undamaged condition. Stack materials to ensure ventilation and drainage. Protect against dampness before and after delivery. Store materials under cover in a well-ventilated enclosure and protect against extreme changes in temperature and humidity. Do not store products in building until wet trade materials are dry.

1.08 SITE CONDITIONS

A. Existing conditions: per Division 1 General Requirements.

PART 2 – PRODUCTS

2.01 WOOD

A. Identify each piece or each bundle of lumber, millwork, and trim by the grade mark of a recognized association or independent inspection agency that is certified by the Board of Review, American Lumber Standards Committee, to grade the species.

B. Sizes and Patterns of Wood Products: Yard and board lumber sizes shall conform to PS20. Provide shaped lumber and millwork in the patterns indicated and standard patterns of the association covering the species. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the applicable standard.

2.02 INTERIOR TRIM

A. Interior Exposed Trim to be Stained

1. Provide custom grade oak trim. Lumber shall be kiln dried.

B. Interior Exposed Trim to be Painted

1. Provide custom grade pine trim.
2.03 EXTERIOR FASCIA’S AND TRIM

A. Treated Exterior Composite Trim
   1. Provide prefinished Miratec Exterior Trim manufactured by Craftmaster Manufacturing, Inc., or AZEK trimboards, or approved equal. Provide manufacturer's standard white prefinished color.
   2. Product shall have a minimum 25-year manufacturer's warranty covering substrate and a minimum 15-year warranty on finish.
   3. Provide widths as indicated on Drawings. All trim shall be 4/4 thickness ((3/4 inch) nominal).

B. Poly-ash trim
   1. Provide Poly-ash trim boards consisting of a blend of polymers and coal combustion products (ash) manufactured by Boral and equal to Boral TruExterior® Trim.
   2. Product shall have a 20-year limited manufacturer warranty.
   3. Provide widths as indicated on Drawings. All trim shall be 4/4 thickness ((3/4 inch) nominal).

C. Vinyl Soffit
   1. Provide Ventura Triple 3 1/3” Hidden Vent Soffit by Ply Gem, Triple 3 1/3” Hidden Vent Soffit by Georgia-Pacific, or Engineer Approved Equal. Color selected by Engineer. Panel thickness shall be minimum 0.040 inches and provide 9.19 square inches of free air per square foot.

D. Stainless Steel Nails
   1. Attach all exterior fascia and trim with AISI 316 stainless steel nails

E. Field Finishing
   1. Provide joint sealant per Section 07 92 00 to infill any gaps between trim boards or between trim boards and adjacent materials or construction.
   2. Infill all nail holes with trim board manufacturer’s recommended material.
   3. Field prime and paint all trim boards per Section 09 00 00.
2.04 MOISTURE CONTENT OF WOOD PRODUCTS

A. Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products at time of delivery to the job site, and when installed, shall be as follows

1. Exterior Treated and Untreated Finish Lumber and Trim 89 mm (4 Inches Nominal) or Less in Thickness: 19 percent
2. Exterior Wood Siding: 15 percent
3. Moisture content of other materials shall be in accordance with the applicable standards.

2.05 HARDWARE

A. Provide sizes, types, and spacing of manufactured building materials recommended by the product manufacturer except as otherwise indicated or specified.

1. Wood Screws
   a. ANSI B18.6.1
2. Bolts, Nuts, Lag Screws, and Studs
   a. ANSI B18.2.1, ASME B18.2.2, and ASTM A687
3. Nails
   a. Nails shall be the size and type best suited for the purpose and shall conform to ASTM F547. Nails shall be stainless steel when used on exterior work. For siding, length of nails shall be sufficient to extend 1-1/2 inches into supports, including wood sheathing over framing. Screws for use where nailing is impractical shall be size best suited for purpose.

2.06 FABRICATION

A. The terms "Premium," "Custom," and "Economy" refer to the quality grades defined in AWI Quality Standards. Items not specified to be of a specific grade shall be Custom grade.

2.07 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 FINISH WORK

A. Provide Samples, sizes, materials, and designs as indicated and as specified. Apply primer to finish Work before installing. Where practicable, shop assemble and finish items of built-up millwork. Joints shall be tight and constructed in a manner to conceal shrinkage. Miter trim and moldings at exterior angles and cope at interior angles and at returns. Material shall show no warp after installation. Install millwork and trim in maximum practical lengths. Fasten finish Work with finish nails. Provide blind nailing where practicable. Set face nails for putty stopping.

B. Exterior Finish Work


2. Exterior Composite Trim: Install treated exterior composite trim with smooth side exposed. Attach per manufacturer's written recommendations. All fasteners shall be concealed and not visible after final installation. Flashing shall be installed at all horizontal trim applications including window and door headers.


4. Window Stools and Aprons: Provide stools with rabbet over windowsill. Provide aprons with returns cut accurately to profile of member.

3.02 FASCIA’S AND EXTERIOR TRIM

A. Exposed surfaces and square edges shall be machine sanded, caulked, and constructed to exclude water. Joints of built-up items, in addition to nailing, shall be glued as necessary for weather-resistant construction. End joints in built-up members shall be well distributed. Joints in flat Work shall be shouldered. Backs of wide-faced miters shall be held together with metal rings and glue. Fascia’s and other flat members shall be in maximum practicable lengths. Cornices shall be braced, blocked, and rigidly anchored for support and protection of vertical joints.
3.03 MOLDING AND INTERIOR TRIM

A. Molding and interior trim shall be installed straight, plumb, level and with closely fitted joints. Exposed surfaces shall be machine sanded at the mill. Molded Work shall be copeed at returns and interior angles and mitered at external corners. Intersections of flatwork shall be shouldered to ease any inherent changes in plane. Window and door trim shall be provided in single lengths. Blind nailing shall be used to the extent practicable, and face nailing shall be set and stopped with a non-staining putty to match the finish applied. Screws shall be used for attachment to metal; setting and stopping of screws shall be of the same quality as required where nails are used.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 06 40 13

EXTERIOR ARCHITECTURAL WOODWORK

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide materials, tools, equipment and labor required to furnish, fabricate and complete the exterior architectural woodwork in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Items to be embedded in concrete and masonry shall be furnished under this section, but installed under Division 03, Concrete, or Division 04, Masonry.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. ASME INTERNATIONAL (ASME)
   a. ASME B18.2.1 Square and Hex Bolts and Screws (Inch Series)
   b. ASME B18.6.1 Wood Screws (Inch Series)

2. ASTM INTERNATIONAL (ASTM)
   a. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   b. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts
   c. ASTM D2559 Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions
   d. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
   e. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

3. NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in Accordance with Division 01 General Requirements.

1. Shop Drawings

a. Dimensioned drawings including all joinery and fastener locations
b. Lumber species and group, size, and stress grade for each component
c. Permanent mounting requirements and details

2. Product Data

a. Lumber, hardware, and fasteners
b. Wood Treatment Data: including chemical treatment manufacturer's instructions for storage, handling, installation, and finishing

3. Material Certificates

a. Certificates of inspection stating species, grade, and percent moisture content of all lumber used in fabrication
b. Water-Borne-Treated Products: include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to Project Site.
c. Warranty of chemical treatment manufacturer for each type of treatment

4. Manufacturer's Instructions

a. Requirements for handling, storage, erection, temporary and permanent bracing, and connections

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber; provide for air circulation within
and around stacks and under temporary coverings including polyethylene and similar materials.

C. Place spacers between each bundle to provide air circulation.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 LUMBER GENERAL

A. Furnish lumber manufactured to comply with NIST PS 20 and with applicable grading rules of inspection agencies certified by ALSC Board of Review.

B. Inspection Agencies:

1. RIS - Redwood Inspection Service
2. SPIB - Southern Pine Inspection Bureau
3. WCLIB - West Coast Lumber Inspection Bureau
4. WWPA - Western Wood Products Association
5. NELMA - Northeastern Lumber Manufacturers Association
6. NSLB - Northern Softwood Lumber Bureau
7. NLGA - National Lumber Grades Authority

C. Each piece of lumber shall factory-marked with grade stamp of inspection agency indicating grade, species, and moisture content at time of surfacing and milling.

D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by NIST PS 20 for moisture content specified for each use.

1. Provide dressed lumber, S4S, unless otherwise indicated.

2. Provide lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.

2.02 TIMBERS

A. Material: Western Red Cedar

B. Sizes: 4x6, 4x12, 6x6
C. Grade: No. 2 STK (NGLA 130c)

2.03 ARCHITECTURAL WOOD BRACKETS

A. Manufacturers:
   1. ProWoodMarket
   2. Ekena Millwork
   3. Southern Woodcraft & Design
   4. Or equal

B. Construction
   1. Brackets shall be fully housed mortise and tenon construction or a combination of loose tenon joinery and lag screws. Polyurethane glue shall be applied to all joinery.
   2. Brackets shall be predrilled for anchor bolt connections to the wall and provided with matching plugs to conceal the anchor post installation.

2.04 FASTENERS

A. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Provide fasteners with a hot-dip zinc coating per ASTM A153 or of Type 304 stainless steel. Where in contact with pressure-treated wood, use hot-dip galvanized or Type 316 stainless steel, and as noted. Use Type 316 stainless steel where stainless steel framing anchors are used.

B. Lag Bolts: ASME B18.2.1

C. Anchor Bolts: Steel bolts complying with ASTM F1554, Grade 36; with ASTM A563 hex nuts and where indicated, flat washers.

2.05 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION - GENERAL

A. Set rough carpentry to required levels and lines, with members plumb and true to line and cut and fitted.
B. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.

3.02 ARCHITECTURAL WOOD BRACKETS

A. Install architectural wood brackets where shown and as required by the manufacturer.

B. Installation shall be level, plumb, and square. Coordinate location with other work involved.

C. Attach to substrates as required to support applied loading. Recess bolts and nuts flush below surface and plug hole with similar material to hide fasteners.

D. Do not splice members.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 07 21 00

THERMAL INSULATION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide the following insulation in accordance with this Section and applicable reference standards listed in Article 1.03.

   a. Masonry cavity wall rigid insulation
   b. Building foundation wall rigid insulation
   c. Building fiberglass insulation in attic
   d. All other insulation as noted on drawings
   e. Insulation accessories as specified herein

B. Products Specified But Not Supplied or Installed Under This Section

1. Insulation for masonry cavity walls that meets the requirements of this section is to be furnished and installed under Section 04 20 00.

C. Related Requirements

1. Section 04 20 00 – Unit Masonry

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. ASTM International (ASTM)

   b. ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
   c. ASTM C687 Standard Practice for Determination of Thermal Resistance of Loose-Fill Building Insulation

e. ASTM D4397 Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications


g. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials

2. International Code Council (ICC)

   a. IBC International Building Code

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data:

   1. Rigid Insulation
   2. Unfaced Fiberglass Insulation
   3. Faced Fiberglass Insulation
   4. Loose-Fill Insulation
   5. Vapor Retarder
   6. Protection Board
   7. Insulation Baffle

C. Manufacturer’s Instructions: Submit manufacturer’s installation instructions

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Division 01 General Requirements.
B. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location

C. Protect plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment

2. Protect against ignition at all times. Do not deliver plastic insulating materials to the Project Site ahead of installation time

3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 RIGID INSULATION

A. Extruded polystyrene board insulation: Rigid, cellular polystyrene thermal insulation with closed cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C578 and the following requirements:

1. ASTM C578 classification: Type IV
   a. Compressive Strength: 25 psi
   b. Density: 1.80 pcf
   c. Minimum Thermal Resistance (R-Value): 5.00 per inch thickness
   d. Water vapor permeance: 1.50 for 1-inch thick

2. Surface Burning Characteristics per ASTM E84:
   a. Maximum flame spread value: 75
   b. Maximum smoke development index: 450

B. Approved for use at the following locations:

1. Insulation of CMU cavity walls
2. Insulation of foundation walls
3. Insulation below slabs-on-grade
4. Insulation below exterior equipment pads for frost protection
C. Limitations:

1. Per IBC, rigid insulation shall be separated from the interior of a building by an approved thermal barrier of ½-inch gypsum wallboard or equivalent thermal barrier as defined by IBC.

2.02 UNFACED FIBERGLASS INSULATION

A. Thermal insulation produced by combining mineral fibers manufactured from glass or slag with thermosetting resins to comply with ASTM C665 and as follows:

1. ASTM C665 Designation: Type 1 – Blankets without membrane coverings
2. Minimum Thermal Resistance (R-Value) per ASTM C518
   a. Min R-Value: 3.14 per inch
3. Surface Burning Characteristics per ASTM E84
   a. Maximum flame spread value: 25
   b. Maximum smoke developed value: 50

B. Approved for use at the following locations:

1. Building exterior walls constructed of wood or steel studs
2. Attic spaces constructed of shop-fabricated wood truss
3. Interior partition walls constructed of wood or steel studs

C. Limitations:

1. Contractor shall provide a continuous vapor retarder at the conditioned side of the unfaced insulation.

2.03 FACED FIBERGLASS INSULATION

A. Thermal insulation produced by combining mineral fibers manufactured from glass or slag with thermosetting resins to comply with ASTM C665 and as follows:

1. ASTM C665 Designation: Type II, Class C – Blankets with a nonreflective vapor-retarder covering one principal face.
2. Insulation Facing
   a. Material: Kraft-Faced
   b. Perms maximum per ASTM E96: 1.0
3. Minimum Thermal Resistance (R-Value) per ASTM C518
a. Min R-Value: 3.14 per inch

4. Surface Burning Characteristics: Per ASTM E84
   a. Maximum flame spread value: 25
   b. Maximum smoke developed value: 50

B. Approved for use at the following locations:
   1. Building exterior walls constructed of wood or steel studs
   2. Attic spaces constructed of shop-fabricated wood truss

C. Limitations:
   1. Permitted for first layer of attic fiberglass insulation between prefabricated wood trusses. Additional layers of insulation shall run perpendicular to first layer and shall be unfaced fiberglass insulation.

   2. Kraft and standard foil facing will burn. Do not place insulation within 3-inches of light fixtures or similar electrical devices unless device is labeled for contact with insulation. Do not use around flues and similar heat sources.

2.04 LOOSE-FILL INSULATION

A. Thermal insulation produced by combining mineral fibers manufactured from glass or slag with thermosetting resins to comply with ASTM C764 and as follows:

   1. ASTM C764 Designation: Type I – Pneumatic Application.

   2. Minimum Thermal Resistance (R-Value)
      a. Thermal Resistance: Per ASTM C518 and ASTM C687
      b. Minimum Installed R-value: 30
      c. Thickness: Per manufacturer charts to obtain required R-Value

   3. Surface Burning Characteristics: ASTM E84 or CAN/ULC S102.2
      a. Maximum flame spread value: 25
      b. Maximum smoke developed value: 50

B. Approved for use at the following locations:
   1. Attic spaces constructed of shop-fabricated wood trusses

C. Limitations:
   1. Contractor shall provide a continuous vapor retarder to the underside of the shop-fabricated wood trusses.
2.05 VAPOR RETARDER

A. Polyethylene vapor retarder: 6 mil thick polyethylene sheeting conforming to ASTM D4397 and having a water vapor permeance of 1 perm or less when tested in accordance in with ASTM E96.

B. Tape for vapor retarder: Pressure sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetration in vapor retarder.

2.06 INSULATION ACCESSORIES

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation or mechanical anchors securely to substrates indicated without damaging or corroding either insulation, anchors, or substrates.

B. Adhesively attached pin anchors: Perforated plate, 2 inches square, welded to projecting pin, with self-locking washer, complying with the following requirements:

1. Plate: Zinc plated steel, 0.106 inch thick
2. Pin: Copper coated low carbon steel, fully annealed, 0.106 inch in diameter, length to suit depth of insulation indicated and, with washer in place, to hold insulation tightly to substrate behind insulation
3. Self-locking Washer: Mild steel, 0.016-inch thick, size as required to hold insulation securely. Where spindles will be exposed to human contact after installation, protect ends with capped self-locking washers

C. Protection Board: Pre-molded, semi rigid asphalt or fiber composition board, 1/4-inch thick, formed under heat and pressure, standard sizes

D. Insulation Baffle: Preformed rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves

2.07 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Examine substrates and conditions with installer present, for compliance with requirements of the Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.
B. Clean substrates of substances harmful to insulations or vapor retarders, including removal or projections that might puncture vapor retarders.

C. Close off opening in cavities receiving poured in place insulation to prevent the escape of insulation. Provide bronze or stainless steel screen inside where openings must be maintained for drainage or ventilation.

3.02 INSTALLATION

A. Installation in accordance with manufacturer's installation instructions.

3.03 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply installation units to substrate by method indicated, complying with manufacturer's recommendations. If no specified method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units. Where insulation units are not held tightly in place by adjacent materials on all sides, provide wire ties or another acceptable mechanical means to prevent displacement or sagging of insulation.

B. Extend insulation to full thickness as indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement.

C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

D. Seal joints between closed cell, non-breathing insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

E. Set vapor retarder faced units with vapor retarder to warm side of construction, except as otherwise indicated. Do not obstruct ventilation spaces, except for fire stopping. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

F. Place loose-fill insulation into spaces and onto surfaces as shown by machine blowing. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not excessively compact.

G. Stuff loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume, to a density of approximately 2.5 per cubic feet.
3.04 INSTALLATION OF MASONRY CAVITY WALL RIGID INSULATION

A. On units of rigid insulation, install small pads of adhesive spaced approximately 1 foot on center both ways on inside face, as recommended by manufacturer. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

B. Supplement adhesive attachment of insulation by securing board with two-piece wall ties designed for this purpose and specified in Section 04 20 00.

3.05 INSTALLATION OF VAPOR RETARDER

A. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 16-inches on center.

C. Seal overlapping joints in vapor retarders with adhesives or tape per vapor retarder manufacturer's printed directions. Seal butt joints and fasteners penetrations with tape of type recommended by vapor retarder manufacturer. Locate all joints over framing members or other solid substrates.

D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor retarder manufacturer.

E. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with tape or another layer of vapor retarder.

3.06 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation will be subject abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
3.08 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 07 26 00

VAPOR BARRIER

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes
   1. Provide vapor barrier in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards
   1. ASTM E96
   2. ASTM E96 0.3
   3. ASTM E1643
   4. ASTM E1745

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.
   B. Product Data: Manufacturer's installation instructions
   C. Samples: For approval by Engineer from manufacturer's standard

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.
1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Vapor Barrier must have the following qualities.

1. WVTR less than 0.008 as tested by ASTM E 96
2. ASTM E 1745, Class A (Plastics)

B. Vapor Barrier Products

1. Stego Wrap 10 mil Vapor Barrier by Stego Industries, LLC
2. Strata-Barrier 11 mil by Strata Systems Inc.
3. W.R. Meadows pre-molded membrane with plasmatic core
4. Zero-Perm by Alumiseal Corp.

2.02 ACCESSORIES

A. Seam Tape

1. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower

B. Vapor Proofing Mastic

1. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower

C. Pipe Boots

1. Construct pipe boots from vapor barrier material, pressure sensitive tape or mastic per manufacturer's instructions

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Ensure that subsoil is approved. Level and tamp or roll aggregate, sand or tamped earth base
3.02 INSTALLATION
   A. Vapor Barrier
      1. Do not use screed systems with screed pins that could puncture the vapor barrier.
      2. Unroll vapor barrier with the longest dimension parallel with the direction of the pour
      3. Lap vapor barrier over footings and seal to foundation walls
      4. Overlap joints 6 inches and seal with manufacturer's tape
      5. Seal penetrations including pipes per manufacturer's instructions
      6. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities
      7. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all four sides with tape

3.03 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 07 46 46
MINERAL-FIBER CEMENT SIDING

PART 1 – GENERAL

1.01 SUMMARY
A. Provide all labor, materials, tools and appurtenances for mineral-fiber cement siding systems, underlayment, caulking, fasteners and related appurtenances as specified, as shown on the Drawings and in accordance with applicable reference standards listed in Article 1.03.

B. Siding shall be non-asbestos fiber-cement siding with all accessories as shown on the Drawings and as specified herein. Coordinate the Work of this section with interfacing and adjoining work for proper sequence of installation.

1.02 PRICE AND PAYMENT PROCEDURES
A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES
A. Reference Standards.
1. ASTM International (ASTM)

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
A. The following shall be submitted in accordance with Division 01 requirements:

B. Product Data
1. Manufacturer's Installation Instructions
2. Submit Manufacturer’s specifications, installation data and other pertinent manufacturer's literature.
3. Warranty

C. Samples

1. Samples

2. Submit 6 inch by 6-inch pieces of shingle and/or siding in texture, colors and widths shown and specified herein.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Stack siding on edge or lay flat on a smooth, level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.

1.08 SITE CONDITIONS

A. Existing conditions: per Division 01 General Requirements.

1. Refer to the Drawings for building wall conditions; including the use of weather-resistive barriers and/or vapor barriers.

2. Install weather-resistive barriers and claddings to dry surfaces.

3. Repair any punctures or tears in the weather-resistive barrier prior to the installation of the siding.

4. Protect siding from other trades.

1.09 WARRANTY

A. Special warranty

1. Provide manufacturer's limited product warranty against manufacturing defects for a minimum duration of 30 years in name of the Owner.

PART 2 – PRODUCTS

2.01 MANUFACTURER

A. Provide the specified material from the following manufacturers.

1. James Hardie Building Products, Inc.

2. Certainteed Corporation
3. Or equal

2.02 MATERIAL

A. Non-asbestos fiber-cement siding to comply with ASTM C1186 Grade II, Type A.

B. Siding to meet the following building code compliance National Evaluation Report No. NER 405 (BOCA, ICBO, SBCCI); City of Los Angeles, Research Report No. 24862; Metro Dade County, Florida Acceptance No. 94-1234.04; US Department of Housing and Urban Development Materials Release 1263a; California DSA PS-019; and City of New York MEA 223-93-M. Non-asbestos fiber-cement siding to be non-combustible when tested in accordance with ASTM E 136.

1. Lap Siding: 6-1/4 inch with 5-inch exposure and Cedarmill wood texture surface.

2. Colors: Colors shall be selected by the Engineer. Submit the manufacturer’s full range of colors and finishes for selection by the Engineer for both Shingles and Lap Siding.

2.03 FASTENERS

A. Fasten lap siding by blind nailing with stainless steel nails at 16-inch on center. See manufacturer's installation instructions for nail size.

B. Fasten shingles with stainless steel nails, see manufacturer's installation instructions for nail size and spacing.

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 SURFACE CONDITION

A. Correct conditions detrimental to timely and proper completion of work.

3.02 INSTALLATION

A. Trim and Molding

1. Install flashing around all wall openings.

2. Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 3/4 inch or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
3. Place fasteners no closer than 3/4 inch and no further than 2 inches from side edge of trim board and no closer than 1 inch from end. Fasten maximum 16 inch on center.

4. Maintain clearance between trim and adjacent finished grade.

5. Trim inside corner with single board.

6. Install single board of outside corner board then align second corner board to outside edge of first corner board.

7. Allow 1/8-inch gap between trim and siding.

8. Seal gap with high quality, paintable caulk.

B. Lap Siding

1. Install a minimum 1/4-inch-thick lath starter strip at the bottom course of the wall. Apply planks horizontally with minimum 1-1/4-inch-wide laps at the top. The bottom edge of the first plank overlaps the starter strip.

2. Allow minimum 1-inch vertical clearance between roofing and bottom edge of siding.

3. Face nail to sheathing

4. Locate splices at least 12 inches away from window and door openings.

5. Wind resistance: Where a specified level of wind resistance is required, lap siding is installed to framing members and secured with fasteners described in Table No. 2 in National Evaluation Service Report No. NER-405.

3.03 FINISHING

A. Finish with shop applied painting system. Engineer to select color from submitted samples.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 07 60 00

FLASHING AND SHEET METAL

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide finished sheet metal work in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Provide finished sheet metal work in accordance with this Section and applicable reference standards listed in Article 1.03, including cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the Work of other trades.

3. Coordinate installation of sheet metal items used in conjunction with roofing work to permit continuous roofing operations.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. MA 271 CMR: Rules and Regulations Governing Sheet Metal Workers

2. SMACNA Architectural Manual

3. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

4. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

5. ASTM B32 Standard Specification for Solder Metal

6. ASTM B69 Standard Specification for Rolled Zinc

7. ASTM B101 Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction
8. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate


10. ASTM B370 Standard Specification for Copper Sheet and Strip for Building Construction

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

C. Samples and Mockups: as specified in Article 1.06. color palettes for metal flashing

D. Manufacturer Instructions

E. Closeout and maintenance material submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the Site. Remove from the Site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until immediately before installation

1.08 SITE CONDITIONS

A. Provide in accordance with Division 01 General Requirements.
PART 2 – PRODUCTS

2.01 MATERIALS

A. Do not use lead, lead-coated metal, or galvanized steel. Use any metal listed by SMACNA Architectural Manual for a particular item, unless otherwise specified or indicated. Conform to the requirements specified and to the thicknesses and configurations established in SMACNA Architectural Manual for the materials. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items must be copper.

B. Furnish sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory-fabricate corner pieces with minimum 12-inch legs. Provide accessories and other items essential to complete the sheet metal installation. Make these accessories of the same materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below.

1. Exposed sheet metal items: Must be of the same material. Consider the following as exposed sheet metal; cap, valley, steeped, base, and eave flashings and related accessories.

2. Copper, sheet and strip: ASTM B370, cold-rolled temper, H 00 standard.


5. Zinc sheet and strip: ASTM B69, Type I, a minimum of 0.024 inch thick.

6. Stainless steel: ASTM A240, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper.

7. Aluminum alloy sheet and plate: ASTM B209, Baked enamel finish; 0.050 inch thick except as otherwise indicated. Brake form to profiles needed.

8. Aluminum alloy, extruded bars, rods, shapes, and tubes: ASTM B221.


10. Fasteners: Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

11. Roof expansion joint cover: Provide factory-manufactured flexible, weatherproof, exterior covers for structural expansion joints. Cover shall be manufactured of 3-ply flexible reinforced Hypalon Bellow supported by closed cell foam with aluminum mounting flanges factory locked to each.
edge of bellow. Provide roof expansion joint covers by Portals Plus or approved equal

12. Elastic sheet flashing: Manufacturer's standard flexible, elastic, black, non-reinforced, flashing sheet of 60 mil minimum total thickness. Provide perm-barrier wall flashing by Grace Construction Products or approved equal

2.02 DRIP EDGE

A. Manufactured from prefinished aluminum coil stock manufactured from 0.032-inch thick coil stock.
B. Color: Submit manufacturer color charts for owner selection of colors.
C. Drip edges are required at the following locations:
   1. At the head of all exterior window framed openings
   2. At the head of all framed openings for exterior doors
   3. Continuous along all roof eaves
   4. Where otherwise indicated on Drawings.

2.03 GUTTERS & DOWNSPOUTS

A. Provide complete gutter, downspout, straps, clips and discharge fittings to collect and remove water from building eaves and canopies.
   2. Material: Prefinished Seamless Aluminum
   3. Color: as selected by Owner or Engineer.
B. Downspouts
   1. Provide open-faced downspouts to resist ice formation.
   2. Size: by manufacturer.
   3. Maximum gutter spacing and gutter locations: per structural Drawings.
   4. Color: as selected by Owner or Engineer.

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Workmanship: Make lines and angles sharp and true, forming weather tight construction without waves, warps, buckles, fastening stresses or distortion, which allows for expansion and contraction. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction

1. Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by Specifications, conform to the applicable requirements of SMACNA Architectural Manual, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the Work watertight.

B. Nailing: Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inches. Confine nailing of flashing to one edge only. Space nails evenly not over 3 inches on center and approximately 1/2 inch from edge, unless otherwise specified or indicated. Face nailing is not permitted. Where sheet metal is applied to other than wood surfaces, include in Shop Drawings, the locations for sleepers and nailing strips required to secure the Work.

C. Cleats: Provide cleats for sheet metal 18 inches and over in width. Space cleats evenly not over 12 inches on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inches wide by 3 inches long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nail heads. Lock the other end into the seam. Where the fastening is to concrete or masonry, use screws and drive in expansion shields set in concrete or masonry.

D. Bolts, rivets, and screws: Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Make joints in aluminum sheets 0.050 inch or less in thickness

E. Seams: Straight and uniform in width and height

1. Flat-lock seams: Finish not less than 3/4 inch wide
2. Lap seams: Overlap seams not soldered, not less than 3 inches
3. Flat seams: Make seams in the direction of the flow
F. Metal drip edge: Provide a metal drip edge, designed to allow water run-off to drip free of underlying construction at eaves and rakes prior to the application of roofing shingles. Apply directly on the wood deck at the eaves and over the underlay along the rakes. Extend back from the edge of the deck not more than 3 inches and secure with compatible nails spaced not more than 10 inches on center along upper edge.

G. Flashing at roof penetrations and equipment supports: Provide pre-fabricated flashing for all pipes, ducts, and conduits projecting through the roof surface and for equipment supports, guy wire anchors, and similar items supported by or attached to the roof deck.

H. Stepped flashing: Stepped flashing shall be installed where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

3.02 PROTECTION FROM CONTACT WITH DISSIMILAR MATERIALS

A. Copper or copper-bearing alloys: Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moisture-proof building felts.

B. Aluminum: Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.

C. Metal surfaces: Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.03 CLEANING

A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

3.04 REPAIRS

A. Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items that cannot be repaired.
3.05 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide factory color finished, galvanized metal panel roof system with concealed clip attachment through to deck substrate. Roof panel profile shall be standing seam in accordance with this Section and applicable reference standards listed in Article 1.03 including cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the Work of other trades.

B. Related Requirements

1. Design Requirements

a. Wind Uplift Resistance

1) The required uplift resistance of the roof assembly shall be calculated in accordance with ASCE 7-10. Metal roof panel assembly shall resist the calculated loads incorporating appropriate safety factors and including increased loads in perimeter and corner areas.

2) The roof assembly shall be tested in accordance with ASTM E1592 to resist the calculated loads. Non-tested assemblies shall not be installed.

3) The installed roof assembly shall be watertight, conform to the roof slope, and resist the uplift pressures calculated. The Contractor shall furnish a commercially available roofing system which satisfies all specified requirements.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment Requirements: Per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Society of Civil Engineers (ASCE)

2. ASTM International (ASTM)
   a. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   c. ASTM A792 Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
   d. ASTM D1308 Effect of Household Chemicals on Clear and Pigmented Organic Finishes
   e. ASTM D1654 Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
   f. ASTM D1970 Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
   g. ASTM D2244 Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
   h. ASTM D2247 Testing Water Resistance of Coatings in 100% Relative Humidity
   i. ASTM D2794 Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
   j. ASTM D3359 Measuring Adhesion by Tape Test
   k. ASTM D4214 Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
   l. ASTM D4587 Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
   m. ASTM D522 Mandrel Bend Test of Attached Organic Coatings
   n. ASTM D523 Standard Test Method for Specular Gloss
   o. ASTM D5894 Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
   p. ASTM D610 Evaluating Degree of Rusting on Painted Steel Surfaces
   q. ASTM D714 Evaluating Degree of Blistering of Paints
r. ASTM D968 Abrasion Resistance of Organic Coatings by Falling Abrasive
s. ASTM D1592 Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
t. ASTM D154 Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

3. Metal Building Manufacturers Association (MBMA)
   a. MBMA RSDM Metal Roofing Systems Design Manual

4. National Roofing Contractors Association (NRCA)
   a. NRCA 0405 Roofing and Waterproofing Manual

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Shop Drawings

1. Metal Roofing
   a. Drawings consisting of catalog cuts, panel configuration, system assembly, attachment details, flashing details, erection drawings, and other data as necessary to clearly describe layouts, construction details, fasteners, and erection. Drawings shall be approved by the metal roofing manufacturer prior to submission.

C. Product Data

1. Roof Panels
2. Factory Color Finish
3. Accessories
4. Fasteners
5. Gaskets and Insulating Compounds

D. Samples

1. Factory-Applied Color Finish Charts

E. Provide standard color charts for roof panel and accessory color selection.
1. Wind Uplift Resistance

F. Reports

1. Roof Assembly
2. Factory Color Finish Performance Requirements

G. Certificates

1. Roof Panels
   a. Certificates from the roof panel manufacturer attesting that the panels and accessories conform to the specified requirements and are suitable for the installation environment at the indicated design slope.

2. Coil Stock Compatibility
   a. Provide certification of coil compatibility with roll forming machinery to be used in the field.

3. Qualification of Manufacturer
   a. Certify that the manufacturer of the roof panel meets requirements specified under paragraph entitled "Qualification of Manufacturer."

4. Qualification of Applicator
   a. Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Applicator."

H. Manufacturer’s Instructions

1. Installation
   a. Roof panel installation manual.
   b. Submit manufacturer's printed installation manual and instructions.

I. Closeout Submittals

1. Warranties
2. Information Card

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualification of Manufacturer
1. Metal roof panel manufacturer shall have been in the business of manufacturing metal roof panels for a period of not less than 5 years.

C. Qualification of Applicator

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

D. Pre-Roofing Conference

1. After approval of submittals and before performing roofing system installation Work, hold a pre-roofing conference to review the following:
   a. Drawings and specifications and submittals related to the roof Work.
   b. Roof system components installation.
   c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representative.
   d. Contractor's plan for coordination of the Work of the various trades involved in providing the roofing system and other components secured to the roofing.
   e. Quality control plan for the roof system installation.
   f. Safety requirements.

2. The conference shall be attended by the Contractor, the Owner's designated personnel, personnel directly responsible for the installation of metal roof system, flashing and sheet metal Work, other trades interfacing with the roof Work, and representative of the metal roofing manufacturer. Before beginning roofing Work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.
B. Deliver, store, and handle panel materials, bulk roofing products, accessories, and other manufactured items in a manner to prevent damage and deformation, as recommended by the manufacturer, and as specified.

C. Delivery

1. Deliver materials to the site in undamaged condition. Provide adequate packaging to protect materials during shipment. Crated materials shall not be uncrated until ready for use, except for inspection. Immediately upon arrival of materials at jobsite, inspect materials for damage, deformation, dampness, and staining. Remove affected materials from the site. Remove moisture from wet materials not otherwise affected, restack and protect from further moisture exposure.

D. Storage

1. Stack materials stored on site on platforms or pallets and cover with tarpaulins or other weathertight covering which prevents trapping of water or condensation under the covering. Store roof panels so that water which may have accumulated during transit or storage will drain off. Do not store panels in contact with materials that might cause staining. Secure coverings and stored items to protect from wind displacement.

E. Handling

1. Handle materials in a manner to avoid damage. Select and operate material handling equipment so as not to damage materials or applied roofing.

1.08 SITE CONDITIONS

A. Existing Conditions: Per Division 01 General Requirements.

1.09 WARRANTIES

A. Provide metal roof system material and workmanship warranties meeting specified requirements. Revision or amendment to manufacturer’s standard warranty shall be provided as required to comply with the specified requirements.

B. Metal Roof Panel Manufacturer Warranty

1. Furnish the metal roof panel manufacturer's 20-year no dollar limit roof system materials and installation workmanship warranty, including flashing, components, trim, and accessories necessary for a watertight roof system construction. The warranty shall run directly to the Owner and commence at time of Owner's acceptance of the roof work. The warranty shall state that:
If within the warranty period the metal roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, displaces, corrodes, perforates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the metal roof system and correction of defective workmanship shall be the responsibility of the metal roof panel manufacturer. All costs associated with the repair or replacement Work shall be the responsibility of the metal roof panel manufacturer.

When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others shall not void the warranty.

C. Manufacturer's Finish Warranty

1. Provide a manufacturer's 20-year exterior material finish warranty warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D2244.

D. Metal Roof System Installer Warranty

1. The roof system installer shall warrant for a period of not less than five years that the roof system, as installed, is free from defects in installation workmanship, to include the roof panel installation, flashing, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. The warranty shall run directly to the Owner. Correction of defective workmanship and replacement of damaged or affected materials shall be the responsibility of the metal roof system installer. All costs associated with the repair or replacement Work shall be the responsibility of the installer.

E. Continuance of Warranty

1. Repair or replacement Work that becomes necessary within the warranty period shall be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the metal roof system manufacturer warranty for the remainder of the manufacturer warranty period.
PART 2 – PRODUCTS

2.01 MATERIALS

A. Roof Panels

1. Roof panels shall be steel with a factory-applied color finish. Panel attachment shall be with concealed clips. Panel profile shall be standing seam. Roof panels shall provide nominal 16 inches of coverage in place. Minimum height of seams at overlap of adjacent roof sheets shall be 1/2-inch. Individual panels shall be of continuous length sufficient to cover the entire length of any unbroken roof slope with no joints or seams, except where indicated or approved otherwise by the Engineer. Panels shall be formed without warping, waviness, or ripples that are not a part of the panel profile and shall be free of damage to the finish coating system. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. All sheets shall be either square-cut or miter-cut.

2. Steel Panels: Zinc-coated steel conforming to ASTM A653, Structural Grade 40 and minimum G90 galvanized smooth metallic coating; aluminum-zinc alloy coated steel conforming to ASTM A792, AZ 55 coating. Pre-painted steel sheet shall also comply with ASTM A755. Roof panel material shall be minimum 24 gage prior to coating application, and as required to meet wind uplift requirements. Panels shall be within 95 percent of the nominal thickness. Prior to shipment, mill finish panels shall be treated with a passivating chemical and oiled to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

3. Texture: Smooth.

B. Roof Panel Factory Color Finish

1. Provide factory-applied, thermally cured coating system on roof panel surfaces. Provide exterior coat of primer and 70 percent polyvinylidene fluoride resin color finish coat on the exposed side. Prime coat shall be not less than 0.2 mil. Color finish coat shall be not less than 0.8 mil. Total color coating system thickness shall be not less than 1 mil and with any additional primer and finish coat thickness required to meet the color finish performance requirements specified. Underside coating shall consist of roof panel manufacturer recommended protective backer coat suitable for the application conditions, not less than 0.3 mil thick unless approved otherwise by the Engineer. Finish coat color shall be as selected by Engineer from manufacturer standard color charts. The exterior color finish shall meet the performance requirements specified.

2. Factory Color Finish Performance Requirements
a. Cyclic Salt Fog/UV Test
   1) A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2014 hours in accordance with ASTM D5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 8, no blistering, as determined by ASTM D714; no rusting, as determined by ASTM D610; and a rating of 6, less than 1/16-inch creepage from scribe as determined by ASTM D1654.

b. Formability Test
   1) When subjected to testing in accordance with ASTM D522 Method B, 1/8-inch diameter mandrel, the coating film shall show no evidence of fracturing to the naked eye.

c. Accelerated Weathering, Chalking Resistance and Color Change
   1) Coating sample shall withstand weathering test of 5000 hours, in accordance with ASTM D4587 and ASTM G154, Type D, without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating with an adhesion rating of less than 4B when tested in accordance with ASTM D3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D2244.

d. Humidity Test
   1) When subjected to a humidity cabinet test in accordance with ASTM D2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

e. Impact Resistance
   1) Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D2794 0.50-inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no cracking.

f. Specular Gloss
   1) Finished roof surfaces for shall have a specular gloss value of 30 plus or minus 5 at an angle of 60 degrees when measured in accordance with ASTM D523.
g. Pollution Resistance

1) Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D1308.

C. Accessories

1. Accessories shall be compatible with the metal roof panels. Sheet metal flashing, trim, metal closure strips, caps, and similar metal accessories shall be not less than the minimum thicknesses specified for roof panels. Exposed metal accessories shall be finished to match the panels furnished. Molded foam rib, ridge and other closure strips shall be closed-cell or solid-cell synthetic rubber or neoprene pre-molded to match configuration of the panels and shall not absorb or retain water.

2. Pre-Manufactured Accessories

a. Pre-manufactured accessories shall be manufacturer's standard for intended purpose, compatible with the metal roof system and approved for use by the metal roof panel manufacturer. Curbs shall be constructed to match roof slope.

D. Fasteners

1. Fasteners for roof panels shall be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel, compatible with the sheet panel or flashing material and of type and size recommended by the manufacturer to meet the performance requirements. Fasteners for accessories shall be the manufacturer's standard. Exposed fasteners shall have integral metal washer head and compressible sealing EPDM washer. Sealing washer shall be approximately 3/32-inch thick. Exposed portion of fasteners shall match color of attached material.

2. Screws: Not smaller than No. 14 self-tapping type and not less than No. 12 self-drilling type.

3. Rivets: Closed-end type where watertight connections are required.

E. Sealant: Sealant shall be an elastomeric type containing no oil or asphalt, as recommended by the roof panel manufacturer. Silicone based sealants are prohibited, unless approved otherwise by the roof panel manufacturer and the Engineer. Exposed sealant shall be colored to match adjacent components and shall cure to a rubberlike consistency. Concealed sealant shall be non-hardening type. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.
F. Gaskets and Insulating Compounds: Gaskets and insulating compounds shall be non-absorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive metal roof panel and flashing installation. Ensure surfaces are suitable, dry and free of defects and projections which might affect the installation.

3.02 INSTALLATION

A. Installation shall meet specified requirements and be in accordance with the manufacturer's installation instructions and approved shop drawings. Correct defects or errors in materials and installation. Do not install damaged materials. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged materials shall be removed from the site.

B. Roofing: Apply roofing panels with longitudinal configurations in the direction of the roof slope. Provide roofing panels in unbroken lengths from peak to low point with no transverse joints except at junction of ventilators, curbs, skylights, chimneys, and similar openings, unless otherwise indicated or approved by the Engineer. Where panel end laps are required, form and install to shed water and seal in a watertight manner as recommended by the panel manufacturer's installation instructions. Attach roof panels in the manner, type and frequency required by the roof panel manufacturer and to resist required wind uplift pressures. Close panel ribs or side laps as required by the manufacturer to meet specified requirements. Lay side laps away from prevailing wind. Side and end lap distances, joint sealing, and fastening and spacing of fasteners shall be in accordance with manufacturer's instructions. Flash seal roof at ridge, eaves, rakes, and at projections through roof. All sheet metal laps, including but not limited to panel side laps end laps, flashing laps and junctures at accessories and penetrations flashings, shall be sealed watertight within the lap area. Closure strips, flashing, and sealing material shall be provided as indicated and where otherwise necessary to provide complete weathertight construction.

1. Field Forming of Roof Panels: Roll forming equipment shall be maintained in proper working order and operated by a factory trained technician. Field formed panels shall meet all specified requirements. Where UL 580
classified materials are required, roll-former equipment certification shall be provided. In cold weather conditions, warming of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

C. Flashings: Provide all flashings, related closures, and accessories necessary for a complete, watertight installation. Minimize exposed fastening of flashings. On sloped planes, form flashing lap joints to shed water and provide sealant within the lap area. Laps joints shall have minimum 4-inch overlap except where greater overlap is indicated, or otherwise required by the roof panel manufacturer. For butt joints of flashings, provide joint splice and cover plates supplemented by waterproof sealants and sealant tapes to form a watertight joint condition. Ensure firm underlying support for joints greater than 8 inches wide and where otherwise indicated or required by the roof panel manufacturer. Installation shall allow for expansion and contraction of flashing without impacting watertight integrity.

D. Exposed Fastener Installation: Where exposed fastening is required, provide fastener spacings in accordance with manufacturer's recommendations, in straight lines and to present a uniform appearance. Drive fasteners normal to surface and to uniform depth to seat washers with gaskets without tearing or cracking gasketing material. Exercise extreme care when drilling pilot hole for fastenings to keep drills perpendicular and centered. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used when applying fasteners shall not exceed that recommended by manufacturer. Remove metal shavings and filings from roofs upon completion to prevent rusting and discoloration of panels.

3.03 PROTECTION OF APPLIED ROOFING

A. Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to indicated live load limits of roof construction.

3.04 CORRECTION OF DEFICIENCIES

A. Where any form of deficiency is found, additional measures shall be taken as deemed necessary by the Engineer to determine the extent of the deficiency and corrective actions shall be as directed by the Engineer.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Construction Monitoring
1. During progress of the roof work, Contractor shall make visual inspections as necessary to ensure compliance with specified requirements. Additionally, verify the following:

   a. Materials comply with the specified requirements.
   b. All materials are properly stored, handled and protected from damage. Damaged materials are removed from the site.
   c. Substrates are in acceptable condition, in compliance with specification, prior to application of underlayment, roof panel, and flashing materials.
   d. Nailers and blocking are provided where and as needed.
   e. Slip sheet, if required, is installed as roof panels are installed.
   f. Panels are installed without buckles, ripples, or waves and in uniform alignment and modulus.
   g. Side laps are formed, sealed, fastened or seam locked as required.
   h. The proper number, type, and spacing of attachment clips and fasteners are installed.
   i. Installer adheres to specified and detailed application parameters.
   j. Associated flashings and sheet metal are installed in a timely manner in accord with the specified requirements.

3.06 INFORMATION CARD

   A. For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 0.032-inch-thick aluminum card for exterior display. Card shall be 8 1/2 by 11 inches minimum. Information card shall identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, roof panel manufacturer and product name, type underlayment(s), date of completion; installing contractor identification and contact information; manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Engineer and provide a paper copy to the Engineer.

3.07 CLOSEOUT ACTIVITIES

   A. Provide in accordance with Division 01 General Requirements.

   END OF SECTION
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SECTION 07 92 00

JOINT SEALANTS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes
   1. Provide joint sealant accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards
   1. ASTM International (ASTM)

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data
   1. Shelf Life
   2. Curing Time
   3. Mixing and Application Instructions
   4. Primer Data

C. Samples and Mockups: as specified in Article 1.06.
   1. Initial selection: Submit Samples of manufacturer's color charts showing complete range of colors, textures, and finishes available for each material used
2. Verification: Submit actual representative Samples of each sealant material that is to be exposed in the completed Work. Show full color ranges and finish variations expected. Provide sealant Samples having minimum size of 4 inches long

D. Certificates
   1. Material Safety Data Sheets
   2. Certification of Compliance

E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Compatibility with substrate: Verify that each of the sealants are compatible for use with joint substrates

C. Joint tolerance: Provide joint tolerances in accordance with manufacturer's printed instructions

D. Mock-up: Project personnel is responsible for installing sealants in mock-up prepared by other trades, using materials and techniques approved for use on the Project

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Deliver materials to the Site in unopened manufacturers' external shipping containers, with brand names, date of manufacture, color, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Carefully handle and store materials to prevent inclusion of foreign materials or subjection to sustained temperatures exceeding 90 degrees F or less than 0 degrees F

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 ENVIRONMENTAL CONDITIONS

A. Apply sealant when the ambient temperature is between 40 and 90 degrees F
1.10 WARRANTY

A. Special Warranty/Extended Correction Period: 5 years against failure of sealant and against water penetration through each sealed joint

PART 2 – PRODUCTS

2.01 SEALANTS

A. Typical interior sealant: Provide polyurethane sealants that meet requirements of ASTM C920, Type M, Grade NS, Class 25, Use NT, M, G, A, O. Locations and color of sealant for the following

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small voids between walls or partitions and adjacent lockers, casework,</td>
<td>As selected by Engineer</td>
</tr>
<tr>
<td>shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items</td>
<td></td>
</tr>
<tr>
<td>Perimeter of frames at doors, windows, and access panels that adjoin exposed interior concrete and masonry surfaces</td>
<td>As selected by Engineer</td>
</tr>
<tr>
<td>Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed</td>
<td>As selected by Engineer</td>
</tr>
<tr>
<td>Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted</td>
<td>As selected by Engineer</td>
</tr>
<tr>
<td>Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change</td>
<td>As selected by Engineer</td>
</tr>
</tbody>
</table>

B. Exterior sealant: For joints in vertical and horizontal surfaces, polyurethane sealant that meets requirements of ASTM C920, Type M, Grade NS, Class 25, Use M, G, A, O. Provide locations and colors of sealant as follows
LOCATION	COLOR
Joints and recesses formed where frames and sub-sills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations	As selected by Engineer

Joints between new and existing exterior masonry walls	As selected by Engineer

Masonry joints where shelf angles occur	As selected by Engineer

Expansion and control joints	As selected by Engineer

Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required	As selected by Engineer

Voids where items pass through exterior walls	As selected by Engineer

Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels	As selected by Engineer

Metal-to-metal joints where sealant is indicated or specified	As selected by Engineer

Joints between ends of gravel stops, fascia’s, copings, and adjacent walls	As selected by Engineer

C. General Sealant:

1. Floor joint sealant: ASTM C920, Type M, Grade P or NS, Class 25, Use T. Provide locations and colors of sealant as follows

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seats of metal thresholds for exterior doors</td>
<td>As selected by Engineer</td>
</tr>
</tbody>
</table>
Control and expansion joints in floors, slabs, ceramic tile, and walkways As selected by Engineer

2. Preformed sealant: Provide preformed sealant of polybutylene or isoprene-butylened based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 34 degrees to plus 71 degrees C (30 degrees to plus 160 degrees F), the sealant must be non-bleeding and no loss of adhesion

3. Concrete slab joint sealant: For joints in concrete slabs, provide polyurethane elastomeric sealant meeting the requirements of ASTM C 920, Type S, Grade P or NS, Class 25, Use T. Color selected by Engineer from submitted Samples

4. Concrete wall joint sealants: For joints in concrete walls, provide polyurethane elastomeric sealant meeting the requirements on ASTM C 920, Type S, Grade NS, Class 25, Use NT. Color selected by Engineer from submitted Samples

2.02 PRIMERS

A. Provide a non-staining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application

2.03 BOND BREAKERS

A. Provide the type and consistency recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint

2.04 SEALANT BACK-UP ROD

A. Provide polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 percent to 33 percent oversized backing for closed cell, unless otherwise indicated. Make backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops

2.05 CLEANING SOLVENTS

A. Provide types recommended by the sealant manufacturer except for aluminum and bronze surfaces that will be in contact with sealant

2.06 SOURCE OF QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 SURFACE PREPARATION

A. Clean surfaces from dirt frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would tend to destroy or impair adhesion. Remove oil and grease with solvent. Surfaces must be wiped dry with clean cloths. When resealing an existing joint, remove existing calk or sealant prior to applying new sealant. For surface types not listed below, contact sealant manufacturer for specific recommendations.

B. Steel surfaces: Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finish work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue-free solvent.

C. Aluminum or bronze surfaces: Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive just prior to sealant application. For removing protective coatings and final cleaning, use non-staining solvents recommended by the manufacturer of the items containing aluminum or bronze surfaces.

D. Concrete and masonry surfaces: Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence, and loose mortar from the joint cavity.

E. Wood surfaces: Keep wood surfaces to be in contact with sealants free of splinters and sawdust or other loose particles.

3.02 SEALANT PREPARATION

A. Do not add liquids, solvents, or powders to the sealant. Mix multi-component elastomeric sealants in accordance with manufacturer's instructions.

3.03 APPLICATION

A. Joint width-to-depth ratios

1. Acceptable Ratios

<table>
<thead>
<tr>
<th>JOINT WIDTH</th>
<th>JOINT DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>Maximum</td>
</tr>
</tbody>
</table>

For metal, glass, or other nonporous surfaces:

1/4 inch (minimum)  1/4 inch  1/4 inch
JOINT SEALANTS

WOODARD & CURRAN

07 92 00-7

<table>
<thead>
<tr>
<th>Joint Width</th>
<th>Depth</th>
<th>Joint Width-to-Depth Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>over 1/4 inch</td>
<td>1/2 of width</td>
<td>Equal to width</td>
</tr>
<tr>
<td>1/4 inch (minimum)</td>
<td>1/4 inch</td>
<td>1/4 inch</td>
</tr>
<tr>
<td>Over 1/4 inch to 1/2 inch</td>
<td>1/4 inch</td>
<td>Equal to width</td>
</tr>
<tr>
<td>Over 1/2 inch to 2 inch</td>
<td>1/2 inch</td>
<td>5/8 inch</td>
</tr>
<tr>
<td>Over 2 inch</td>
<td>(As recommended by sealant manufacturer)</td>
<td></td>
</tr>
</tbody>
</table>

2. Unacceptable ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining Work. Grinding is not required on metal surfaces.

B. Masking tape: Place masking tape on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Remove masking tape within 10 minutes after joint has been filled and tooled.

C. Backstops: Install backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide a joint of the depth specified. Install backstops in the following locations:

1. Where indicated

2. Where backstop is not indicated but joint cavities exceed the acceptable maximum depths specified in paragraph entitled, Joint Width-to-Depth Ratios.

D. Primer: Immediately prior to application of the sealant, clean out loose particles from joints. Where recommended by sealant manufacturer, apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's instructions. Do not apply primer to exposed finish surfaces.

E. Bond breaker: Provide bond breakers to the back or bottom of joint cavities, as recommended by the sealant manufacturer for each type of joint and sealant used, to prevent sealant from adhering to these surfaces. Carefully apply the bond breaker to avoid contamination of adjoining surfaces or breaking bond with surfaces other than those covered by the bond breaker.

F. Sealants: Provide a sealant compatible with the materials to which it is applied. Do not use a sealant that has exceeded shelf life or has jelled and cannot be discharged in a continuous flow from the gun. Apply the sealant in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Force sealant into joints to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Make sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled.
or unfilled joints, apply sealant, and tool smooth as specified. Apply sealer over the sealant when and as specified by the sealant manufacturer.

### 3.04 PROTECTION AND CLEANING

**A. Protection:** Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled.

**B. Final cleaning:** Upon completion of sealant application, remove remaining smears and stains and leave the Work in a clean and neat condition.

1. **Masonry and other porous surfaces:** Immediately scrape off fresh sealant that has been smeared on masonry and rub clean with a solvent as recommended by the sealant manufacturer. Allow excess sealant to cure for 24 hours, then remove by wire brushing or sanding.

2. **Metal and other non-porous surfaces:** Remove excess sealant with a solvent-moistened cloth.

### 3.05 FIELD QUALITY CONTROL

**A.** Provide in accordance with Division 01 General Requirements.

### 3.06 CLOSEOUT ACTIVITIES

**A.** Provide in accordance with Division 01 General Requirements.

**END OF SECTION**
SECTION 08 11 00

METAL DOORS AND FRAMES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide metal doors and frames in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 08 71 00 - Door Hardware
2. Section 09 90 00 - Painting and Coating

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Welding Society (AWS)
   a. AWS D1.1 Structural Welding Code – Steel
2. ASTM International (ASTM)
   a. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   b. ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
   c. ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
   d. ASTM D2863
3. Builders Hardware Manufacturers Association (BHMA)
   a. BMHA A115 Specifications for Steel Door and Frame Preparation for Hardware
4. National Fire Protection Association (NFPA)
5. Steel Door Institute (SDI/DOOR)
   a. SDI/DOOR 113 Standard Practice for Determining the State Date Thermal Transmittance of Steel Door and Frame Assemblies
   b. SDI/DOOR A250.4 Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.
   c. SDI/DOOR A250.6 Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
   d. SDI/DOOR A250.8 Specifications for Stand Steel Doors and Frames
   e. SDI/DOOR A250.11 Recommended Erection Instructions for Steel Frames

6. Underwriters Laboratories (UL)
   a. UL 10B Standard for Fire Tests of Door Assemblies

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data
   1. Doors
   2. Frames
   3. Accessories

C. Shop Drawings
   1. Doors
   2. Frames
   3. Accessories
   4. Schedule of doors
5. Schedule of frames

6. Submit door and frame locations.

D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading

1. 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.

C. Storage and Protection

1. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

1.08 SITE CONDITIONS

A. Provide in accordance with Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Stanley

B. Republic Builders Products Corp.

C. Ceco Door

D. Curries

E. or equal

2.02 STANDARD STEEL DOORS

A. SDI/DOOR A250.8, except as specified otherwise:
1. Thickness: 1-3/4 inch
2. Face Sheets: 16 gauge galvanized steel
3. Edges: 16 gauge galvanizes steel
4. Undercut where indicated.

B. Exterior doors: Top edge closed flush and sealed to prevent water intrusion.

C. Hardware: Prepare doors to receive specific door hardware.

D. Testing: In accordance with SDI/DOOR A250.4, must meet the requirements for Level C

2.03 DOOR INSULATION CORES

A. Where specified, provide insulated cores in accordance with SDI/DOOR 113 and as specified:
   1. Material: Rigid Polyurethane Form
   2. Minimum R Factor: 10.0; ASTM C 518
   3. Maximum U Factor: 0.10; ASTM C 518

2.04 DOOR ACCESSORIES

A. Moldings: Provide around glass of interior and exterior doors.
   1. Provide non-removable moldings on outside of exterior doors and on corridor side of interior doors.
   2. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings or provide snap on moldings.

2.05 STANDARD STEEL FRAMES

A. SDI/DOOR A250.8, except as otherwise specified. Form frames to sizes and shapes with welded corners (knockdown corners are not permitted). Provide steel frames for doors, unless otherwise indicated

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 and in accordance with the practice specified by the producer of the metal being welded
2. Stops and beads: Form stops and beads from 20-gauge 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 inches on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

3. Anchors: Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated, not lighter than 18 gauge.

4. Wall Anchors: Provide at least three bolts for each jamb. For frames that are more than 7.5 feet in height, provide one additional bolt for each jamb for each additional 2.5 feet or fraction. Provide retrofit frames with bolt holes and dimples for 316 stainless steel expansion bolts.

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

2.06 FIRE AND SMOKE DOORS AND FRAMES

A. NFPA 80 and NFPA 105 and this Specification. The requirements of NFPA 80 and NFPA 105 shall take precedence over details indicated or specified.

B. Door and frame labels: Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10B. Labels shall be metal with raised letters and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames and to the hinge edge of the door. Door labels shall not be painted.

2.07 WEATHER STRIPPING

A. As specified in Section 08 71 00, Door Hardware.

2.08 HARDWARE PREPARATION

A. Provide minimum hardware reinforcing gauges as specified in SDI/DOOR A250.6.

B. Drill and tap doors and frames to receive finish hardware.

C. 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 BHMA A115.

D. Drill and tap for surface-applied hardware at the Project Site.

E. Build additional reinforcing for surface-applied hardware into the door at the factory.
F. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable.

G. Punch doorframes, with the exception of frames that will have weather stripping gasketing, to receive a minimum of two rubber or vinyl door silencers on lock side of single doors.

H. Set lock strikes out to provide clearance for silencers

2.09 FINISHES

A. Hot-dip zinc-coated and factory-primed finish: Fabricate all doors and frames from hot-dipped zinc-coated steel, alloyed type, that complies with ASTM A924 and ASTM A653.

1. Coating Weight: Meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40.

2. Repair damaged zinc-coated surfaces by the application of zinc dust paint.

3. Thoroughly clean and chemically treat to insure maximum paint adhesion.


2.10 FABRICATION AND WORKMANSHIP

A. 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.

1. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment.

2. Dress exposed welded and soldered joints smooth.

3. Design doorframe sections for use with the wall construction indicated.

4. Corner joints shall be well formed and in true alignment.

5. Conceal fastenings where practicable.

6. Design frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.

B. Grouted frames: For frames to be installed in exterior walls, fill with foam insulation
2.11 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION
   A. 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. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed.
   
   B. Doors: Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

   C. Fire and smoke doors and frames: Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated smoke doors and frames in accordance with NFPA 80 and NFPA 105.

3.02 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.03 STARTUP & COMMISSIONING
   A. Provide in accordance with Division 01 General Requirements.

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

3.05 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

3.06 PROTECTION
   A. 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.
   
   B. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat, by the Painting Subcontractor in accordance with Section 09 90 00.

END OF SECTION
SECTION 08 16 15
FIBERGLASS DOORS AND FRAMES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide fiberglass doors and frames in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Design Requirements for design door opening assemblies to resist failure from corrosion. Design door opening assemblies to have minimum fiberglass content of 30 percent mean, by weight

B. Related Requirements

1. Section 08 71 00 Door Hardware
2. Section 08 81 00 Glass Glazing
3. Door opening assemblies: Maximum flame spread 25 in accordance with ASTM E84, self-extinguishing in accordance with ASTM D635
4. Door opening assemblies: FDA accepted
5. Door opening assemblies: USDA accepted

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.04 REFERENCES

A. Reference Standards

1. ASTM D635
2. ASTM E84

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.
B. Product Data
   1. Manufacturer's printed product data indicating characteristics of products specified in this section
   2. Manufacturer's Installation Instructions
   3. Manufacturer's standard warranty documents, executed by manufacturer's representative, countersigned by Contractor

C. Shop Drawings
   1. Fabrication and Installation Drawings
   2. Plans: Indicate location of each door opening assembly in Project
   3. Dimensioned elevation of each type of door opening assembly in Project, indicate sizes and locations of door hardware, lites and louvers, if specified
   4. Installation details of each type of installation condition in the Project. Indicate installation details of glazing, if specified
   5. Schedule: Indicate each door opening assembly in Project, cross-reference to Plans, elevations, and details

D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements for door and frame production experience and as follows.
   1. Manufacturer: Minimum 20 continuous years documented experience producing products specified in this section

C. Source: Provide doors and frames by a single manufacturer for the entire Project

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading
   1. Deliver, handle, and store doors and frames at the job Site in such a manner as to prevent damage. Only remove cartons upon arrival of doors at job Site if cartons are wet or damaged. All damaged or otherwise unsuitable doors
and frames, when so ascertained, shall be immediately removed from the job site.

C. Acceptance at Site
   1. Doors shall not be received before the building is enclosed.

D. Storage and Protection
   1. Doors shall be stored out of weather and extreme temperatures. The doors shall be stored in a vertical position on blocking, clear of the floor and with blocking between the doors to permit air circulation between the doors.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 WARRANTY

A. Manufacturer's Warranty: Manufacturer's 10-year warranty against failure due to corrosion from specified environment.

B. To include 10 years free from defects in material and workmanship from date of shipment, and 25 years from degradation of failure due to corrosion from date of shipment, provided the structural integrity of the doors and frames has not been violated or compromised. No unauthorized cuts, bores, or other structural alterations affecting the core of the door, or the structure of the frame.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Products manufactured by the following companies complying with these Specifications will be acceptable for interior and exterior doors:
   1. Corrim Company
   2. Chem-Pruf Door Company
   3. Simon Door Company
   4. Approved Equal

B. Products manufactured by the following companies complying with these Specifications will be acceptable for non-insulated interior doors only:
   1. Overly Door Company
   2. Approved Equal
C. Products manufactured that have successfully completed ANSI A250.4 Mod. Swing Cycle test in excess of 1,000,000 cycles, with no failure of any design features of the door.

2.02 DOORS

A. Door Fabrication FRP (Fiberglass Reinforced Plastic) Face Sheets

1. Face sheets: Standard face sheets shall be manufactured using a corrosion resistant resin system with light stabilizing additives. The resin shall be reinforced with fiberglass

2. Face sheets shall be 0.070-inch to 0.125-inch thickness, with the standard being 0.120-inch. Total door thickness to be a nominal 1-3/4 inches.

3. Finish

   a. Color shall be selected by Engineer from manufacturer's full range of colors, including all available standard and optional colors
   b. Minimum 15 mils thick coverage, plus or minus 3 mils
   c. Smooth, seamless finish

B. Internal Construction: Polyurethane foam core, a 1-1/2 inch thick rigid block of polyurethane, or a 2 psf expanded polyurethane foam shall be laminated to the interior or the panels. The R factor shall be 11–12

C. Stiles and rails shall be 1-1/2 inch square pultruded fiberglass tubes. A polyester-based resin filled with 1/4 inch chopped glass strands and aerosil shall be used for reinforcements and corner blocks. The bottom rail shall allow 1-1/4 inches of height alterability without loss of the panel’s integrity. No metal or wood lumber reinforcements will be allowed

D. Hardware Preparations

1. Reinforcement Blocking

   a. Lockset: Non-swelling polymer blocking
   b. Surface mount hardware: Non-swelling polymer blocking
   c. Thru-bolted hardware: Non-swelling polymer blocking

2. Mortise Hardware

   a. Full mortise hinges: Non-swelling polymer blocking
   b. Mortise locksets: To suit template provided
   c. Exit devices: To suit template provided
3. All doors shall be mortised and reinforced to allow application of hinges and locks, in accordance with hardware schedule and manufacturer’s templates. The hinges shall be attached by using stainless steel wood screws. Pilot holes shall be in strict accordance to manufacturer’s recommendations.

E. Door Accessories

1. Provide stainless steel fasteners as required.

2.03 FRAMES

A. Frame fabrication FRP (Fiberglass Reinforced Plastic): Fire rated and non-rated frames shall be FRP. Fire rated frames are required to be FRP, similar to non-rated frames in manufacture and appearance and shall be in compliance with the labeling agency in accordance with UL 10C. Fire rated frames manufactured in a material other than fiberglass will not be accepted.

1. Jamb depth: Refer to Architectural Drawings.


3. Return: 7/16 inch

4. Stop: 5/8 inch

5. Rabbet: 1-15/16 inch

6. Corner miter: Head and Jamb members shall be standard 45 degree miter, providing a neatly mitered corner connection, fabricated for Knocked Down (KD) field assembly.

7. Pultrusion: In compliance with pultrusion industry standards.

B. Reinforcements and Braces/Supports

1. Corner reinforcement: 4 inch by 4 inch by 5-3/8 inch by 1/4 inch thick pultruded fiberglass angle. Attached to head bar at factory using stainless steel screws or suitable polymer rivets.


3. Closer reinforcement: Same as mortise hinge reinforcement, less screws.
4. Strike reinforcement: 1-1/2 inch by 9 inch x 3/4 inch thick polymer material. Attached to frame by means of bonding and stainless steel countersunk screws or suitable polymer rivets

C. Anchoring systems: T-strap or wire anchor for masonry construction or concealed 316 stainless steel anchors per Contractor's option

D. Finish: Gel coat; 15 mils thick, plus or minus 3 mils on all exposed surfaces. Color to match door unless otherwise indicated

2.04 FABRICATION

A. Fabricate FRP doors and frames as shown on the Drawings and in accordance with best shop practices. Frames shall be rigid, neat in appearance, and free from defects. Field measurements shall be taken as required for coordinating with adjoining Work

B. Form exposed surfaces free from warp, wave, and buckle, with all corners square, unless otherwise shown. Set each member in proper alignment and relationship to other members with all surfaces straight and in a true plane.

C. Reinforce members and joints with plates, tubes, or angles for rigidity and strength.

D. Doors and frames shall be mortised and reinforced for hardware in accordance with the hardware manufacturer’s instructions and templates. The reinforcing shall be designed to receive hinges, locks, strikes, closures

E. Furnish at least 3 metal anchors or polymer spacers in each jamb of frames up to 84 inches high and 1 additional anchor for each 24 inch height above 84 inches, in shapes, sizes and spacing shown or required for anchorage into adjoining wall construction. Fabricate joint anchor of stainless steel

F. Terminate bottom of frames at the indicated finished floor level

G. Provide clearance for doors of 1/8 inch at jambs and heads; 1/4 inch clearance above threshold

2.05 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSPECTION

A. Installer shall examine the substrate and conditions under which fiberglass reinforced plastic work is to be installed and notify the general Contractor in writing of any conditions detrimental to the proper and timely completion of the Work. Do
not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the installer

3.02 INSTALLATION

A. Install FRP doors, frames and accessories in accordance with fabrication and installation Drawings, NFPA 80 standards at fire-rated openings, and as herein specified. Installation to be similar to that of hollow metal doors and frames, and in accordance with FRP manufacturer’s installation instructions

B. Place frames prior to construction of enclosed walls and ceilings. Set frames accurately in position, plumed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Frame must not be drilled for bracing supports as finish may be damaged.

C. In masonry construction, locate 3 wall anchors per jamb at hinge and strike levels. Frames may be grouted full of mortar at jambs and anchors shall be built into the joints as walls are laid up. A continuous bead of silicone sealant is to be applied between the head and jamb at the miter joint.

D. Fit FRP doors accurately in frames, within clearances specified in this section

3.03 TOLERANCES

A. Maximum diagonal distortion: 1/4 inch measured with a straight edge, corner to corner. Maximum measurable plane is 4 feet by 7 feet

3.04 ADJUSTING

A. At substantial completion, adjust all operable components to ensure proper installation and that they function smooth and freely

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.06 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.07 CLEANING

A. Remove dirt and excess sealant from exposed surfaces. Follow the manufacturers’ recommended cleaning techniques and procedures for cleaning all surfaces. Use only cleaning products that will not scratch or damage the surfaces, and are recommended by the manufacturer

B. Remove debris from Project Site
3.08 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 08 51 13
ALUMINUM WINDOWS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide aluminum windows and related items in accordance with this Section and applicable reference standards listed in Article 1.03.

a. Fixed Windows
b. Factory Glazing
c. Sealant within window system
d. Hardware, accessories and appurtenances

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. AAMA 101
2. AAMA 603.8 standard
3. AAMA 902
4. ASTM B117
5. ASTM E283
6. ASTM E330
7. ASTM E331
8. ASTM E547

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.
1.05  SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Shop Drawings: Submit only window types listed on the Drawings. Shop Drawings showing installation conditions throughout shall be submitted for approval. Shop Drawings shall include elevations of all windows (minimum scale 1/2 inch equals 1 foot), and full size details of every conditions indicating thickness of aluminum, fastenings, the size and spacing of anchor, method of glazing, details of operations hardware, methods and materials for weather stripping, and method of attaching screens.

C. Product data: Submit catalogue cuts for all window types and screens.

D. Samples: Submit color chips for selection by Engineer from manufacturer's standard.

E. Test Reports: Submit reports for window types listed on the Drawings indicating compliance with AAMA Specifications and performance criteria.

1.06  QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Samples: Provide color Samples and glass Samples for selection by Engineer from manufacturer's standard colors.

1.07  DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. All materials shall be delivered, stored, handled, and installed so as not to be damaged or deformed.

1.08  SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09  WARRANTY

A. Special Warranty/Extended Correction Period

1. Manufacturer’s 10 year limited warranty on window unit parts with free replacement for any defective window part; except glass or screening.

2. Manufacturer’s 5 year limited warranty on window finish against chipping, peeling, or cracking.

3. Manufacturer’s 15 year limited warranty on insulated glass units.
a. Insulated glass portion of the window: Warranted not to fail for a period of 15 years from the date of purchase. A failed unit is one that develops a significant obstruction of vision resulting from film formation or dust collection between the interior glass surfaces of the unit caused by failure of the hermetic seal. Small marks, scratches, and spots that do not exceed manufacturer's standards or Federal Specifications DD-4516 do not make insulating glass units defective. Cracks or broken glass of any kind are excluded.

PART 2 – PRODUCTS

2.01 GENERAL INSULATED GLASS REQUIREMENTS

A. Low-emissivity tempered glass
   1. Provide tempered glass for all windows
   2. Provide low-emissivity, Low-E, coating

B. Existing buildings: Glass shall be tinted as indicated on Drawings

2.02 FIXED WINDOW

A. Manufacturers: Provide one of the following windows that comply with AAMA 101 performance requirements for fixed window, heavy commercial, minimum rating shall be FW-HC40
   1. Series 400 Fixed Lite Aluminum Prime Window as manufactured by Universal Window and Door, LLC
   2. Series TR-9500 Fixed Aluminum Window as manufactured by TRACO
   3. Approved Equal

B. Material: Aluminum shall be of commercial quality aluminum alloy 6063-T5 free from defects impairing strength durability. All window members shall be of extruded aluminum and shall have a guaranteed minimum ultimate tensile strength of 22,000 per square inch, and a yield of 670,000 per square inch. Secondary members such as self-alignment clips, weather stripping, guides, etc., shall be made of a suitable and compatible material

C. Finish: Standard finish shall be factory-applied thermo setting acrylic enamel. Color shall be manufacturer's standard bronze color. Finish to conform to AAMA 603.8 standard

D. Glazing: Overall insulating glass thickness of 1 inch consisting of 2 lites of 1/4 inch thick clear tempered glass with a Low-E coating and one space created by a desiccant-filled aluminum spacer system. Refer to Architectural Drawings for tint
E. General requirements: All windows shall be of the thermally broken type, including sash and frame members.

F. Performance criteria for fixed windows: All windows shall conform to FW-HC40 Specifications in AAMA 101 when tests are performed on the prescribed 60 inch by 71 inch minimum test size with the following minimum test results:

1. Uniform load deflection test: Under an exterior load of 40 per square foot, no member in the completely assembled window shall deflect more than \( L/175 \) of its span per ASTM E 330.

2. Uniform load structural test: The window shall be subjected separately to an exterior and interior uniform load of 60 per square foot with no glass breakage or permanent damage causing the unit to be inoperable. Tests shall be conducted in accordance to ASTM E 330.

3. Maximum Air infiltration per ASTM E 283: 0.1 cfm/sf at 6.24 per square foot.

4. Water penetration per ASTM E 331 and ASTM E 547: No leakage at 8 per square foot minimum static air pressure.

5. Glass U-Value (winter) equals 0.45 maximum.

6. Glass R-Value (winter) equals 2.22 minimum.

7. Condensation resistance factor equals 60 frame and 69 glass.

G. Muntins: Muntins shall be extruded aluminum or roll-formed aluminum; with exposed surfaces finished to match window color; concealed fasteners; designed for unrestricted expansion and contraction. Muntin bar cross-section profile and material chosen from manufacturer's standard. Grid pattern as shown on Drawings. Provide internal muntins; encapsulated between the 2 glass lites in the insulating glass unit to protect them from damage and dirt buildup.

2.03 SOURCE OF QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install all windows in accordance with manufacturer's installation instructions and Shop Drawings.
B. Windows shall be set plumb, level to a tolerance of not more than 1/16 inch in 10 feet and in alignment without frame distortion and securely anchored in place as indicated, in accordance with the manufacturer's printed instructions and the Drawings

C. Fasteners, clips, fittings, aluminum trim, closures, and shapes shall be provided as indicated and as required to provide a complete installation

D. Joints shall be sealed between sash units, aluminum sills, and covers and similar metal-to-metal contact surfaces with sealant or tape as recommended and furnished by the window manufacturer. Installations shall be weather tight

E. Joint sealing and calking between metal and masonry is specified in Section 07 92 00 Joint Sealants

3.02 DISSIMILAR MATERIALS

A. Aluminum shall be kept from direct contact with steel or other dissimilar materials by painting, non-absorptive tape, gasket, or other approved system as recommended by the manufacturer and as specified

B. Aluminum surfaces in contact with steel shall be given one coat of zinc-chromate primer, applied to a dry-film thickness of not less than 1.5 mils, or one coat of a suitable non-hardening joint compound capable of excluding moisture from the joint during prolonged service

C. Steel surfaces in contact with aluminum shall be given one coat of zinc-chromate paint, applied to a dry-coat thickness of 1.5 mils, and two or more coats of aluminum paint conforming to SSPC Paint 101, aluminum alkyd, Type II, applied to a dry-film thickness of 1.5 mils for each coat and a total dry-film thickness of 3 mils

D. Corrosion-resistant, aluminized, or hot-dip galvanized steel placed in contact with aluminum need not be painted

E. Aluminum surfaces placed in contact with wood, concrete, or masonry construction shall be given one coat of bituminous paint conforming to SSPC Paint 12, applied to a thickness of at least 1/16 inch

3.03 CLEANING

A. Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance and to prevent fouling of weathering surfaces and weather stripping, and to prevent interference with the operation of hardware
3.04 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 08 62 23
TUBULAR SKYLIGHTS

PART 1 – GENERAL

1.01 SUMMARY
A. Section Includes
   1. Provide tubular lighting devices consisting of roof domes, reflective tubes, diffuser assemblies, and accessories in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES
A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES
A. Reference Standards
   1. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
   3. ASTM A463 Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process
   4. ASTM A653 Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process
   5. ASTM 792 Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
   6. ASTM E283 Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
   7. ASTM E308 Standard Practice for Computing the Colors of Objects by Using the CIE System
   8. ASTM E330 Structural Performance of Exterior Windows, Curtain Walls and Doors
   9. ASTM E547 Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain walls by Cyclic Air Pressure Difference
10. ASTM E1886 Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials


12. ASTM D635 Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position


14. UL 181 Factory Made Air Ducts and Air Connectors

15. ICC AC-16 Acceptance Criteria for Plastic Skylights

B. Performance Requirements: Completed tubular daylighting device assemblies shall be capable of meeting the following performance requirements.

1. Air infiltration test: Air infiltration will not exceed 0.30 cubic feet per minute per square foot aperture with a pressure delta of 1.57 pounds per square foot across the tube when tested in accordance with ASTM E283

2. Water resistance test: No uncontrolled water leakage at 10.5 pounds per square foot pressure differential with water rate of 5 gallons per hour per square foot when tested in accordance with ASTM E547

3. Uniform Load Test
   a. No breakage, permanent damage to fasteners, hardware parts, or damage to make daylighting system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 150 pounds per square foot 7.18 kPa or Negative Load of 70 pounds per square foot 3.35 kPa
   b. All units shall be tested with a safety factor of 3 for positive pressure and 2 for negative pressure, acting normal to plane of roof in accordance with ASTM E330

4. Hurricane Resistance
   a. Meets ASTM E1886 and ASTM E1996 for missile and cyclic pressure differential testing

5. Fire Testing
   a. When used with the Dome Edge Protection Band, all domes meet fire rating requirements as described in the 2015 International Building Code
b. Self-ignition temperature: Greater than 650 degrees F per ASTM D1929  
c. Smoke Density: Rating no greater than 450 per ASTM Standard E84 in way intended for use. Classification C  
d. Rate of burn and/or extent: Maximum Burning Rate: 2.5 inches per minute 62 millimeters per minute Classification CC-2 per ASTM D635  
e. Rate of burn and/or extent: Maximum Burn Extent: 1 inch (25 mm) Classification CC-1 per ASTM D635

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
A. Submit in accordance with Division 01 General Requirements.  
B. Product Data: Manufacturer's data sheets on each product to be used, including  
1. Preparation instructions and recommendations  
2. Storage and handling requirements and recommendations  
3. Installation methods  
C. Shop Drawings: Showing layout, profiles and product components, including anchorage, flashings and accessories  
D. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements  
E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE
A. Provide in accordance with Division 01 General Requirements.  
B. Qualifications: per Division 01 General Requirements for manufacturing and as follows.  
1. Engaged in the manufacture of tubular daylighting devices for minimum of 15 years

1.07 DELIVERY, STORAGE, AND HANDLING
A. Provide in accordance with Division 01 General Requirements.
B. Unload and store products in manufacturer's unopened packaging until ready for installation. Store materials on substantial pallets, dunnage, or other supports and spacers, free from the earth and properly drained, preventing splattering with dirt and other foreign matter.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 WARRANTY

A. Special Warranty/Extended Correction Period

1. Daylighting device: Manufacturer’s 10 year warranty

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Solatube International, Inc.

B. Velux

C. Wasco

D. ODL

2.02 TUBULAR DAYLIGHTING DEVICES

A. Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16

B. Solatube Model 330 DS-O Open Ceiling, 21 inch (530 mm) Daylighting System or equal

1. Roof dome assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube

   a. Glazing: Type DA, 0.143 inch (3.7 mm) minimum thickness injection molded acrylic classified as CC2 material; UV inhibiting (100 percent UV C, 100 percent UV B and 98.5 percent UV A), impact modified acrylic blend.
2. LightTracker Reflector, made of aluminum sheet, thickness 0.015 inch (0.4 mm) with SpectraLight Infinity, positioned in the dome to capture low angle sunlight

3. Roof Flashing Base
   a. One-piece, seamless, leak-proof flashing functioning as base support for dome and top of tube. Sheet steel, corrosion resistant conforming to ASTM A653 or ASTM A463, or ASTM A792, 0.028 inch (0.7 mm) plus or minus .006 inch (.015 mm) thick
      1) Base Style: Type F11, Self-mounted, 11 inches (279 mm) high

4. Flashing insulator: Type FI, thermal isolation material for use under flashing

5. Roof flashing turret extensions: Provide manufacturer's standard extensions for applications requiring Type T12, additional lengths of 12 inches (300 mm) extension

6. Tube ring: Attached to top of base section; 0.090 inch (2.3 mm) nominal thickness injection molded high impact PVC; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing

7. Tube ring seal: Attached to the base of the dome ring; butyl glazing rope, 0.24 inch (6 mm) diameter; to minimize air infiltration

8. Dome seal: Adhesive backed weather strip, 0.63 inch (16 mm) tall by 0.28 inch (7 mm).

9. Reflective tubes: Aluminum sheet, thickness 0.018 inch (0.5 mm)
   a. General
      1) Interior Finish: SpectraLight Infinity high reflectance specular finish on exposed reflective surface. Specular reflectance for visible spectrum (400 nm to 760 nm) greater than 99 percent. Total solar spectrum reflectance (400 nm to 2500 nm) less than 80.2 percent
      2) Color: $a^*$ and $b^*$ (defined by CIE L*$a^*b^*$ color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E308
   b. Extension Tube
1) Reflective extension tube, Type EXX, notched for open ceiling diffuser attachment, 24 inches (610 mm) or 48 inches (1220 mm) long

10. Diffuser assemblies for tubes not penetrating ceilings (open ceiling): Solatube Model 330 DS-O 21 inch (530 mm) diameter diffuser attached directly to bottom of tube
   a. Lens: Type L1 OptiView Fresnel lens design to maximize light output and diffusion. Visible light transmission shall be greater than 90 percent at 0.022 inch (0.6 mm) thick. Classified as CC2
   b. Diffuser Seal: Open cell foam, acrylic adhesive backed, 0.75 inch (19 mm) wide by 0.125 inch (3.2 mm) thick to minimize condensation and bug, dirt and air infiltration per ASTM E283
   c. Diffuser Trim Ring: Injection molded acrylic. Nominal wall thickness 0.172 inches (4.4 mm)
   d. Secondary Diffuser: Type SS, Acrylic plastic classified as CC2 material. Thickness shall not be less than 0.100 inches

11. Accessories: Open ceiling trim ring Type R, ABS Plastic, White; nominal thickness of 0.04 inches (1 mm)

2.03 ACCESSORIES
   A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon
   B. Suspension wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement
   C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer

2.04 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 EXAMINATION
   A. Do not begin installation until substrates have been properly prepared
   B. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding
3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the Project conditions

3.03 INSTALLATION

A. Install in accordance with manufacturer's printed instructions

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits

C. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Owner and Engineer. Correct if needed before proceeding with installation of subsequent units

3.04 PROTECTION

A. Protect installed products until completion of Project

B. Touch-up, repair or replace damaged products

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.06 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 08 71 00

DOOR HARDWARE

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide finish hardware for doors to provide correct functions for intended use, provide related items and services, as indicated on Drawings and in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Furnish hardware schedules and templates as required for fabrication of doors and frames under other Sections.

B. Related Requirements

1. Section 07 92 00 Joint Sealants
2. Section 08 11 00 Metal Doors and Frames
3. Section 08 16 15 Fiberglass Doors and Frames
4. Section 08 81 00 Glass Glazing

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data: Manufacturer's product data, catalog cuts, descriptive data, UL listings, and other pertinent technical data for each of the products used

C. Certifications of fire-ratings for hardware items located in rated assemblies

D. Shop Drawings

1. Final hardware and keying schedule. Format schedule vertically. List each door opening using same designations indicated on Drawings
E. Manufacturer Instructions
   1. Installation Templates: For Work installed or prepared for installation by others

F. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.05 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.
   B. Provide the services of a certified hardware consultant to prepare hardware and keying schedules.
   C. Fire-resistance ratings: When fire-resistance ratings are indicated or required by authorities having jurisdiction, provide hardware items identical to those which have been tested and labeled for fire-rated use by independent testing agencies acceptable to Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Package and label each hardware item separately with all screws, bolts, and accessories required for a complete and proper installation. Coordinate the labeling of packages with hardware set numbers.
   C. Store hardware items in locked spaces. Replace all hardware items lost or damaged. Provide copies of Supplier receipts for hardware items delivered to the Project.

1.07 SITE CONDITIONS
   A. Provide in accordance with Division 01 General Requirements.

1.08 MAINTENANCE
   A. Provide services of hardware Supplier's representative to inspect hardware 6 months after completion of Project. Readjust and restore hardware.

PART 2 – PRODUCTS

2.01 FINISH HARDWARE - GENERAL REQUIREMENTS
   A. One manufacturer and catalog number is listed for each type of hardware specified. These catalog numbers are listed to set the standard of quality required. Provide the specified hardware item, or an equal product from one of the following manufacturers.
1. Sargent
2. Hager Companies
3. McKinney
4. Soss
5. Stanley
6. PEMKO
7. Ives
8. Brookline
9. LCN
10. Yale
11. Reese
12. National Guard Products
13. Zero
14. Glynn-Johnson

B. For each type of hardware, provide products of a single manufacturer

C. Manufacturer's names or trademarks displayed in a visible location will not be permitted on any piece of hardware

D. Base metal: Provide hardware items of 304 stainless steel

E. Fasteners: Provide concealed fasteners to the greatest extent possible. Do not use through-bolts unless otherwise acceptable to the Engineer. Provide 304 stainless steel fasteners.

### 2.02 HARDWARE FINISHES

A. Submit Samples of each finish to be exposed. Show full range of color and finish variations expected

1. Provide US 32D dull stainless for all hardware
2. Provide painted plastic covers on closers
2.03  LOCKSETS AND LATCHSETS

A. As manufactured by Sargent or approved equal

B. Provide lock and latchset functions listed in the hardware schedule provided on Drawings.

C. Mortise locksets and latchsets: Except where scheduled otherwise, provide Sargent 7900 Mortise lock

D. Exit device: Sargent 30 Series where scheduled

E. US 32D dull stainless lever trim, ADA compliant

F. Provide 1/2 inch minimum throws. Comply with UL requirements for fire-rated hardware

G. Provide manufacturer's standard box strike with extended curved lip. Finish strikes and lips to match lock or latch

H. Provide rabbeted locks and latches where rabbeted door stiles are indicated or required

2.04  KEYING AND LOCK CYLINDERS

A. Contractor shall utilize the services of a professional locksmith, as required to comply with Owner's instructions for keying of Project. Provide Grandmaster Key System, unless otherwise directed by Owner

B. Provide interchangeable core cylinders, removable by use of special key, for all locking devices on this Project, unless otherwise directed by Owner

C. Provide cylinders and keys from stainless steel, brass, or nickel silver

D. Provide three keys for each lock, 5 Master keys, 5 Grandmaster keys. Provide one blank key for each lock, unless otherwise directed by Owner

E. Provide 3 additional cores, keyed only into this system, unless otherwise directed by Owner

2.05  KEY CONTROL SYSTEM

A. Provide key control system consisting of labels, tags, card index, and metal wall mounted cabinet. Set up control system, label and identify each key, type index cards, and deliver to Owner complete and ready for use

B. Refer to Hardware Schedule provided on the Drawings for electrical lockset requirements and locations
2.06 HINGES AND BUTTS

A. Provide stainless steel hinges template produced, full mortise, five knuckle-type, except as otherwise scheduled, and as follows

1. For major corridor doors, entrance doors, lobby doors, and public toilet room doors, provide four-ball bearing hinges

2. For all other doors not listed above, provide standard weight, 2 ball bearing hinges

B. Hinge height: 4-1/2 inches

C. Determine proper hinge width based upon door thickness and trim conditions. Provide minimum 4-1/2 inch wide hinges

D. Provide 3 hinges for doors up to 7 feet 6 inches high, and 1 additional hinge for each additional 2 feet 6 inches of height. Provide one additional hinge for doors over 3 feet 6 inches wide

E. Provide flat button pins matching hinges in finish and material. Provide non-removable pins on out-swinging exterior and corridor doors. Provide non-rising pins for all other hinges

2.07 PUSH/PULL HARDWARE

A. Provide Ives or Engineer Approve Equal

1. Provide Ives No. 8103EZ 8-inch pull handle

2. Provide Ives No. 9100 29-inch push bar

3. Provide Ives No. 8200 4-inches by 16-inches push plate

2.08 CLOSERS

A. Provide LNC 4010 Series or Engineer Approved Equal

B. Provide closers where indicated. Closers shall have hold-open features and built-in door stop function at an adjustable angle. Hold-open door closers are not permitted to be used on fire door assemblies

C. Mount closers on the least public side of doors to the greatest extent possible. Provide closers with parallel arms wherever closers are on the stop side of doors that swing out into corridors and public spaces. Where parallel arms are used, provide closers that are one size larger than manufacturer's recommendation

D. Follow manufacturer's recommendations for size of closer based upon size and weight of door, exposure, and frequency of use
E. Closer cylinders, arms, adapter plated, and metal covers shall have a powder coating finish with optimal special rust inhibitor (SRI) primer designed for installations in corrosive environments

2.09 PROTECTION PLATES AND KICK PLATES

A. Provide Hager No. 194S or Engineer Approved Equal armor and kick plates, beveled on all four sides

B. Provide armor and kick plates that are 1/2 inch less than door width when mounted on the pull side, and 1-1/2 inches less than door width when mounted on stop side

C. Height: 42 inches high for armor plates, 10 inches high for kick plates

D. Material: 0.05-inch gauge solid metal closely matching lockset/latchset finish. Plated metal door trim units are not acceptable

2.10 STOPS

A. Provide Ives wall stops #406 or Engineer Approve Equal to suite wall condition. Where indicated, or where wall stop is not practical, provide Ives floor stops #436 or #438 or Engineer Approved Equal to suit floor conditions and clearances. Provide carpet risers where required

2.11 WEATHERSTRIPPING, SOUNDSTRIPPING, AND THRESHOLDS

A. Provide weather stripping for every exterior door, doors with unheated spaces on one side, and wherever scheduled. Weather stripped doors are required to provide a continuous seal at the entire perimeter of door with no cracks

1. Drop seals: Provide Reese Automatic Door Bottom Catalog #372 or Engineer Approve Equal for metal and Fiberglass Reinforced Polyester (FRP) doors

2. Gaskets: Provide Reese Catalog #797B or Engineer Approve Equal gaskets at door heads and jambs

2.12 MISCELLANEOUS HARDWARE

A. Drip Caps: For doors that swing directly out into the rain, provide Reese Catalog #R199A drip cap or Engineer Approve Equal

B. Silencers: For wood frames, provide Hager Companies No. 307D or Engineer Approve Equal grey resilient silencers. For steel doors, provide Hager Companies No. 308D or Engineer Approve Equal grey resilient silencers. Provide 3 silencers for single doors, and 2 silencers for doors hinged in pairs
2.13 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine doors, frames, and conditions under which the Work of this Section will be performed. Notify Contractor in writing of conditions detrimental to the proper completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected. Commencing Work means Installer accepts substrates and conditions.

3.02 INSTALLATION

A. Hardware schedule: As shown on the Drawings

B. Provide installation templates for Work installed or prepared for installation by others

C. Comply with manufacturers' instructions and recommendations, except where more restrictive requirements are specified in this Section

D. Installation of hardware shall comply with NFPA 80 and NFPA 101 requirements

E. Set hardware plumb, level, and in exact alignment and location. Conceal and countersink fasteners wherever possible

F. Set exterior thresholds in bed of sealant provided in accordance with Section 07 92 00 Joint Sealants

3.03 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust hardware items to work smoothly, easily, and correctly

B. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer of hardware being cleaned. Remove and replace Work which cannot be successfully cleaned, as judged solely by the Engineer

C. Provide temporary protection to ensure Work being without damage or deterioration at time of Final Acceptance. Remove protections and re-clean as necessary immediately prior to Final Acceptance

D. Cover knobs, levers, pulls, and push plates with heavy cloth to protect against damage until Final Acceptance of the Project

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
3.05 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 08 81 00

GLASS GLAZING

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes

1. Provide glazing systems in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the Work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E1300

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American National Standards Institute (ANSI)

   a. ANSI Z97.1 For safety glazing materials used in buildings - safety performance specifications and methods of test

2. ASTM International (ASTM)

   a. ASTM C509
   b. ASTM C864
   c. ASTM C920
   d. ASTM C1048
   e. ASTM C1184
   f. ASTM D395
   g. ASTM D2287
   h. ASTM E773
i. ASTM E774
j. ASTM E1300
k. ASTM E2010

3. Glass Association of North America (GANA)
   a. GANA Glazing Manual
   b. GANA Sealant Manual

4. Insulating Glass Manufacturers Association (IGMA)
   a. IGMA TB-3001
   b. IGMA TM-3000

5. National Fire Protection Association (NFPA)
   a. NFPA 80
   b. NFPA 252
   c. NFPA 257

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Shop Drawings: Submit Drawings showing complete details of the proposed setting methods, edge blocking, size of openings, frame details, materials, and types and thickness of glass

C. Certificates: Submit certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates

D. Manufacturer's instructions: Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified

E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE

1. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Deliver products to the Site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 WARRANTY

A. Special Warranty/Extended Correction Period

1. Warranty insulating glass units against development of material obstruction to vision, such as dust, fogging, or film formation on the inner glass surfaces, caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the Work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Engineer

PART 2 – PRODUCTS

2.01 TEMPERED GLASS

A. ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 1 (transparent), Quality q3. All panels of tempered glass shall be 1/4 inch thick. All glass within 18 inches of the floor shall be tempered glass

1. Type I, Class 1 (clear), Quality q4

2.02 INSULATING GLASS UNITS

A. Two panes of glass separated by a dehydrated airspace and hermetically sealed. Dimensional tolerances shall be as specified in IGMA TR-1200. The units shall conform to ASTM E773 and ASTM E774, Class A. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone

1. Glass U-value (winter) = 0.42 (max)
2. Condensation Resistance Factor = 69 (min)

2.03 SETTING AND SEALING MATERIALS

A. Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, non-skinning compounds, non-resilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted shall be gray or neutral color.

B. Provide elastomeric and structural sealants

1. Elastomeric Sealant: ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing wood and metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units, and with plastic sheet. Color of sealant shall match adjacent frame.

2. Structural Sealant: ASTM C1184, Type S

C. Joint backer shall have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

D. Preformed Channels: Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition.

E. Sealing Tapes: Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use only where glazing rabbet is designed for tape, and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes shall be chemically compatible with the product being set.

F. Closed-cell neoprene setting blocks shall be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50, plus or minus 5. Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths, and locations shall be as required and recommended in writing by glass manufacturer. Block color shall be black.

G. Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pullback at corners. Glazing gasket profiles shall be as indicated on Drawings.
1. Fixed glazing gaskets shall be closed-cell sponge smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1

2. Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75

3. Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weather tight

H. Provide accessories as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide non-corroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Preparation, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind glass edges smooth in the shop that will be exposed in finish Work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.02 ENVIRONMENTAL REQUIREMENTS

A. Do not start glazing Work until the outdoor temperature is above 40 degrees F and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing Work during installation. Do not perform glazing Work during damp or rainy weather

3.03 GLASS SETTING

A. Shop glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations.
Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops that are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

B. Cut sheet glass and set with the visible lines or waves horizontal.

C. Insulating glass units: Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation shall conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

D. Install wire glass for fire doors in accordance with installation requirements of NFPA 80.

3.04 CLEANING

A. Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass shall be clean at the time the Work is accepted. Clean plastic sheet in accordance with manufacturer's instructions.

3.05 PROTECTION

A. Glass Work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

3.06 WASTE MANAGEMENT

A. Disposal and recycling of waste materials, including corrugated cardboard recycling, shall be in accordance with the Waste Management Plan. Separate float glass and reuse or recycle. Upon removal, separate protective materials and reuse or recycle. Separate tempered glass for use as aggregate or nonstructural fill. Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire-safe area at moderate temperature.
3.07 SCHEDULE

A. Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

<table>
<thead>
<tr>
<th>PRODUCTS</th>
<th>INCH-POUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>1/8 inch</td>
</tr>
<tr>
<td></td>
<td>3/16 inch</td>
</tr>
<tr>
<td></td>
<td>7/32 inch</td>
</tr>
<tr>
<td></td>
<td>1/4 inch</td>
</tr>
<tr>
<td></td>
<td>3/8 inch</td>
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<tr>
<td>Interlayer</td>
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</tr>
<tr>
<td>Glazing Channels</td>
<td>1/4 inch</td>
</tr>
</tbody>
</table>

3.08 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.09 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 09 77 00

SPECIAL CEILING SURFACING

PART 1 – GENERAL

1.01 SUMMARY
A. Section Includes
   1. Provide materials, tools, equipment and labor required to furnish and install composite ceiling panels as shown on the Drawings, in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES
A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES
A. Reference Standards
   1. ASTM International (ASTM)
      a. ASTM D256 Determining the Izod Pendulum Impact Resistance of Plastics
      b. ASTM D638 Standard Test Method for Tensile Properties of Plastics
      c. ASTM D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
      d. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
A. Submit in accordance with Division 01 General Requirements.

1.06 QUALITY ASSURANCE
A. Provide in accordance with Division 01 General Requirements.
B. Qualifications: Per Division 01 General Requirements for Installer and as follows.

1. Minimum of 5 years of experience with composite ceiling panel work similar in scope and size to this Project

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays

C. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact

D. Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer

1. Store panels indoors
2. Lay panels flat. Do not stand panels on edge
3. Protect panels from moisture
4. Do not store panels in contact with the floor or against an outside wall
5. Do not remove protective film from panel surface until after installation
6. Maintain optimum storage conditions of 60 to 75 degrees F at 35 to 55 percent relative humidity. Avoid extremes in temperature and humidity

E. Remove foreign matter from face of panel by using a soft bristle brush, avoiding abrasive action

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 MAINTENANCE

A. Provide 5 percent additional material for use by Owner in building maintenance and repair.

1.10 WARRANTY

A. Special Warranty/Extended Correction Period: 5 year manufacturer’s warranty.
PART 2 – PRODUCTS

2.01 SPECIAL CEILING SURFACING

A. Provide Fiberglass Reinforced Plastic (FRP) ceiling panels as manufactured by one of the following.

1. Nudo
2. Crane
3. Prime Panels
4. Or equal

B. Ceiling panel system shall be fiberglass reinforced plastic panels laminated to gypsum equal to NūFiber by Nudo, meeting the following requirements.

1. Texture: Smooth
2. Substrate: Moisture Resistant Gypsum
3. Substrate Thickness: 0.675 inch
4. Fire-Rating Class: C
5. Color: To be selected by Owner
6. Size: 4 feet by 8 feet
7. Physical Properties:
   a. Flexural Strength (ASTM D790): 7600 lb/in
   b. Flexural Modulus (ASTM D790): 854,234 psi
   c. Tensile Strength (ASTM D638): 5000 psi
   d. Barcol Hardness (ASTM D2583): --
   f. Surface Burning Characteristics (ASTM E84): Class C

2.02 ACCESSORIES

A. Provide Polyvinyl chloride (PVC) moldings. Color to be selected by Owner.
2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions. Verify that Site conditions are acceptable for installation of ceiling panels. Examine back-up surfaces to determine that corners are plumb and straight, surfaces are smooth, uniform, clean and free from foreign matter, nails are countersunk and joints and cracks are filled flush and smooth with the adjoining surface. Do not proceed with installation of ceiling panels until unacceptable conditions are corrected.

1. Installation shall not begin until building is enclosed, permanent heating and cooling equipment is in operation and residual moisture from plaster, concrete or terrazzo work has dissipated.

2. Install panels between 60 degrees F to 75 degrees F and relative humidity below 55 percent, ideally at the same conditions as the room's normal operating temperatures after building is occupied.

3. Provide ventilation to disperse fumes during application of adhesive as recommended by adhesive manufacturer.

4. Do not install ceiling system until normal lighting conditions exist. Normal lighting conditions are described as those in place when the Project is finished.

B. Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on Shop Drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

3.02 INSTALLATION

A. General

1. Inspect panels for any defects immediately. Do not install panels of unacceptable quality. Field cutting of all ceiling systems should be accomplished using a circular saw with fine tooth carbide blade

2. Position panel so that the saw blade enters the finished High-Pressure Laminate (HPL) side first to avoid chipping or damage. Protect decorative laminate face of panel by covering work area, do not remove protective cover until after installation.
3. Follow adhesive manufacturer's recommendations for appropriate height of adhesive bead left by trowel and do not allow adhesive to skin over. When interior paneling is on an exterior ceiling or wet area, provide a barrier sheet and follow the adhesive manufacturer's installation recommendations for a secure bond.

B. Installation Using PVC Trims

1. Start in the corner. Mark plumb line 48-1/8 inches from corner.

2. Apply adhesive directly to entire back of composite ceiling panel using correct trowel with 100 percent adhesive coverage using crosshatch pattern. Apply adhesive to within 1/2 inch of all edges of panel.

3. Slide panel into molding and withdraw 1/8 inch for PVC moldings to provide appropriate gap. Align with plumb line.

4. Begin in top corner nearest molding with laminate roller, rolling down and out toward the edge without molding.

5. Continue rolling down and out working across panel away from previously installed panel or initial molding. Remove all trapped air.

6. Install one-piece division bar and caps or next molding by sliding onto panel

7. Repeat process, working in one direction around room.

8. Immediately remove all adhesive residue. To remove, clean with nonabrasive cotton cloth and warm water. If necessary, use a mild nonabrasive detergent. For cleanup with solvent based adhesives, use mineral spirits or acetone to remove residue.

3.03 CLEANING

A. Clean panel surfaces in compliance with manufacturer's recommendations.

1. Use a clean, damp, nonabrasive cotton cloth and a mild liquid detergent or household cleaner.

2. Rinse with clean water using a clean, nonabrasive cotton cloth.

3. Dry panels with a soft, clean nonabrasive cotton cloth.

4. Do not use cleaners containing acid, alkali or sodium hypochlorite.
3.04 PROTECTION
   A. Protect installed Work from damage due to subsequent construction activity on the Site.

3.05 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 09 90 00

PAINTING AND COATING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide surface preparation and painting in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Provide the following types of painting work per the Paint Schedules attached and on Drawings:
   a. Painting of new and existing steel doors and frames
   b. Painting of new and existing interior masonry, concrete, and miscellaneous metal surfaces as indicated
   c. Painting and labeling of ductile iron pipes, copper pipes, Polyvinyl Chloride (PVC) / Chlorinated Polyvinyl Chloride (CPVC) pipes, and fittings where indicated
   d. Painting of equipment where indicated, and labeling of all equipment
   e. Touch-up painting of factory-coated equipment
   f. Painting of HVAC equipment and ducts where indicated

B. Related Requirements

1. Section 05 50 00 – Miscellaneous Metals
2. Section 08 10 00 – Metal Doors and Frames
3. Section 40 05 13 – Process Pipe and Fittings

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. ASTM International (ASTM)
a. ASTM A780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
b. ASTM D4258 Standard Practice for Surface Cleaning Concrete for Coating
c. ASTM D4259 Standard Practice for Abrading Concrete
d. ASTM D4260 Standard Practice for Liquid and Gelled Acid Etching of Concrete
e. ASTM 4261 Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating
f. ASTM D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
g. ASTM D4414 Standard Practice for Measurement of Wet Film Thickness by Notch Gages
h. ASTM D4417 Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel
i. ASTM D6386 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Products and Hardware Surfaces for Painting
j. ASTM D6944 Standard Test Method for Measuring Humidity with a Physchrometer
k. ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

2. International Concrete Repair Institute, (ICRI)

a. ICRI Technical Guideline No 310.1 Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
b. ICRI Technical Guideline No 310.2 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair with CSP Chips

3. NACE International, (NACE)

a. NACE Publication 6D-173 A Manual for Painter Safety
b. NACE SP0178 Surface Finishing of Welds Prior to Coating
c. NACE No. 6/SSPC-SP13 Surface Preparation of Concrete

4. NSF International (NSF)

a. NSF/ANSI 61 Drinking Water System Components – Health Effects

5. Steel Structures Painting Council (SSPC)
a. SSPC-Paint 16, Coal Tar Epoxy-Polyamide
b. SSPC-Paint 20, Zinc-Rich Coating Inorganic and Organic
c. SSPC-SP12/NACE 5 Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra High-Pressure Jetting Prior to Recoating
d. SSPC-SP13/NACE No. 6 Surface Preparation of Concrete
e. SSPC-Guide 12 Guide for Illumination of Industrial Painting Projects
f. SSPC-VIS-1 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

B. Definitions

1. Concrete Surface Profiles (CSP) per ICRI Technical Guideline No 310-2. Concrete surface preparation definitions listed below shall be field verified with Concrete Surface Profile Chips.

   a. CSP 1: Acid Etched
   b. CSP 2: Grinding
   c. CSP 3: Light Shotblast
   d. CSP 4: Light Scarification
   e. CSP 5: Medium Shotblast
   f. CSP 6: Medium Scarification
   g. CSP 7: Heavy Abrasive Blast
   h. CSP 8: Scabbed
   i. CSP 9: Heavy Scarification
   j. CSP 10: Course Planing

2. Surface Preparation of Carbon Steel per SSPC Surface preparation Standards. Definitions below summarize surface preparation requirements for each level of cleaning. Refer to SSPC standards for complete requirement for each level of surface preparation and cleaning.

   a. Adherent: Mill scale, rust and coating are considered tightly adherent if they cannot be lifting with a dull putty knife.
   b. SSPC-SP1: Solvent Cleaning: The removal of all visible oil, grease, soil, drawing and cutting compounds and other soluble contaminants from surfaces with solvents or commercial cleaners using various methods of cleaning such as wiping, dipping, steam cleaning or vapor degreasing.
c. SSPC-SP2: Hand Tool Cleaning: The removal of all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by the use of non-power hand tools.

d. SSPC-SP3: Power Tool Cleaning: The removal of all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by the use of power-assisted hand tools.

e. SSPC-SP5/NACE 1: White Metal Blast Cleaning: The complete removal of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specified methods.

f. SSPC-SP6/NACE 3: Commercial Blast Cleaning: The complete removal of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specified methods. Discoloration caused by certain stains shall be limited to no more than 33 percent of each unit area. Unit area is approximately 9 sq in.

g. SSPC-SP7/NACE Brush-off Blast Cleaning: A brush-off, blast-cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust and loose coating. Tightly adhered mill scale, rust and coating may remain on the surface.

h. SSPC-SP10/NACE 2 Near-White Metal Blast Cleaning: The removal of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specified method. Discoloration caused by certain stains shall be limited to no more than 5 percent of each unit area. Unit area is approximately 9 sq in.

i. SSPC-SP11 Power Tool Cleaning to Bare Metal: The removal of all visible oil, grease, dirt, mill scale, rust, paint, oxide, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portion of pits if the original surface is pitted. Differs from SSPC-SP3 in that it requires more thorough cleaning and a surface profile not less than 1 mil (25 microns).

3. SSPC-SP12/NACE 5 Pressure Categorization:

a. Water Jetting: Use of water at high or ultrahigh-pressure to prepare a surface for recoating using pressure above 10,000 psi. Water jetting will not produce a profile; rather it exposes the original abrasive-blast surface profile.

b. Low-Pressure Water Cleaning (LP WC): Cleaning performed at pressures less than 5,000 psi.
c. High-Pressure Water Cleaning (HP WC): Cleaning performed at pressures from 5,000 psi to 10,000 psi

d. High-Pressure Water Jetting (HP WJ): Cleaning performed at pressures from 10,000 psi to 25,000 psi.

e. Ultra-High-Pressure Water Jetting (UHP WJ): Cleaning performed at pressures above 25,000 psi.

4. SSPC-SP12 / NACE 5 Visual Conditions of Surface Cleanliness:

a. Water jetting shall be performed to meet one of the following four conditions: WJ-1, WJ-2, WJ-3, WJ-4, and a minimum acceptable surface shall have all loose rust, loose mill scale, and loose coatings uniformly removed.

b. WJ-1: Surface shall be free of all previously existing visible rust, coatings, mill scale, and foreign matter and have a matte metal finish.

c. WJ-2: Surface shall be cleaned to a matte finish with at least 95% of the surface area free of all previously existing visible residues and the remaining 5% containing only random dispersed stains of rust, coatings, and foreign matter.

d. WJ-3: Surface shall be cleaned to a matte finish with at least two-thirds of the surface free of all previously existing visible residues (except mill scale), and the remaining one-third containing only randomly dispersed stains of previously existing rust, coatings, and foreign matter.

e. WJ-4: Surface shall have all loose mill scale, and loose coatings uniformly removed.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

1. Block Fillers

2. Primers

3. Manufacturer's technical information including label analysis and instructions for handling, storage, and application of each material proposed for use.
4. Manufacturer's material data and certificates of performance for proposed substitutions.

5. List each material and cross-reference the specific coating, finish system, and application. Identify each material by the manufacturer's catalog number and general classification.

C. Samples and Mockups: as specified in Article 1.06.

1. Provide Samples for initial color selection in the form of manufacturer's color charts. After color selection, furnish color chips of selections made for surfaces to be coated.

D. Certificates: From manufacturer that products supplied comply with local Regulations controlling use of volatile organic compounds (VOCs).

E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements for Applicators and as follows.

1. Engage experienced applicators who have completed painting system applications similar in material and extent to those indicated for the Project that have resulted in a construction record of successful in-service performance.

C. Samples On wall surfaces and other exterior and interior components, duplicate finishes of prepared Samples. Provide full-coat finish Samples on at least 100 square feet of surface until required sheen, color, and texture are obtained; simulate finished lighting conditions for review of in-place Work.

1. Final acceptance of colors will be from Project-applied Samples.

2. The Engineer will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted. Apply coatings in this room or surface according to the Paint Schedules attached and, on the Drawings, or as specified.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading
1. Deliver materials to the Site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information.
   a. Product name or title of material
   b. Product description (generic classification or binder type)
   c. Manufacturer's stock number and date of manufacture
   d. Contents by volume, for pigment and vehicle constituents
   e. Thinning instructions
   f. Application instructions
   g. Color name and number

C. Storage and Protection

1. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F. Maintain containers used in storage in a clean condition, free of foreign materials and residue. Protect from freezing.

2. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and Work areas are protected from fire and health hazards resulting from handling, mixing, and application.

D. Waste Management and Disposal

1. Remove all unused material from the site, unless the Owner requests portions of unused material to be provided in properly sealed containers for future repair and maintenance of coatings. Transport (extra) material to Owner specified storage facility located at the project site.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 MAINTENANCE

A. Extra Materials: Furnish as specified below.

1. Extra material is not specifically required.

2. Provide the Owner the option to retain portions of unused surplus material in properly sealed containers prior to removing from site for disposal.
PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Tnemec
B. Sherwin Williams (S&W)
C. PPG
D. Or equal

2.02 PAINT MATERIALS

A. Provide materials designated by item or area to be painted in Paint Schedules attached and on Drawings. Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers.
B. Provide primers and undercoat paint produced by the same manufacturer as the finish coats.
C. Material compatibility: Provide block fillers, primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.
D. Material quality: Manufacturer's best-quality trade sale paint material of the various coating types specified. Ensure paint material containers display manufacturer's product identification.
E. Colors from the manufacturer's full range of standard colors.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Ensure surfaces receiving paint are thoroughly dry before paint is applied. Do not begin to apply paint until unsatisfactory conditions have been corrected.
B. Coordination of Work: Review other Specifications in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of
compatible primers. Notify the Engineer about anticipated problems using the materials specified over substrates primed by others.

3.02 PREPARATION

A. General Requirements

1. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Following completion of painting operations in each space or area, ensure workers skilled in the trades involved reinstall items.

2. Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

3. Clean and prepare surfaces to be painted according to the manufacturer's instructions for each substrate condition and as specified herein. Use more stringent cleaning and surface preparation if manufacturer’s recommendations differ from the requirements specified herein.

   a. Provide barrier coats over incompatible primers or remove and re-prime. Notify Engineer in writing about anticipated problems using the specified finish-coat material with substrates primed by others.

   b. Ensure existing painted surfaces are structurally sound, dry, clean, and free of oil, grease, dirt, mildew, form release agents, curing compounds, efflorescence, loose and flaking paint, or other foreign material. Engineer will approve condition of prepared substrate prior to application of coating system. Test old coatings for lifting per coating manufacturer's recommendations.

4. Abrasive Blast Surfaces: Shall be coated before any visible rust forms on the surface. Abrasive blast cleaning shall be performed only when the relative humidity is no higher than 85% and the surface temperature of the steel at its coldest point is at least 5 degrees Fahrenheit above the temperature of the dew point. Material that is abrasive blast-cleaned shall be primed in the same shift, no more than 12-hours after the surfaces have been blast-cleaned.

B. New or Previously Uncoated Surfaces:

1. Prepare to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, loose rust, and release agents.

   a. Concrete Surfaces:
1) Curing and Sealing Compounds: If curing and sealing compounds have been applied to concrete surfaces, use CSP-1 Acid etch cleaning or CSP-4 light scarification to remove existing curing and sealing compounds.

2) Abrasive blast-clean to ICRI CSP 2 to CSP 3.

3) Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.

b. Concrete Masonry Block, (CMU):
   1) Prepared surface shall be clean and dry
   2) Low-Pressure Water Cleaning (LP WC) as required to provide clean surface

c. Ferrous Metals: Prepare metal according as follows:
   1) Structural steel, Steel Bar Joists, and miscellaneous metal used for interior building framing components that are not exposed to view and are not scheduled to be field painted: SSPC-SP2 prior to “shop coat” with fabricator’s standard primer.

   2) Submerged components: Sandblasted clean in accordance with SSPC-SP10/NACE 2, Near-White Blast Cleaning immediately prior to priming.

   3) All other Ferrous Metals: Sandblasted clean in accordance with SSPC-SP-6, Commercial Grade, immediately prior to priming.

2. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods in accordance with ASTM D6386.

3. PVC Pipe: Scarify surface prior to prime coat.

C. Previously Coated Surfaces:
   1. Prepare to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, loose rust, and release agents.
a. Concrete walls, columns, and ceilings (Excludes Floors): Low-Pressure Water Cleaning (LP WC) to remove existing loose coatings. Pressure shall be less than 5000 psi. 4000 psi minimum should be used to ensure that all weekly adhered coating is removed. Tightly adherent material will be allowed to remain. Tightly adherent is defined by material that cannot be removed when tooling with a dull putty knife.

b. Concrete Floors: ICRI CSP 5 to CSP-6

c. Ferrous metals including structural steel columns and beams: SSPC-SP7 Brush-Off Blast Cleaning to remove all dirt, loose rust, and loose coatings.

d. Painted metal roof or floor deck: SSPC-SP7 Brush-Off Blast Cleaning to remove all dirt, loose rust, and loose coatings.

e. Galvanized (corroded) Roof or Floor Deck: SSPC-SP6 Commercial Blast Cleaning or SSPC-SP11 Power Tool Cleaning to Bare Metal.

2. Coating Compatibility: Check for coating compatibility by applying a test patch of the recommended coating system, covering at least 2-3 square feet. Allow to dry one week before testing adhesion per ASTM D3359. If the coating is incompatible contact engineer and coating manufacturer for recommendations.

3. Existing Interior Finished Spaces: Where existing interior occupied spaces are schedules to be coated, perform surface preparation and cleaning without damage to existing finishes, electronics, and equipment that cannot be removed prior to coating. Surface preparation and cleaning shall include the following steps until all efflorescence, chalk, dust, dirt, grease, oils, loose rust, and release agents are removed.

a. Detergent Scrubbing and rinsing as required to removed dust, dirt, grease, oils, and release agents.

b. Solvent cleaning.

c. Hand Tool Cleaning

d. Power Tool Cleaning.

4. Over-Coating of Hard, High-gloss, or existing epoxy coatings. Overcoating mechanical equipment or other surfaces that would otherwise be damaged by Water Cleaning or Abrasive Blast Cleaning:

a. Clean existing coating with degreaser or other cleaner recommended by coating manufacturer.

b. Remove damaged, delaminated, or questionable portions of existing coat from the substrate.
c. Sand, grind, or abrasive blast existing coating to clean and texture surface to improve bond of over-coat.

### 3.03 COLOR SELECTION

A. Colors of finish coats: as indicated or specified or as selected by Owner.

### 3.04 APPLICATION

A. General

1. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F and 90 degrees F.

2. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F and 95 degrees F.

3. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or to damp or wet surfaces. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

4. Priming Abrasive Blast Surfaces: Shall be primed before any visible rust forms on the surface. Abrasive blast cleaning shall be performed only when the relative humidity is no higher than 85% and the surface temperature of the steel at its coldest point is at least 5 degrees Fahrenheit above the temperature of the dew point. Material that is abrasive blast-cleaned shall be primed in the same shift, no more than 12-hours after the surfaces have been blast-cleaned.

5. Carefully mix and prepare paint materials according to manufacturer's directions.

   a. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

   b. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

6. Use only thinners approved by the paint manufacturer and only within recommended limits.

7. Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
a. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

b. Paint colors, surface treatments, and finishes as indicated in the Paint Schedules.

c. Provide finish coats that are compatible with primers used.

d. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.

e. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed surfaces/fasteners, receive a dry film thickness equivalent to that of flat surfaces.

f. The term “exposed surfaces” includes areas visible when permanent or built-in fixtures, convектор covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.

g. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

h. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.

i. Paint backsides of access panels and removable or hinged covers to match exposed surfaces.

j. Finish exterior doors on tops, bottoms, and side edges same as exterior faces.

k. Sand lightly between each succeeding enamel or varnish coat.

l. Omit primer on metal surfaces that have been shop-primed and touch-up painted.

m. Prime concrete masonry unit (CMU) walls and apply 1 finish coat prior to installation of any wall mounted equipment, piping, conduits, or fixed objects that would limit access for application of coating system and/or conceal portions of the wall surface. Apply second finish coat after all Work of other trades is completed.
B. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

   1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Apply paints and coatings by brush, roller, spray, or other applicators according to the manufacturer's directions.

   1. Use brushes best suited for the material applied.

   2. Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

   3. Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Apply materials no thinner than the manufacturers’ recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Paint only mechanical and electrical work exposed in mechanical equipment rooms and in occupied spaces and paint mechanical, electrical, HVAC, process equipment, and other utility items as indicated on the Drawings. Do not paint items that are factory painted. Factory applied coating systems are specified in the Specification where the product or item is specified. Items to be painted include:

   1. Piping
   2. Pumps
   3. Heat exchangers
   4. Tanks
   5. HVAC ductwork
   6. Insulation
   7. Supports
   8. Motors and mechanical equipment
   9. Accessory items
F. Ferrous metals indicated on the Drawings to be painted will be provided with a shop primer compatible with the coatings specified. Paint ferrous metals specified in Section 05 50 00 that are not galvanized and indicated to be painted on the Drawings.

G. Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

3.05 PRIME COATS

A. Before applying finish coats, apply a prime coat of material as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime-coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing. Apply prime coat to previously painted surfaces if finish coats are not compatible with existing coating.

3.06 PIGMENTED (OPAQUE) FINISHES

A. Completely cover to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

3.07 PIPE, VALVE/EQUIPMENT IDENTIFICATION AND COLOR CODING

A. Provide identification of pipes, valves and pumps by color as specified in the Section 40 05 13. Color selections for each system shall be provided by the Engineer and Owner.

3.08 COMPLETED WORK

A. Match approved Samples for color, texture, and coverage. Remove, refinish, or repaint Work not complying with specified requirements.

3.09 CLEANING

A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the Site. Clean up debris resulting from Work and dispose in Project on-site trash receptacles.

B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.
3.10 PROTECTION

A. Protect Work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Engineer.

B. Provide Wet Paint signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their Work after completing painting operations.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.11 REPAIR

A. Hot-dip Galvanized Surfaces:

1. Field repair all damaged hot-dip galvanized coatings.

2. Work shall conform to ASTM A780.

B. Coatings:

1. Repair any damaged shop applied primers and coatings as required to provide the same level of protection as provided by undamaged coating systems.

2. Color and finish of repairs shall match adjacent undamaged coating.

3.12 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field tests and inspections: May be required by Owner up to 4 times during the period when paint is being applied.

1. Engage the services of an independent testing agency with minimum 5 years of experience to sample the paint material used. Provide that Samples of material delivered to the Project are taken, identified, sealed, and certified in the presence of the Contractor.

2. The independent testing agency shall perform appropriate tests at no additional cost to the Owner for the following characteristics:

   a. Quantitative materials analysis
   b. Abrasion resistance
   c. Apparent reflectivity
d. Flexibility

e. Washability

f. Absorption

g. Accelerated weathering

h. Dry opacity

i. Accelerated yellowness

j. Recoating

k. Skinning

l. Color retention

m. Alkali and mildew resistance

3. If test results show material being used does not comply with specified requirements, stop painting, remove noncomplying paint, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are incompatible

3.13 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.14 ATTACHMENTS

A. Paint Schedule.

END OF SECTION
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PAINT SCHEDULE

Number of coats scheduled is as a minimum. Painting and finishing shall conform to applicable Laws and building code regarding fire hazard classifications and volatile organic content of finish materials. Provide products by the manufacturers named or approved equal.

Refer to "Room Finish Schedule" on the Drawings for building areas to be painted.

Provide paint and coating systems listed below where the Drawings refer to this Specification section or reference any item to be painted or coated, unless a specific paint or coating system is specified elsewhere.

This list is intended to cover all potential conditions that may require painting and not all paint and coating systems listed below may not be included in the Work.

<table>
<thead>
<tr>
<th>A. Equipment: Exterior Non-Submerged Ferrous Metals (Epoxy, Polyurethane)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory Applied Primer</td>
</tr>
<tr>
<td>2. S-W: Corothane I Galvapac Zinc Primer 1K</td>
</tr>
<tr>
<td>3. PPG: Amercoat 68 HS</td>
</tr>
<tr>
<td>4. Or Equal</td>
</tr>
<tr>
<td>Factory Applied Intermediate Coat</td>
</tr>
<tr>
<td>2. S-W: Macropoxy 646-100</td>
</tr>
<tr>
<td>3. PPG: Amercoat 370</td>
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<tr>
<td>4. Or Equal</td>
</tr>
<tr>
<td>Factory Applied Finish Coat</td>
</tr>
<tr>
<td>2. S-W: Hi-Solids Polyurethane</td>
</tr>
<tr>
<td>3. PPG: Amercoat 450H Shield</td>
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<tr>
<td>4. Or Equal</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>B. Equipment: Interior Non-Submerged Ferrous Metals (Epoxy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory Applied Primer</td>
</tr>
<tr>
<td>2. S-W: Corothane I Galvapac Zinc Primer 1K</td>
</tr>
<tr>
<td>3. PPG: Amercoat 68 HS”</td>
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<tr>
<td>4. Or Equal</td>
</tr>
<tr>
<td>Factory Applied Intermediate Coat</td>
</tr>
<tr>
<td>2. S-W: Macropoxy 646-100</td>
</tr>
<tr>
<td>3. PPG: Amerlock2/400</td>
</tr>
<tr>
<td>4. Or Equal</td>
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<tr>
<td>Factory Applied Finish Coat</td>
</tr>
<tr>
<td>2. S-W: Macropoxy 646-100</td>
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<td>3. PPG: Amerlock2/400</td>
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<tr>
<td>4. Or Equal</td>
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</tbody>
</table>
## C. Equipment: Exterior or Interior Submerged Ferrous Metals (Epoxy)

<table>
<thead>
<tr>
<th>Type</th>
<th>Manufacturer/Model</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factory Applied Primer</strong></td>
<td>1. Tnemec: Series 1 Omnithane</td>
<td>2.5 – 3.5 mils</td>
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<tr>
<td></td>
<td>2. S-W: Corothane I Galvapac Zinc Primer 1K</td>
<td>3 – 4 mils</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 68HS”</td>
<td>2 – 5 mils</td>
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<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
</tr>
<tr>
<td><strong>Factory Applied Intermediate Coat</strong></td>
<td>1. Tnemec: Series 66HS Hi-Build Epoxoline</td>
<td>6 – 8 mils</td>
</tr>
<tr>
<td></td>
<td>2. S-W: Dura-Plate 235</td>
<td>6 – 8 mils</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 370</td>
<td>4 – 6 mils</td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
</tr>
<tr>
<td><strong>Factory Applied Finish Coat</strong></td>
<td>1. Tnemec: Series 66HS Hi-Build Epoxoline</td>
<td>6 – 8 mils</td>
</tr>
<tr>
<td></td>
<td>2. S-W: Dura-Plate 235</td>
<td>6 – 8 mils</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 450H Shield</td>
<td>2 – 5 mils</td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
</tr>
</tbody>
</table>

## D. Hot-Dip Galvanized Field Repair Coating (SSPC Paint 20, Acrylic/Polyurethane)

<table>
<thead>
<tr>
<th>Type</th>
<th>Manufacturer/Model</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field Applied SSPC Paint Spec 20 (Repair Coat)</strong></td>
<td>1. Tnemec: Series 90-97 Tneme-Zinc</td>
<td>2.5 – 3.5 mils</td>
</tr>
<tr>
<td></td>
<td>2. S-W: Zinc Clad 200</td>
<td>2 – 3 mils</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 68 HS</td>
<td>2 – 5 mils</td>
</tr>
<tr>
<td></td>
<td>4. Or Equal: conforming to SSPC Paint Spec 20</td>
<td></td>
</tr>
<tr>
<td><strong>Field Applied (2) Finish Coats (color match Hot-dip finish)</strong></td>
<td>1. Tnemec: Series 1029 Enduratone</td>
<td>2 – 3 mils/ct</td>
</tr>
<tr>
<td></td>
<td>2. S-W: Pro-Industrial DTM Acrylic</td>
<td>4 – 6 mils/ct</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 450H</td>
<td>4 – 5 mils/ct</td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
</tr>
</tbody>
</table>

## E. Ferrous Metals: Exterior Exposure (Epoxy, Polyurethane)

<table>
<thead>
<tr>
<th>Type</th>
<th>Manufacturer/Model</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factory Applied Primer</strong></td>
<td>1. Tnemec: Series 66HS Hi-Build Epoxoline</td>
<td>2 – 3 mils</td>
</tr>
<tr>
<td></td>
<td>2. S-W: Macroxy 646</td>
<td>4 – 6 mils</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 385</td>
<td>4 – 8 mils</td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
</tr>
<tr>
<td><strong>Field Applied Two Finish Coats</strong></td>
<td>1. Tnemec: Series 1095 Endura-Shield</td>
<td>2 – 5 mils/ct</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 450H</td>
<td>2 – 4 mils/ct</td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
</tr>
</tbody>
</table>
### F. Ferrous Metals: Interior Exposure (Epoxy)

<table>
<thead>
<tr>
<th>Paint Type</th>
<th>Description</th>
<th>DFT</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory Applied Primer (Shop Primer)</td>
<td>1. Fabricator’s Standard Shop Primer: only permitted if specified (allowed) in other Specification Sections.</td>
<td>DFT 1 mil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Tnemec: Series 27 F.C. Tytopoxy</td>
<td>DFT 2 – 3 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Recatable Epoxy Primer</td>
<td>DFT 4 – 6 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 370</td>
<td>DFT 4 – 6 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factory Applied Primer (unless noted otherwise)</td>
<td>1. Tnemec: Series 66 HS Hi-Build Epoxoline</td>
<td>DFT 2 – 3 mils/ct</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Macropoxy 646</td>
<td>DFT 3 – 5 mils/ct</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 2</td>
<td>DFT 4 – 8 mils/ct</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Applied Two Finish Coats</td>
<td>1. Tnemec: Series 66 HS Hi-Build Epoxoline</td>
<td>DFT 2 – 3 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Macropoxy 646</td>
<td>DFT 3 – 5 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 2</td>
<td>DFT 4 – 8 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### G. Ductile, Cast Iron, Copper, Aluminum, or PVC: Interior or Exterior (Epoxy/Polyurethane)

<table>
<thead>
<tr>
<th>Paint Type</th>
<th>Description</th>
<th>DFT</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Applied Prime Coat</td>
<td>1. Tnemec: Series 66 HS Hi-Build Epoxoline</td>
<td>DFT 2 – 3 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Macropoxy 646</td>
<td>DFT 3 – 5 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 2</td>
<td>DFT 4 – 8 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Applied Intermediate Coat</td>
<td>1. Tnemec: Series 66 HS Hi-Build Epoxoline</td>
<td>DFT 4 – 6 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Macropoxy 646</td>
<td>DFT 3 – 5 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 2</td>
<td>DFT 4 – 8 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Applied Finish Coat</td>
<td>1. Tnemec: Series 1095 Endura-Shield</td>
<td>DFT 2 – 5 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 250H</td>
<td>DFT 4 – 6 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### H. Ductile Iron Pipe Submerged (Epoxy)

<table>
<thead>
<tr>
<th>Paint Type</th>
<th>Description</th>
<th>DFT</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Applied Prime Coat</td>
<td>1. Tnemec: Series 20 HS Pota-Pox</td>
<td>DFT 2 – 3 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Dura-Plate 235</td>
<td>DFT 4 – 6 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 2</td>
<td>DFT 4 – 8 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Applied Intermediate Coat</td>
<td>1. Tnemec: Series 20 HS Pota-Pox</td>
<td>DFT 4 – 6 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Dura-Plate 235</td>
<td>DFT 3 – 4 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 2/400</td>
<td>DFT 4 – 8 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Applied Finish Coat</td>
<td>1. Tnemec: Series 20 HS Pota-Pox</td>
<td>DFT 4 – 6 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. S-W: Dura-Plate 235</td>
<td>DFT 4 – 6 mil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amerlock 2/400</td>
<td>DFT 4 – 8 mils</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### I. Insulated Pipe Interior or Exterior Exposure (Acrylic)

<table>
<thead>
<tr>
<th>Field Applied Prime Coat</th>
<th>Field Applied Intermediate Coat</th>
<th>Field Applied Finish Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Or Equal</td>
<td>4. Or Equal</td>
<td>4. Or Equal</td>
</tr>
<tr>
<td>DFT 1 – 1.5 mils</td>
<td>DFT 2 – 3 mils</td>
<td>DFT 2 – 3 mils</td>
</tr>
<tr>
<td>DFT 2.5 – 4 mils</td>
<td>DFT 2.5 – 4 mils</td>
<td>DFT 2.5 – 4 mils</td>
</tr>
<tr>
<td>DFT 2 – 4 mils</td>
<td>DFT 2 – 4 mils</td>
<td>DFT 2 – 4 mils</td>
</tr>
</tbody>
</table>

### J. Interior CMU Walls (Epoxy)

<table>
<thead>
<tr>
<th>Field Applied Prime Coat</th>
<th>Field Applied Intermediate Coat</th>
<th>Field Applied Finish Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Or Equal</td>
<td>4. Or Equal</td>
<td>4. Or Equal</td>
</tr>
<tr>
<td>85 SF/GAL</td>
<td>85 SF/GAL</td>
<td>85 SF/GAL</td>
</tr>
<tr>
<td>85 SF/GAL</td>
<td>85 SF/GAL</td>
<td>85 SF/GAL</td>
</tr>
<tr>
<td>DFT 3 – 4 mils</td>
<td>DFT 3 – 4 mils</td>
<td>DFT 3 – 4 mils</td>
</tr>
<tr>
<td>DFT 3 – 5 mils</td>
<td>DFT 3 – 5 mils</td>
<td>DFT 3 – 5 mils</td>
</tr>
<tr>
<td>DFT 4 – 8 mils</td>
<td>DFT 4 – 8 mils</td>
<td>DFT 4 – 8 mils</td>
</tr>
</tbody>
</table>

### K. Poly-Ash Soffit and Trim Interior or Exterior Exposure (Acrylic)

<table>
<thead>
<tr>
<th>Field Applied Prime Coat</th>
<th>Field Applied Intermediate Coat</th>
<th>Field Applied Finish Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Or Equal</td>
<td>4. Or Equal</td>
<td>4. Or Equal</td>
</tr>
<tr>
<td>DFT 2 – 3 mils</td>
<td>DFT 2 – 3 mils</td>
<td>DFT 2 – 3 mils</td>
</tr>
<tr>
<td>DFT 2 – 3 mils</td>
<td>DFT 1.5 – 2 mils</td>
<td>DFT 1.5 – 2 mils</td>
</tr>
<tr>
<td>DFT 2 – 3 mils</td>
<td>DFT 1 – 2 mils</td>
<td>DFT 1 – 2 mils</td>
</tr>
</tbody>
</table>
### L. Interior or Exterior Steel Doors and Frames- (Polyurethane)

<table>
<thead>
<tr>
<th>Shop Applied Prime Coat</th>
<th>1. Factory Primed Per Section 08 11 00</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Applied Two Finish Coats</td>
<td>1. Tnemec: 1095 Endura-Shield</td>
<td>DFT 2 – 5 mils</td>
</tr>
<tr>
<td></td>
<td>3. PPG: Amercoat 450H</td>
<td>DFT 2 – 4 mils</td>
</tr>
<tr>
<td></td>
<td>4. Or Equal</td>
<td></td>
</tr>
</tbody>
</table>

### M. Bituminous Coating (SSPC Paint 16)

<table>
<thead>
<tr>
<th>Shop Applied &amp; (Field Touch-up)</th>
<th>2. Tnemec: Series 46H-413 Tneme-Tar</th>
<th>2 shop coats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3. S-W: Targuard Coal Tar Epoxy</td>
<td>DFT 8– 10 mils/ct</td>
</tr>
<tr>
<td></td>
<td>4. PPG: Amercoat 78HB</td>
<td></td>
</tr>
</tbody>
</table>
SECTION 10 28 13

TOILET ACCESSORIES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide toilet accessories in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. ASTM International (ASTM)

   a. ASTM C1036 Flat Glass

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Product Data

   1. Finishes
   2. Accessory Items
   3. Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions

C. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.
1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Wrap toilet accessories for shipment and storage, then deliver to Site in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 WARRANTY

A. Special Warranty/Extended Correction Period

1. Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Grainger

2.02 MANUFACTURED UNITS

A. Provide toilet accessories where indicated on the Drawings. Each accessory item shall be complete with the necessary mounting plates of sturdy construction with corrosion resistant surface

1. Anchors and Fasteners

a. Provide anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide exposed fasteners with finish to match the accessory

2. Finishes

a. Except where noted otherwise, provide the following finishes on metal

<table>
<thead>
<tr>
<th>Metal</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel</td>
<td>No. 4 satin finish</td>
</tr>
<tr>
<td>Carbon steel, copper alloy, and brass</td>
<td>Chromium plated, bright</td>
</tr>
</tbody>
</table>
2.03 ACCESSORY ITEMS

A. Conform to the requirements for accessory items specified below

1. Grab Bar: Provide an 18 gauge, 1-1/4 inch grab bar OD Type 304 stainless steel, equal to American Specialties Inc. #3400, as indicated. Provide form and length for grab bar as indicated. Provide grab with peened non-slip surface. Furnish installed bars capable of withstanding a 250-pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Allow 1-1/2 inch space between wall and grab bar

2. Mirror, Metal: Provide a brightly polished stainless steel metal mirror of 0.037 inch minimum thickness with 1/4 inch glazing, 36 inch height by 24 inch width with 5 inch by 1/2 inch integral shelf, edges turned back 1/4 inch and recess fitted with tempered hardboard backing, and theft-proof fasteners, equal to American Specialties Inc. #0625, as indicated

3. Paper Towel Dispenser: Provide paper towel dispenser constructed of a minimum 18 gauge, Type 304 stainless steel, surface mounted, equal to American Specialties Inc. #8522. Dispenser shall hold 8 inch or 9 inch wide and up to 800 feet long standard paper towel roll and shall have dispenser lever. Furnish tumbler key lock locking mechanism

4. Toilet Tissue Dispenser: Provide surface mounted jumbo-roll toilet tissue dispenser that will hold two rolls of 9-inch diameter tissue equal to American Specialties Inc. #0040. Provide a stainless steel, satin finish cabinet

5. Double Robe Hook: Provide surface mounted double robe hook equal to American Specialties Inc. #0745-Z. Install hook 5 feet 6 inches above finish floor

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as Work progresses. After installation, thoroughly clean exposed surfaces and restore damaged Work to its original condition or replace with new Work
1. Recessed Accessories: Fasten accessories with wood screws to studs, blocking or rough frame in wood construction. Set anchors in mortar in masonry construction. Fasten to metal studs or framing with sheet metal screws in metal construction.

2. Surface Mounted Accessories: Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with sheet metal screws or wood screws in lead-lined braided jute, Teflon or neoprene sleeves, or lead expansion shields, or with toggle bolts or other approved fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs or to solid wood blocking secured between wood studs, or to metal backplates secured to metal studs.

3.02 CLEANING
   A. Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

3.03 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 10 44 16

FIRE EXTINGUISHERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide fire extinguishers in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. International Code Council (ICC)
2. National Fire Protection Association (NFPA)
3. U.S. National Archives and Records Administration (NARA)
4. Underwriters Laboratories (UL)

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

1. Fire Extinguisher
2. Accessories
3. Wall Brackets
4. Replacement Parts
C. Shop Drawings
   1. Fire Extinguisher
   2. Accessories
   3. Wall Brackets

D. Certificates
   1. Certification that fire extinguishers comply with local codes and Regulations
   2. Certification that fire extinguishers comply with OSHA, NFPA, and UL requirements

E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements

1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Protect materials from weather, soil, and damage during delivery, storage, and construction
   C. Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 TYPE
   A. Must conform to NFPA 10. Quantity and placement must comply with the applicable sections of IFC 1414, IFC 906, NFPA 1, NFPA 101, and 29 CFR 1910.157
   B. Provide dry chemical type fire extinguishers compliant with UL 299, rated A:B:C for all extinguishers, unless noted otherwise
C. Provide carbon dioxide fire extinguishers compliant with UL 299, rated B:C for extinguishers located within the electrical room

D. 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

2.02 MATERIAL

A. Fire extinguisher shall be red enameled steel

2.03 SIZE

A. Fire extinguisher shall be 10 pounds

2.04 ACCESSORIES

A. Provide pressure gage on each fire extinguisher

2.05 WALL BRACKETS

A. Provide wall-hook fire extinguisher wall brackets

B. Wall bracket and accessories must be as approved

C. Mounting Height: Top of fire extinguishers shall not be more than 5 feet above the floor

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Provide manufacturer's warranty with inspection tag on each extinguisher

PART 3 – EXECUTION

3.01 INSTALLATION

A. Class A light-hazard occupancies such as office buildings must have a Class A extinguisher within a 75-foot travel distance with 1 unit of 1A rating for every 3,000 square feet of floor area; ordinary hazard occupancies such as warehouses and department stores: 75-foot travel distance with one unit of 2A rating for every 3,000 square feet; and extra hazard occupancies such as woodworking and spray painting locations: 75-foot travel distance with one unit of 3A rating for every 3,000 square feet
3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.03 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 22 05 11

COMMON WORK RESULTS FOR PLUMBING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The requirements of this Section shall apply to all sections of Division 22.

1.02 APPLICABLE PUBLICATIONS

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

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
   1. Boiler and Pressure Vessel Code (BPVC)
      a. SEC IX-2007 Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D. MANUFACTURERS STANDARDIZATION SOCIETY (MSS) OF THE VALVE AND FITTINGS INDUSTRY, INC.
   1. SP-58-02 Pipe Hangers and Supports-Materials, Design, and Manufacture
   2. SP 69-2003 (R 2004) Pipe Hangers and Supports – Selection and Application

E. Massachusetts 248 CMR, latest edition

F. International Energy Conservation Code (IECC)
G. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
   1. MG1-2003, Rev. 1-2007 Motors and Generators

H. INTERNATIONAL CODE COUNCIL, (ICC)
   1. International Building Code
   2. International Plumbing Code

1.03 SUBMITTALS

A. Submittals shall be submitted in accordance with Division 01, General Requirements.

B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

C. Manufacturer’s Literature and Data: Manufacturer’s literature shall be submitted under the pertinent Section rather than under this Section.
   1. Equipment and materials identification.
   2. Wall, floor, and ceiling plates.

D. Maintenance Data and Operating Instructions
   1. Maintenance and operating manuals in accordance with Division 01, for systems and equipment.
   2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.

E. Test Reports
   1. Tests, Flushing, and Disinfection: Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls. Testing, flushing, and disinfection shall be in the presence of the Engineer; provide a minimum of 72 hours of notice.
2. Test of Backflow Prevention Assemblies: Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the Manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

1.04 QUALITY ASSURANCE

A. Products Criteria

1. Standard Products: Material and equipment shall be the standard products of a Manufacturer regularly engaged in the manufacture of the products for at least 2 years.

2. All items furnished shall be free from defects that would adversely affect the performance, maintainability, and appearance of individual components and overall assembly.

3. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Engineer.

4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one Manufacturer.

5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

6. Nameplates: Nameplates bearing the Manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

7. Asbestos products or equipment or materials containing asbestos shall not be used.
B. Welding: Before any welding is performed, Contractor shall submit a certificate certifying that welders comply with the following requirements:

1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".

2. Comply with provisions of ASME B31 series "Code for Pressure Piping".

3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

4. All welds shall be stamped according to the provisions of the American Welding Society.

C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the Manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

D. Execution (Installation, Construction) Quality

1. All items shall be applied and installed in accordance with Manufacturer's written instructions. Conflicts between the Manufacturer's instructions and the contract drawings and specifications shall be referred to the Engineer for resolution. Written hard copies or computer files of the Manufacturer’s installation instructions shall be provided to the Engineer at least two weeks prior to commencing installation of any item.


1.05 DELIVERY, STORAGE, AND HANDLING

A. Protection of Equipment

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Owner has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the Engineer. Such replacement shall be at no additional cost to the Owner.

3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter, both stored and installed. Both inside and outside shall be cleaned before painting or placing equipment in operation.

4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.

2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.

3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Owner. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC), and Massachusetts 248 CMR, latest editions. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.

4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.06 REGULATORY REQUIREMENTS

A. Unless otherwise required herein, plumbing work shall be in accordance with Massachusetts 248 CMR. Energy consuming products and systems shall be in accordance with PL 109-58, International Energy Conservation Code (IECC), and ASHRAE 90.1 – IP.

PART 2 – PRODUCTS

2.01 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements.
B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.

1. All components of an assembled unit need not be products of the same Manufacturer.

2. Constituent parts that are alike shall be products of a single Manufacturer.

3. Components shall be compatible with each other and with the total assembly for intended service.

4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear Manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment, which serve the same function, shall be the same make and model.

2.02 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.03 SAFETY GUARDS

A. All equipment shall have moving parts protected from personal injury.

2.04 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals.

B. Interior (Indoor) Equipment: Engraved nameplates, lamacoid with rigid black plastic with white letters, shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, fans, etc. shall be identified.

C. Control Items: All temperature, pressure, and controllers shall be labeled and the component’s function identified. Identify and label each item as they appear on the control diagrams.
2.05 PIPE HANGERS, SUPPORTS, AND RESTRAINTS

A. Pipe hangers, supports, and restraints shall be as specified in Section 40 05 15 PROCESS PIPE SUPPORTS.

2.06 ASBESTOS

A. Materials containing asbestos are not permitted.

PART 3 – EXECUTION

3.01 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

B. The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

C. Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

D. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities.

1. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
E. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: All equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gauges and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on drawings shall not be changed nor reduced.

F. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.

G. Location of pipe sleeves, trenches, and chases shall be accurately coordinated with equipment and piping locations.

H. Cutting Holes
   1. Holes through concrete shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by the Engineer where working area space is limited.
   2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by the Engineer. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to the Engineer for approval.

I. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.

J. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.

K. Protection and Cleaning
   1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the Manufacturer's recommendations and as approved by the Engineer. Damaged or defective items, in the opinion of the Engineer, shall be replaced.
   2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials, and equipment.
L. Concrete and Grout: Concrete and non-shrink grout shall be as specified in Division 03. Provide concrete housekeeping pads for all floor mounted equipment per the details on the Drawings.

M. Gauges, thermometers, valves, and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices.

N. Thermometers and gauges shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

O. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments. Comply with NFPA-70.

P. Work in bathrooms, restrooms: All pipe penetrations behind escutcheons shall be sealed with plumber’s putty.

Q. Inaccessible Equipment
   1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
   2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

R. Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories.

3.02 PIPE HANGERS, SUPPORTS, AND RESTRAINTS

A. Pipe hangers, supports, and restraints shall be installed as specified in Section 40 05 15 PROCESS PIPE SUPPORTS.
3.03 LUBRICATION

A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.

B. All devices and equipment shall be equipped with required lubrication fittings.

C. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

D. All lubrication points shall be extended to one side of the equipment.

3.04 CLEANING AND PAINTING

A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Owner, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Painting of pipes shall only be required for exposed or outdoor spaces for ferrous metallic piping and systems, and shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

B. In addition, the following special conditions apply:

1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the Manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.

2. The following material and equipment shall NOT be painted:
   a. Motors, controllers, control switches, and safety switches
   b. Control and interlock devices
   c. Regulators
   d. Pressure reducing valves
   e. Control valves and thermostatic elements
   f. Lubrication devices and grease fittings.
   g. Copper, brass, aluminum, stainless steel, and bronze surfaces. Surfaces shall be painted or finished if indicated on the Drawings.
   h. Valve stems and rotating shafts
   i. Pressure gauges and thermometers
   j. Glass
   k. Name plates
3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint obtained from the Manufacturer or computer matched.

4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump Manufacturer.

5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.

6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

C. Factory Painting Systems

1. Shop Painting Systems for Metal Surfaces
   a. 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°F shall be cleaned to bare metal.
   b. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

3.05 IDENTIFICATION SIGNS

A. Laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manuals, and in diagrams specified elsewhere. Attach by with stainless steel hardware or chain.

B. Factory Built Equipment: Metal plate, securely attached, with name and address of the Manufacturer, serial number, model number, size, performance shall be placed on factory built equipment.
3.06 STARTUP AND TEMPORARY OPERATION

A. Startup of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Division 01.

3.07 SYSTEM FLUSHING

A. During Flushing

1. Before operational tests or disinfection, potable water piping system shall be flushed. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Engineer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

B. After Flushing

1. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh, potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Comply with ASHRAE 90.1 - IP for minimum efficiency requirements. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 50.12 Part 141.80(c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.
3.08 OPERATING AND PERFORMANCE TESTS

A. Prior to the final inspection, all required tests shall be performed as specified in Division 01. Submit the test reports and records to the Engineer.

B. Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 2 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

1. Time, date, and duration of test.
2. Water pressures at the most remote and the highest fixtures.
3. Operation of each fixture and fixture trim.
4. Operation of each valve, hydrant, and faucet.
5. Pump suction and discharge pressures.
6. Temperature of each domestic hot-water supply.
7. Operation of each floor and roof drain by flooding with water.
8. Operation of each vacuum breaker and backflow preventer.
9. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.
10. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, water, electricity, and personnel required for the tests.

C. Should evidence of malfunction in any tested system, piece of equipment, or component part thereof occur during or as a result of tests, proper corrections, repairs, or replacements shall be made, and repeat tests at no additional cost to the Owner.

D. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.
E. Local plumbing inspector shall inspect and provide signed certification of all water, vent, and sanitary systems.

3.09 DISINFECTION

A. After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

B. Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 25 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

C. After a 24 hour contact period, verify that no less than 10 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 10 ppm chlorine residual remains in the treated system.

D. Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

E. Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Engineer. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements. Testing costs shall be paid for as part of the Testing Allowance as indicated in Division 00 and 01.

F. Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 OPERATION AND MAINTENANCE MANUALS

A. Provide Operations and Maintenance Manuals in accordance with Division 01.
B. All new and temporary equipment and all elements of each assembly shall be included.

C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.

D. Manufacturer’s installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.

E. Lubrication instructions, type, and quantity of lubricant shall be included.

F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.

G. Set points of all interlock devices shall be listed.

H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.

I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.

J. Emergency procedures.

3.11 DEFECTIVE WORK

A. If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

END OF SECTION
SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, install, test and make ready for operation; general-duty valves for plumbing piping systems, domestic water and sanitary systems.

1.02 APPLICABLE PUBLICATIONS

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


C. AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

1. ASSE 1003-01 (R 2003) Performance Requirements for Water Pressure Reducing Valves

2. ASSE 1012-02 Backflow Preventer with Intermediate Atmospheric Vent

3. ASSE 1013-05 Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers

D. INTERNATIONAL CODE COUNCIL (ICC)

1. IPC-06 (R 2015) International Plumbing Code

E. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS)

1. SP-25-98 Standard Marking System for Valves, Fittings, Flanges, and Unions

2. SP-70-06 Cast Iron Gate Valves, Flanged and Threaded Ends.

3. SP-72-99 Ball Valves With Flanged or Butt Welding For General Purpose

4. SP-80-03 Bronze Gate, Globe, Angle and Check Valves

5. SP-110-96 Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends
1.03 SUBMITTALS

A. Submit Manufacturer’s literature and data pertaining to the valves in a properly bound package, in accordance with Division 01 requirements. Include the following as a minimum:

1. Valves
2. Pressure Reducing Valves
3. Backwater Valves
4. Backflow Preventers
5. Backflow Prevention Assemblies
6. All items listed in Part 2 – Products.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Valves shall be prepared for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Valves shall be prepared for storage as follows:

1. Maintain valve end protection and protect opening from foreign debris.
2. Store valves indoors and maintain at higher than ambient dew point temperature.

C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.
PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available Manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Conbraco Industries, Inc.; Apollo Valves
2. Crane Co.; Crane Valve Group; Crane Valves
3. Hammond Valve
4. Milwaukee Valve Company
5. NIBCO, Inc.
7. Engineer Approved Equal

2.02 VALVES

A. Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be brass with Pro-Press type fittings. Valves shall conform to the following standards:

1. Ball Valves with Flanged Butt-Welding Ends for General Service MSS SP-72
2. Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends MSS SP-110
3. Bronze Gate, Globe, Angle, and Check Valves MSS SP-80
5. Vacuum Relief Valves CSA/AM Z21.22
6. Water Pressure Reducing Valves ASSE 1003

B. Lead-free valves.
C. Asbestos packing and gaskets are prohibited.

D. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.

E. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.

F. Ball valves, pressure regulating valves, gate valves, globe valves, and plug valves used to supply potable water shall meet the requirements of NSF 61.

G. Shut-off

1. Cold and Hot water
   a. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-72, SP-110. Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4140 kPa (600 psig). The body material shall be Brass ASTM F1960. The ends shall be Pro-Pex or Pro-Press type connections.

H. Check

1. Check valves less than 80 mm or DN80 (3 inches) shall be class 125, bronze swing check valves with nonmetallic Buna-N disc. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B 62, solder joints, and PTFE or TFE disc.

2.03 BACKFLOW PREVENTERS

A. Backflow prevention devices must be approved by the local regulatory agency.

B. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be ASSE 1013 listed and certified.

C. Reduced pressure backflow preventers shall be installed in the following applications:
1. Water make up to heating systems, generators, and similar equipment consuming water.

2. Water service entrance

D. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y gate valves or ball valves and an integral relief monitor switch. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. A wye type strainer shall be installed on the inlet.

E. The atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be cast bronze. All internal polymers shall be NSF listed. The seat disc elastomer shall be silicone. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable.

1. Hose connection vacuum breakers shall conform to ASSE 1011.

2. Pressure vacuum breaker assembly shall conform to ASSE 1020.

3. Air gaps in plumbing systems shall conform to ASME A112.1.2.

F. Acceptable Manufacturers

1. Watts Industries, Inc. (Basis of Design)

2. Conbraco Industries, Inc.

3. Zurn Industries, Inc.

4. Engineer Approved Equal

PART 3 – EXECUTION

3.01 EXAMINATION

A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks used to prevent disc movement during shipping and handling.

B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.

C. Threads on valve and mating pipe shall be examined for form and cleanliness.
D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Valves shall be located for easy access and shall be provided with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.

C. Valves shall be installed in horizontal piping with stem at or above center of pipe.

D. Valves shall be installed in a position to allow full stem movement.

E. Check valves shall be installed for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

F. Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket.

3.03 BACKFLOW PREVENTION DEVICES

A. Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with Massachusetts 248 CMR and IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance.

B. In addition, backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the non-potable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any non-potable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.
3.04 TEST OF BACKFLOW PREVENTION ASSEMBLIES

A. Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies.

B. Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

1. Data on Device
2. Data on Testing Firm
3. Type of Assembly
4. Name
5. Manufacturer
6. Address
7. Model Number
8. Certified Tester
9. Serial Number
10. Certified Tester No.
11. Size
12. Date of Test
13. Location
14. Test Pressure Readings
15. Serial Number and Test Data of Gauges

C. If the unit fails to meet specified requirements, the unit shall be repaired and retested.
3.05 ADJUSTING

A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Valves shall be replaced if persistent leaking occurs.

3.06 ACCESS PANELS

A. Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be provided per the details on the Drawings and per the Contract Documents.

END OF SECTION
SECTION 22 07 11

PLUMBING INSULATION

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish and install, field applied insulation, jacket and related appurtenances for thermal efficiency and condensation control for plumbing piping and equipment. Refer to the Drawings for specific insulation and jacket types to be used for each area of the project. Provide insulation with thicknesses as specified or as indicated on the Drawings.

B. Definitions

1. ASJ: All service jacket, white finish facing or jacket.
2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
3. Cold: Equipment or piping handling media at design temperature of 16°C (60°F) or below.
4. Concealed: Piping above ceilings and in chases, interstitial space, and pipe spaces.
5. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
6. FSK: Foil-scrim-kraft facing.
7. Hot: Plumbing equipment or piping handling media above 41°C (105°F).
8. Density: kg/m3 - kilograms per cubic meter (Pcf - pounds per cubic foot).
9. Thermal conductance: Heat flow rate through materials
   a. Flat surface: Watts per square meter (BTU per hour per square foot)
   b. Pipe or Cylinder: Watts per square meter (BTU per hour per linear foot)
10. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
11. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.

12. CW: Cold water

13. HW: Hot water

14. PVDC: Polyvinylidene chloride vapor retarder jacketing, white

1.02 APPLICABLE PUBLICATIONS

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

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)


5. C533-09 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation


12. C1126-10 Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation


17. E136-09 b Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C (1380 F)

C. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1. 101-09 Life Safety Code

2. 251-06 Standard Methods of Tests of Fire Endurance of Building Construction Materials

3. 255-06 Standard Method of Tests of Surface Burning Characteristics of Building Materials

D. UNDERWRITERS LABORATORIES, INC (UL)

1. 723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 08/03

1.03 SUBMITTALS

A. Submit in accordance with Division 01 requirements.

B. Shop Drawings

1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.

   a. Insulation materials: Specify each type used and state surface burning characteristics.
b. Insulation facings and jackets: Each type used.
c. Insulation accessory materials: Each type used.
d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
e. Make reference to applicable specification paragraph numbers for coordination.

### 1.04 QUALITY ASSURANCE

**A. Criteria**

1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

   a. 4.3.3.1 Pipe insulation and coverings, vapor retarder facings, adhesives, fasteners, tapes, unless otherwise provided for in 4.3.3.1.12 or 4.3.3.1.2, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

   b. 4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)

   c. 4.3.3.3 Pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

   d. 4.3.3.3.1 In no case shall the test temperature be below 121 C (250 F).

   e. 4.3.10.2.6.7 Smoke detectors shall not be required to meet the provisions of this Section.

2. Test methods: ASTM E84, UL 723, or NFPA 255.

3. Specified k factors are at 24 C (75 F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation Manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation
and condensation control insulation, no thickness adjustment need be made.

4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

1.05 STORAGE AND HANDLING OF MATERIAL

A. Store materials in a clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of Manufacturers of adhesives, mastics and finishing cements.

PART 2 – PRODUCTS

2.01 PRODUCTS

A. Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:

1. Aeroflex USA, Inc.; Aerocel
2. Armacell LLC; AP Armaflex.
4. Johns Manville; Micro-Lok
5. Knauf Insulation; 1000-Degree Pipe Insulation
6. Owens Corning; Fiberglas Pipe Insulation
7. McGuire Manufacturing
8. F. Truebro; a brand of IPS Corporation
9. Engineer Approved Equal

2.02 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. For exterior applications, provide closed-cell elastomeric insulation on resistant, specifically designed for exterior applications.

F. Mineral-Fiber, Preformed Pipe Insulation:
   1. Type I, 850 F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL.

G. Fiberglass Piping Insulation:
   1. ASTM C 547, Class 1 for all metallic, copper piping, and plastic piping unless otherwise specified or indicated on the Drawings.

2.03 INSULATING CEMENTS


2.04 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2.05 SEALANTS

A. PVC Jacket Flashing Sealant
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant
   3. Service Temperature Range: Minus 40 to plus 250°F
   4. Color: White
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches
   2. Thickness: 11.5 mils
   3. Adhesion: 90 ounces force/inch in width
   4. Elongation: 2 percent
   5. Tensile Strength: 40 lbf/inch in width
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape

2.07 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers
   1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.08 PIPE COVERING PROTECTION SADDLES

A. Cold pipe support: Premolded pipe insulation (360 degrees) at supports. Material shall be high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).
1. Approved Alternate: Metallic insulation protection shield shall also be acceptable at the contractor’s option.

<table>
<thead>
<tr>
<th>Nominal Pipe Size and Accessories Material (Insert Blocks)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Pipe Size mm (inches)</strong></td>
</tr>
<tr>
<td>Up through 125 (5)</td>
</tr>
<tr>
<td>150 (6)</td>
</tr>
<tr>
<td>200 (8), 250 (10), 300 (12)</td>
</tr>
<tr>
<td>350 (14), 400 (16)</td>
</tr>
<tr>
<td>450 through 600 (18 through 24)</td>
</tr>
</tbody>
</table>

B. Warm or hot pipe supports: Premolded pipe insulation (360 degree) at supports. Material shall be high density Polyisocyanurate (for temperatures up to 300°F). Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m$^3$ (3.0 pcf).

1. Approved Alternate: Metallic insulation protection shield shall also be acceptable at the contractor’s option.

**PART 3 – EXECUTION**

**3.01 GENERAL REQUIREMENTS**

A. Required pressure tests of piping joints and connections shall be completed and the work approved by the Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

B. Except for specific exceptions, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.

C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16°C (60°F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

D. Install vapor stops at all insulation terminations on either side of valves, pumps, and equipment and particularly in straight lengths of pipe insulation.
E. Construct insulation on parts of equipment such as cold water pumps and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gauge) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.

G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.

H. Apply insulation materials subject to the Manufacturer's recommended temperature limits. Apply adhesives, mastic, and coatings at the Manufacturer's recommended minimum coverage.

I. Elbows, flanges, and other fittings shall be insulated with the same material as is used on the pipe straights.

J. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.

K. Firestop Pipe Insulation

1. Pipe penetrations requiring fire stop insulation including, but not limited to the following:
   a. Pipe risers through floors
   b. Pipe chase walls and floors

L. Provide vapor barrier jackets over insulation as follows:

1. All piping exposed to outdoor weather.

2. All interior piping conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.), below ambient air temperature, in high humidity areas.

M. Provide metal jackets over insulation as follows:

1. All plumbing piping exposed to outdoor weather.
2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling, or floor penetrations.

3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

4. Provide metal jackets where indicated on the Drawings.

### 3.02 INSULATION INSTALLATION

**A. Installation of Flexible Elastomeric Insulation**

1. Seal longitudinal seams and end joints with Manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2. **Insulation Installation on Pipe Fittings and Elbows**
   
   a. Install mitered sections of pipe insulation.
   
   b. Secure insulation materials and seal seams with Manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. **Insulation Installation on Valves and Pipe Specialties**
   
   a. Install preformed valve covers manufactured of same material as pipe insulation when available.
   
   b. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   
   c. Secure insulation to valves and specialties and seal seams with Manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**B. Installation of Mineral-Fiber Preformed Pipe Insulation**

1. **Insulation Installation on Straight Pipes and Tubes**
   
   a. Secure each layer of preformed pipe with ASJ-SSL without deforming insulation materials.
   
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

2. **Insulation Installation on Pipe Fittings, Elbows, Valves, and Pipe Specialties**

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PLUMBING INSULATION

WOODARD & CURRAN / Triple Point Engineering, LLC

22 07 11-10
3.03 SLEEVE REQUIREMENTS

A. Pipe sleeves shall be furnished and set in their proper and permanent location. Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

1. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

2. A modular mechanical type sealing assembly shall be used. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates.

3. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Refer to the pipe sleeve and seal details on the Drawings for additional details and requirements.

4. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.

5. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be as detailed on the Drawings.
6. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Division 07. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

7. Sleeves through below-grade walls in contact with earth shall be as shown on the details on the Drawings.

8. Pipe sleeves in fire-rated walls shall match the fire rating of the wall being penetrated. Refer to the pipe penetration details on the Drawings for additional details.

### 3.04 FLASHING REQUIREMENTS

A. Pipes passing through roof shall be installed through a 16 ounce aluminum flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule.

B. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal.

C. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated.

D. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint.

**END OF SECTION**
SECTION 22 11 00
FACILITY WATER DISTRIBUTION

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, install, test and make ready for operation; domestic water systems, including piping, equipment, insulation and all necessary accessories as specified and as indicated on the Drawings.

1.02 APPLICABLE PUBLICATIONS

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

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
1. B16.15-2006 Cast Bronze Threaded Fittings Classes 125 and 250 ANSI/ASME
4. NSF/ANSI 61 Drinking Water System Components - Health Effects

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
1. B32-08 Solder Metal
2. B75-02 Seamless Copper Tube
3. B88-09 Seamless Copper Water Tube
4. B300-10 AWWA Standard for Hypochlorites
5. B301-10 AWWA Standard for Liquid Chlorine
6. B584-09a Copper Alloy Sand Castings for General Applications Revision A
7. E1120-08 Standard Specification for Liquid Chlorine
8. E1229-08 Standard Specification for Calcium Hypochlorite
D. AMERICAN WATER WORKS ASSOCIATION (AWWA)
   1. C651-05 Disinfecting Water Mains

E. INTERNATIONAL PLUMBING CODE
   1. International Plumbing Code

F. AMERICAN SOCIETY OF SANITARY ENGINEERS (ASSE)
   1. ANSI/ASSE 1010-2004 Water Hammer Arresters

G. PLUMBING AND DRAINAGE INSTITUTE (PDI)
   1. PDI WH-201 2007 Water Hammer Arrestor

1.03 SUBMITTALS

A. Submit in accordance with Division 01.

B. Manufacturer's Literature and Data
   1. Strainers
   2. Water Hammer Arresters
   3. Temperature-Actuated Water Mixing Valves
   4. Drain Valves
   5. All items listed in Part 2 – Products.

1.04 QUALITY ASSURANCE

A. Submit prior to welding of steel piping a certificate of Welder’s certification. The certificate shall be current and more than one year old.

B. For mechanical pressed sealed fittings, only tools of fitting manufacture shall be used.

C. Mechanical pressed fittings shall be installed by factory trained workers.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single Manufacturer. Grooving tools shall be by the same Manufacturer as the groove components.

E. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
1.05 SPARE PARTS

A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

PART 2 – PRODUCTS

2.01 EXPOSED AND CONCEALED WATER PIPING

A. Pipe: Copper tube, ASTM B88, Type L, drawn.

B. Fittings for Copper Tube

1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 and SP 110, solder, braze or Pro-Press joints. Use 95/5 tin and antimony for all soldered joints.

C. Adapters: Provide adapters for joining screwed pipe to copper tubing.

D. Solder: ASTM B32 Composition Sb5 HA or HB. Provide non-corrosive flux.

E. Brazing alloy: AWS A5.8, Classification BCuP

2.02 STRAINERS

A. Provide on high pressure side of pressure reducing valves, on inlet side of indicating and control instruments, on equipment subject to sediment damage, and where shown on drawings. Strainer element shall be removable without disconnection of piping.

B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.

1. Body: Smaller than 80 mm (3 inches), brass or bronze.

2. Pressure Rating: 125 psig minimum unless otherwise indicated

3. Body: Bronze

4. Screen: Stainless steel with round perforations unless otherwise indicated.

5. Perforation Size: 0.020 inch

6. Drain: Pipe plug

2.03 STERILIZATION CHEMICALS

A. Hypochlorites ANSI/AWWA B300-10

B. Liquid Chlorine ANSI/AWWA B301-10
2.04 WATER HAMMER ARRESTER

A. Water Hammer Arresters (WHA)

1. Standard: PDI WHZ01
2. Pressure/Temperature Ratings: 150 psi/33-180°F
3. Size: Per PDI Standards for fixtures served, submit Manufacturer’s sizing for approval.
4. Body: Copper tubing
5. Piston: Polypropylene
6. Adapter: Brass
7. O-ring: EPDM
8. Acceptable Manufacturer
   a. PPP
   b. Engineer Approved Equal

B. Provide water hammer arresters at:

1. All solenoid valves
2. All groups of two or more flush valves
3. All quick opening or closing valves
4. All washing equipment
5. All Foot Valve Assemblies

C. Water hammer arresters shall be provided on hot- and cold-water supplies and shall be located with precise location and sizing in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

2.05 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Provide thermostatic mixing valve for emergency stations, lavatory faucets, sinks, faucets, shower valves, etc. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating.
1. Standard: ASSE 1017
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Type: Thermostatically controlled, water mixing valve
4. Material: The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper.
5. Connections: Threaded union inlets and outlet, or PEX.
6. Accessories: Manual temperature control, color-coded dial thermometer, stops, check valves, unions, sediment strainers on the inlets, and shut-off ball valves on hot- and cold-water supplies, and adjustable, color-coded temperature-control handle.
7. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type.
8. Tempered-Water Setting: 110 F; Emergency Stations/Showers: 70 F
9. Mixing valves shall maintain water temperature within 5 degrees F of any setting.
10. Tempered-Water Design Flow Rate: 22 gpm at emergency stations/showers
11. Pressure Drop at Design Flow Rate: 15 psig
12. Valve Finish: Polished, chrome plated
13. Piping Finish: Copper
14. Acceptable Manufacturers:
   a. Guardian Equipment (Basis of Design)
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company
   d. Engineer Approved Equal

2.06 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves
   1. Standard: MSS SP-110 for standard-port, two-piece ball valves
   2. Pressure Rating: 400-psig minimum CWP
3. Size: NPS 3/4
4. Body: Bronze or Copper Alloy
5. Ball: Chrome-plated brass
6. Seats and Seals: Replaceable, PTFE
7. Handle: Vinyl-covered steel
8. Inlet: Threaded or solder joint to copper pipe

2.07 ESCUTCHEON PLATES

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes, and cover the entire pipe sleeve projection.

B. Provide chromium-plated on copper alloy plates or polished stainless-steel finish.

C. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3 inch) pipe, 0.89 mm (0.035-inch) for larger pipe.

D. Locations: Use where pipe penetrates floors, walls, and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

A. Comply with the International Plumbing Code, Massachusetts 248 CMR and the requirements outlined herein.

B. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets, and equipment, including those furnished by the Owner or specified in other sections.

C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic, shall be reamed to full size after cutting.

D. All pipe runs shall be laid out to avoid interference with other work. Pipe shall be accurately cut and worked into place without springing or forcing.
E. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated.

F. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services.

G. Install union and shut-off valve on pressure piping at connections to equipment.

H. Install chrome plated cast brass escutcheon with set screw at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

I. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved.

J. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

K. Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required.

L. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch run outs from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Engineer.
M. Domestic Water
   1. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
   2. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

3.02 PIPE HANGERS, SUPPORTS, AND RESTRAINTS
   A. Pipe hangers, supports, and restraints shall be installed as specified in Section 40 05 15 PROCESS PIPE SUPPORTS.

3.03 PIPE PENETRATIONS
   A. Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin. Refer to the details on the Drawings for pipe sleeves and seals.

3.04 ESCUTCHEON PLATES
   A. Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.05 JOINTS
   A. Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.
   B. Threaded: Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with a polytetrafluoroethylene tape applied.
   C. Unions and Flanges: Unions, flanges, and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.
D. Copper Tube and Pipe

1. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver, or a silver brazing filler metal.

2. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015. Soldered joints shall not be used in compressed air piping between the air compressor and the receiver.

3. Mechanically extracted joints shall be made in accordance with ICC IPC.

4. Copper press connections shall be made in strict accordance with the Manufacturer's installation instructions for manufactured rated size. The joints shall be pressed using the tool(s) approved by the Manufacturer of that joint. Minimum distance between fittings shall be in accordance with the Manufacturer's requirements.

3.06 TESTS

A. General: Test system either in its entirety or in sections.

B. Local plumbing inspector shall inspect and provide signed certification of all plumbing systems.

C. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 690 kPa (100 psi) gauge for two hours. No decrease in pressure is allowed. Provide a pressure gauge with a shutoff and bleeder valve at the highest point of the piping being tested.

D. All Other Piping Tests: Test new installed piping under 1 1/2 times actual operating conditions and prove tight.

3.07 STERILIZATION

A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.

B. Use liquid chlorine or hypochlorites for sterilization.

END OF SECTION
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SECTION 22 13 00

FACILITY SANITARY WASTE AND VENT SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, install, test and make ready for operation; sanitary sewer and vent systems, including piping and all necessary accessories as specified and as indicated on the Drawings.

1.02 APPLICABLE PUBLICATIONS

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

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
   1. A13.1-07 Scheme for Identification of Piping Systems

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D. INTERNATIONAL CODE COUNCIL
   1. IPC-06 International Plumbing Code

1.03 SUBMITTALS

A. Submit Manufacturer’s literature and data in accordance with Division 01. Include the following as a minimum:

   1. Piping
   2. Traps
   3. All items listed in Part 2 – Products.
PART 2 – PRODUCTS

2.01 SANITARY WASTE, DRAIN, AND VENT PIPING

A. Polyvinyl Chloride (PVC)
   1. Polyvinyl chloride (PVC) DWV pipe and fittings shall be used for all sanitary waste, drain, and vent piping.
   2. Polyvinyl chloride sanitary waste, drain, and vent pipe and fittings shall be Schedule 40 solid core sewer piping conforming to ASTM D 1785 and ASTM D2665, sewer and drain series with ends for solvent cemented joints.
   3. Fittings
      a. PVC fittings shall be solvent welded socket type using solvent cement conforming to ASTM D2564.
   4. Acceptable Manufacturers
      a. Charlotte Pipe and Foundry Company (Basis of Design)
      b. IPEX Group Inc.
      c. Engineer Approved Equal

2.02 SPECIALTY PIPE FITTINGS

A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be as indicated on the Drawings.

B. Dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82 C (180 F). The end connection shall be solder joint copper alloy and threaded ferrous.

C. Dielectric flange insulating kits shall be of non-conducting materials for field assembly of companion flanges with a pressure rating of 150 psig. The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.

D. The dielectric nipples shall be electroplated steel nipple complying with ASTM F 1545 with a pressure rating of 300 psig at 225 F. The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.
PART 3 – EXECUTION

3.01 PIPE INSTALLATION

A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC), Massachusetts 248 CMR, and these specifications.

B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets, and equipment, including those furnished by the Owner or specified in other sections.

C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.

D. All pipe runs shall be laid out to avoid interference with other work.

E. The piping shall be installed above accessible ceilings where possible.

F. The piping shall be installed to permit valve servicing or operation.

G. Unless specifically indicated on the drawings, the minimum slope shall be 2% slope.

H. The piping shall be installed free of sags and bends.

I. Seismic restraint shall be installed where required by code.

J. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends, and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Buried soil and waste drainage and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to Manufacturer’s written instruction for use of lubricants, cements, and other installation requirements.

L. Bell and spigot compression and hubless gasketed clamp joints for soil, waste, and vent piping shall be installed per the Manufacturer's recommendations.

M. Aboveground PVC piping shall be installed according to ASTM D2665. Underground PVC piping shall be installed according to ASTM D2321.
N. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated.

3.02 JOINT CONSTRUCTION
A. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

3.03 SPECIALTY PIPE FITTINGS
A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.04 PIPE HANGERS, SUPPORTS, AND RESTRAINTS
A. Pipe hangers, supports, and restraints shall be installed as specified in Section 40 05 15 PROCESS PIPE SUPPORTS.

3.05 PIPE DRAINS
A. Pipe drains indicated shall consist of ¾-inch hose bibb with renewable seat and full port ball valve ahead of hose bibb. At other low points, ¾-inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.
B. Sight Drains: Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.06 TESTS
A. Sanitary waste and drain systems shall be tested either in their entirety or in sections.
B. Waste system tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted as directed.
1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.

2. For an air test, an air pressure of 35 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gauge shall be used for the air test.

3. After installing all fixtures and equipment, open water supply so that all P-traps can be observed. For 15 minutes of operation, all P-traps shall be inspected for leaks and any leaks found shall be corrected.

4. Final Tests: The following test shall be used.
   
a. Local plumbing inspector shall inspect and provide signed certification of all waste systems.

END OF SECTION
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SECTION 22 40 00

PLUMBING FIXTURES

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, install, test and make ready for operation; plumbing fixtures, associated trim, fittings and accessories necessary to make a complete installation from wall or floor connections to rough piping.

1.02 APPLICABLE PUBLICATIONS

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

B. AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

C. THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. A112.6.1M-02 (R2008) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use

2. A112.19.1M-08 Enameled Cast Iron Plumbing Fixtures

3. A112.19.2M-03 Vitreous China Plumbing Fixtures


D. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. A276-2010 Stainless and Heat-Resisting Steel Bars and Shapes

2. WW-P-541-E/GEN Plumbing Fixtures with Amendment 1


E. AMERICAN SOCIETY OF SANITARY ENGINEERS (ASSE)

1. 1016-05 Performance Requirements for Individual Thermostatic, Pressure Balancing and Combination Pressure Balancing and Thermostatic Control Valves for Individual Fixture Fittings
F. NATIONAL SANITATION FOUNDATION (NSF)/AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. 61-2009 Drinking Water System Components-Health Effects

G. INTERNATIONAL BUILDING CODE, ICC IPBC

1.03 SUBMITTALS

A. Submit Manufacturer’s literature and data pertaining to fixtures in a properly bound package, in accordance with Division 01. Include the following as a minimum. Provide a separate submittal for each plumbing fixture as specified and as indicated on the Drawings.

1. Flush tank water closets
2. Wall hung lavatories
3. All items listed in Part 2 – Products.
4. All items listed on the Plumbing Schedule on the Drawings.

1.04 QUALITY ASSURANCE

A. Criteria

1. Fixtures shall be water conservation type, in accordance with ICC IPC. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1.

2. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws.

3. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap.

4. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view.
5. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains shall be copper alloy with all visible surfaces chrome plated.

6. Plastic in contact with hot water shall be suitable for 180 F water temperature.

PART 2 – PRODUCTS

2.01 STOPS

A. Provide lock-shield loose key or screwdriver pattern angle stops, straight stops or stops integral with faucet, with each compression type faucet whether specifically called for or not, including sinks in wood and metal casework, laboratory furniture and pharmacy furniture. Locate stops centrally above or below fixture in accessible location.

B. Furnish keys for lock shield stops to Owner.

C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.

D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe, i.e. red brass pipe nipple, chrome plated where exposed.

2.02 LAMINAR FLOW CONTROL DEVICE

A. Smooth, bright stainless steel or satin finish, chrome plated metal laminar flow device shall provide non-aeration, clear, coherent laminar flow that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.

B. Flow Control Restrictor

1. Capable of restricting flow from 1.4 gpm to 1.6 gpm for lavatories; 1.4 gpm to 1.6 gpm for sinks.

2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 25 psi and 80 psi.

3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-cleaning action, and is capable of easy manual cleaning.
2.03 CARRIERS

A. ASME/ANSI A112.6.1M, all lavatory chair carriers shall be capable of supporting the lavatory with a 250-pound vertical load applied at the front of the fixture.

B. Where, lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. The drainage fitting of the back to back carrier shall be so constructed that it prevents the discharge from one fixture from flowing into the opposite fixture.

2.04 WATER CLOSETS (WC-1)

A. Floor Mount Elongated Water Closet (Tank Type, ANSI A112.19.2M) domestic, elongated bowl with tank, white vitreous china, closed coupled, insulated tank, floor outlet.

1. Top of toilet seat height above floor shall be 14 to 15 inches, except 17 to 19 inches for wheelchair water closets.

2. Pressure assist type flush tank.

3. Provide wax bowl ring including plastic sleeve.

4. Provide water closet supply assembly with chrome plated finish, chrome plated brass stops, chrome plated copper risers and flange. Inlet shall match to domestic water feed as shown on the Drawings.

5. Provide white solid plastic elongated open-front seat with cover.

6. Fittings: Tank fittings and accessories

   a. Tank shall not exceed 1.6 gallons per flush.

   b. Stops, tank – angle

7. Manufacturers

   a. American Standard, Inc. (Basis of Design)

   b. Kohler Co.

   c. Zurn Industries, Inc.

   d. Engineer Approved Equal
2.05 LAVATORIES (LAV-1)

A. (ASME/ANSI A112.19.2), white vitreous china lavatory shall be straight back type, with minimum dimensions of 19 inches wide by 17 inches front to rear, with supply openings for use with top mounted center set faucets.

1. Lavatory shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

2. Water flow rate shall not exceed 1.5 gpm when measured at a flowing water pressure of 60 psi.

3. Provide top mounted washer less center set lavatory faucets. Chrome-plated faucet.

4. Faucet shall be single handle type, Symmons Dia SLS-3510-1.5 or equal.

5. Drain: Cast or wrought brass with flat grid strainer with offset tailpiece, and overflow plug with 17 gauge tailpiece.

6. Stops: Angle type. See paragraph 2.01 Stops

7. Trap: Cast copper alloy, P-trap. Adjustable with connected elbow and 17 gage tubing extension to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Provide trap with cleanout fitting.

8. Provide chrome plated lavatory supply valves with wheel handle and extensions. Include chrome plated brass stops, full turn brass stem, chrome plated copper risers. Include all necessary accessories.

9. Provide cover for drain, stops, and trap.

10. Acceptable Manufacturers

a. American Standard, Inc. (Basis of Design)

b. Kohler Co.

c. Zurn Industries, Inc.

d. Engineer Approved Equal
PART 3 – EXECUTION

3.01 INSTALLATION

A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed as specified under Section 07 92 00 JOINT SEALANTS.

B. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls and related finish surfaces. Exposed heads of bolts and nuts in finished rooms shall be hexagonal, polished chrome plated brass with rounded tops.

C. Expansion Bolts: For concrete. Shall be 6 mm (1/4 inch) diameter bolts, and to extend at least 76 mm (3 inches). Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.

D. Power Set Fasteners: May be used for concrete walls, shall be 6 mm (1/4 inch) threaded studs, and shall extend at least 32 mm (1 1/4 inches) into wall.

E. Tightly cover and protect fixtures and equipment against dirt, water, and chemical or mechanical injury.

3.02 FIXTURES AND FIXTURE TRIMMINGS

A. Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures.

B. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting.

C. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified.

3.03 FIXTURE CONNECTIONS

A. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal or wax ring for water closets. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.
3.04 FIXTURE SUPPORTS

A. Fixture supports for off-the-floor fixtures shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.05 CLEANING

A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

END OF SECTION
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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Overall requirements for mechanical installations common to Specifications in Division 23 Heating, Ventilating and Air Conditioning (HVAC).

2. Ensure each mechanical trade is sufficiently familiar with and responsible for electrical operation and wiring of the mechanical system for which they are responsible. Electrical tradesmen may be used by each mechanical trade for the associated portion of wiring, however, require that responsibility for repair and maintenance of each mechanical system is provided by each mechanical trade.

B. Related Requirements

1. Division 23 Specifications for HVAC

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. Air Movement and Control Association (AMCA)

2. Air Conditioning, Heating and Refrigeration Institute (AHRI)

3. Air Diffusion Council (ADC)

4. American Conference of Governmental Industrial Hygienists (ACGIH)

5. American National Standards Institute (ANSI)


   b. Other applicable standards

6. American Society of Heating, Refrigerating and Air conditioning Engineers (ASHRAE)
7. American Society of Mechanical Engineers (ASME)
9. Factory Mutual (FM)
10. Hydraulic Institute Standards (HI) standards
11. Instrumental Society of America (SA) standards
12. Manufacturer’s Standardization Society (MSS) standards
13. National Electrical Manufacturers Association (NEMA) standards
14. National Institute of Standards and Technology (NBS)
15. National Fire Protection Association (NFPA)
16. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
17. Underwriters Laboratory (UL) standards

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements and as specified in individual Specification sections.

B. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1. Mark Drawings to indicate revisions to piping and ductwork, size and exterior and interior locations; locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations dimensioned to column lines; actual inverts and locations of underground piping; concealed equipment and control system devices dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and items requiring maintenance located (such as traps, strainers, expansion compensators, tanks).
1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Packing, Shipping, Handling, and Unloading
      1. Identify products with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
   C. Acceptance at Site
      1. Coordinate deliveries of mechanical materials and equipment to minimize construction Site congestion. Limit each shipment to the items and quantities needed for the smooth and efficient flow of installations.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 NAMEPLATES
   A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar necessary data. Locate nameplates in accessible location.

2.02 EQUIPMENT
   A. Provide equipment meeting ANSI/ASHRAE/IES Standard 90.1.

2.03 COMPONENTS
   A. System components are identified throughout the Drawings for proper system operation.

2.04 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Install equipment and materials to allow required access for servicing and maintenance. Coordinate final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of parts that require replacement or servicing. Extend grease fittings to accessible location.

B. Coordinate equipment and materials for installation with other building components.

C. Verify dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

E. Sequence, coordinate and integrate installation of mechanical materials and equipment for efficient flow of Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Coordinate cutting and patching of building components to accommodate installation of mechanical equipment and materials.

G. Coordinate installation of mechanical materials and equipment above ceilings with suspension system, lighting fixtures, and other installations.

H. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

I. Coordinate installation of identifying devices after completing coverage and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

3.02 EQUIPMENT CONNECTIONS

A. Drawings schematically show the order of connection of various terminal units, louvers, valves, and other mechanical equipment but do not show every detail of piping and ductwork. Connect fixtures in accordance with standard details, accepted trade practice, and the intent of the Specifications and Drawings. Coordinate with other trades.
3.03 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING
   A. Provide in accordance with Division 01 General Requirements.

3.05 CLEANING
   A. Cap ductwork during construction to protect from dust and debris. Thoroughly clean interior of ductwork and air systems.
   B. Cleaning filters, strainers, and mechanical systems prior to final acceptance.

3.06 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 23 05 15

HVAC IDENTIFICATION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes
   1. Painted Identification Materials
   2. Plastic Equipment Markers
   3. Plasticized Tags

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards
   1. American National Standards Institute (ANSI)
      a. ANSI A13.1

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.
B. Manufacturer's technical product data and installation instructions for each identification material and device required
C. Qualification statements
D. Samples and mockups: as specified in Article 1.06.
E. Closeout and maintenance material submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Mechanical identification materials shall be provided by firms regularly engaged in manufacture of identification devices of types and sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

C. Samples of each color, lettering style and other graphic representation required for each identification material or system.

1.01 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.01 SITE CONDITIONS

A. Existing conditions: per Division 01 General Requirements.

1.02 MAINTENANCE

A. Furnish minimum of 5 percent extra stock of each mechanical identification material required.

B. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

1. Allen Systems, Inc.


3. Seton Name Plate Corp.

4. or equal

2.02 MATERIALS

A. Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
B. Mechanical Identification Materials

1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for application, selections is Installer’s option, but provide single selection for each product category.

C. Painted Identification Materials

1. Provide standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 1-1/4-inch high letters for ductwork and not less than 3/4-inch high letters for access door signs and similar operational instructions.

2. Utilize standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

3. Utilize standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

D. Plastic Equipment Markers

1. Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:

   a. Yellow – Heating equipment and components.
   b. Blue – Equipment and components that do not meet any of the above criteria.

2. Include the following, matching terminology on schedules as closely as possible:

   a. Name and plan number
   b. Equipment service
   c. Design capacity
   d. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

3. Provide approximate 2-1/2 inch by 4-inch markers for control devices, dampers, and valves; and 4-1/2 inch by 6-inch for equipment.
E. Plasticized Tags
   1. Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing approximately 3-1/4 inch by 5-5/8 inch, with brass grommets and wire fasteners and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

F. Lettering and Graphics
   1. Coordinate names, abbreviations and other designations used in mechanical identification Work, with corresponding designations shown, specified, or scheduled. Provide numbers, lettering and wording indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

2. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

2.03 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION
   A. Where identification is to be applied to surfaces which require painting or other covering or finish, install identification after completion of covering and painting. Install identification prior to installation of removable concealment, if any.

   B. Mechanical Equipment Identification

1. Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

   a. Meters, gauges, thermometers and similar units
   b. Fans, blowers
   c. Heaters
2. Where lettering larger than 1-inch height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.

3. Minimum 1/4-inch high lettering for name of unit where viewing distance is less than 2 feet, 1/2-inch high for distances up to 6 feet and proportionately larger lettering for greater distances. Provide secondary lettering of 67 percent to 75 percent of size of the principal lettering.

4. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

5. At Installer's option, where equipment to be identified is concealed, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

   a. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

3.02 ADJUSTING

   A. Relocate any mechanical identification device which has become visually blocked by Work of this division or other divisions.

3.03 CLEANING

   A. Clean face of identification devices.

END OF SECTION
SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide testing, adjusting and balancing heating and ventilating systems in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. Associated Air Balance Council (AABC)
2. National Environmental Balancing Bureau (NEBB)

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1. Provide a schedule of balancing procedures for each building or system, submitted in sufficient time so Engineer may observe procedures as they progress. Before commencing Work, submit methods and instruments to be used to adjust and balance air systems.

2. Provide proposed testing programs a minimum of 2 weeks prior to scheduled test to assure agreement as to personnel and instrumentation required and scope of each testing program.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

1. Source and field quality control submittals
   a. Proposed testing schedules and procedures
   b. Results of periodic field inspections
c. Preliminary draft system balancing reports as systems are completed and tested

d. Final systems and balancing reports as final system adjustments are made as systems are accepted by Owner

2. Qualifications statements

B. Closeout and maintenance material submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications per Division 01 General requirements for balancing Subcontractor as follows.

1. Minimum of 2 test-and-balance engineers certified by AABC or NEBB, each with minimum 5 years’ experience

2. AABC or NEBB membership required for air testing

C. Independent testing

D. Certifications

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Provide gaskets, lubricants and other expendable materials required to be replaced during execution of Work.

B. Provide fixed-pitched pulleys required for fan adjustments on an exchange basis.

C. Where test results indicate that air quantities at system fans are below or in excess of specified amount, change driving pulley ratio or make approved changes to obtain specified or scheduled air quantities.
D. Testing Apparatus

1. Provide plugs, caps, stops, valves, pumps, compressors, blowers, and similar devices required to perform Work.

2. Provide anemometers, thermometers, gauges, voltmeters, ammeters, tachometers and similar instruments, not part of the permanent installation, but required to record the performance of equipment and systems.

3. Certify testing instruments are accurate to within plus or minus 0.10 degrees F for temperature or plus or minus 0.10-inch w.c. for pressure. Calibrate instruments within 7 days of testing and every 30 days thereafter for duration of testing period. Submit certification of calibration to Engineer prior to commencing the Work.

2.02 TESTING REPORTS

A. Provide detailed Excel-based reports in hard copy and PDF format with the following general data.

1. Project title and number
2. Contract number
3. Project location
4. Project mechanical engineer
5. Test and balance agency
6. Test and balance engineer
7. Contractor
8. Balancing Subcontractor
9. Mechanical Subcontractor
10. Test dates
11. Certification

B. At a minimum, report will include the following.

1. Preface: general discussion of systems, any abnormalities, and problems encountered.
2. Instrumentation list including type, model, manufacturer, serial number, and calibration dates.

3. In each report, number or letter supply and exhaust openings and traverse points to correspond to numbers and letters used on report data sheets and on report diagrams.

C. Prepare 11-inch by 17-inch single line diagrams or half-size Drawings showing duct systems indicating terminal air outlets including diffusers, grilles and registers, perforated plates, nozzles and other types of air supply, exhaust or return outlets. Minimum scale for diagrams showing measurement points: 1/8-inch = 1-foot final form submitted. Make location of test points clear and easy to locate on diagram. Identification mark of test points shall be the same as shown on test report. Identification for test points will include indication of units served, and not have a duplicate in the Project. Adjust supply outlets so there are no drafts. Grille and register readings may be made by a vane anemometer, but diffuser readings made by a flow hood or velometer, using tip recommended by diffuser manufacturer. Each test sheet will include the following data.

1. Project name and address
2. Name of HVAC Contractor
3. Name of balancing organization
4. Instruments used to perform test
5. Name of test technician or test Engineer
6. Fan system or zone number
7. Room number or area name
8. Manufacturer, size and type of outlet
9. Cfm at each outlet on system and corresponding cfm at each outlet as noted on Drawings
10. Percent deviation of measured flow versus design flow
11. Indication of branch and terminal that are the open/low basis for balancing remainder of system

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 INSPECTIONS

A. During construction, balancing agency will inspect installation of pipe systems, sheet metal work, temperature controls, and other component parts of the heating, ventilating, and air conditioning systems. Inspections will be performed periodically as work progresses. A minimum of 1 inspection is required when 90 percent of equipment is installed. Balancing agency will submit a brief written report of each inspection to Engineer.

3.02 START OF BALANCING

A. Notify balancing organization and Engineer when systems become operational and ready for preliminary and final testing, adjusting, and balancing.

B. Do not begin final balancing until system installation is complete and capable of normal operation. Provide personnel to assist in rough balance and calibration.

C. Verify grilles, dampers, fans, coils, pumps, valves, and linkages to be installed and operating.

D. System must be capable of operating under control as specified and indicated on Drawings.

E. Verify fan, pump and motor shafts are parallel with straight edge, and sheaves are in proper alignment.

F. Verify belts are properly tensioned when unit is operating with no excessive squeal at startup. Adjust sheaves or motor base as needed for proper tension.

G. Start fans and pumps to verify rotation is correct. If rotation is incorrect, coordinate with electrical contractor to switch power leads for motor to rotate correctly.

H. Check nameplate voltage on motor, compare to scheduled voltage. Notify Engineer of discrepancies immediately. Measure and record actual voltage across all power leads. Notify Engineer of discrepancies immediately.

I. Check motor nameplates full load amps, measure and record amperage across all power leads. If there are marked discrepancies in amperage draws between legs, notify Engineer immediately.

J. Measure and record fan, pump and motor rpm. Check that motor rpm matches nameplate and scheduled rpm.
K. If balancing Subcontractor finds that systems are not ready upon commencing Work, or if a dispute occurs as to readiness of the systems, balancing agency shall request an inspection by the Engineer. Inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for testing and balancing. Should the inspection reveal the notification to have been premature, all costs for the inspection and Work previously accomplished by the balancing agency shall be paid for by the Contractor. Furthermore, complete items that are not ready for testing and balancing and place in operational readiness before testing and balancing services recommence.

L. Repair or replace leaks, damage and defects discovered or resulting from startup, testing and balancing to like-new condition with acceptable materials. Continue tests until system operates without adjustments or repairs.

3.03 EQUIPMENT CURVES

A. Provide any required characteristic curve charts for fans to include air conditioning units and air handling units to balancing organization. Characteristic curve charts shall show static pressure, capacity horsepower, and overall efficiency for operating conditions from no load to 130 percent of specified load.

3.04 REQUIRED ACCURACY

A. Balance systems to within limits of capacity shown on Drawings. Apply limits to both individual components and to system totals.

B. General systems - plus/minus 10 percent.

3.05 TESTING

A. HVAC Air Systems

1. Balance supply return and exhaust air systems in accordance with AABC or NEBB standards with properly calibrated direct reading instruments such as an AnemoTherm or velometer.

2. If instructed by Engineer, provide further balancing of temperature by thermometer or temperature recorder.

3. Perform sequence of air balancing as follows.

   a. Establish airflow quantity at exhaust fan by main duct traverse

   b. Establish airflow quantities at louver

   c. Adjust fan speeds if results of system capacity tests are not within tolerances specified and repeat as required.
4. Furnish data in Excel-based spreadsheet format tabulating the following.
   a. Quantity of air in cfm at each air outlet and inlet
   b. Dry bulb temperature in each room
   c. Dry bulb temperature of supply air
   d. Outdoor dry and wet bulb temperature at time tests are conducted.
      (Wet bulb temperature only required for AC systems)

5. Adjust belts, sheaves and alignment of air handling equipment.

6. Where various combinations of sheaves must be installed on fan systems to
   achieve correct air delivery, change sheaves, and continue to take
   successive readings until correct combinations are installed.

7. Furnish data in Excel-based spreadsheet taken at each air moving device,
   including fans, packaged units and air handling units, tabulating the
   following.
   a. Manufacturers, model number and serial number of units
   b. Design and manufacturer's rated data
   c. Total quantity of exhaust or relief air in cfm
   d. Total quantity of outside air in cfm
   e. Outlet velocity – fpm
   f. Rpm of each fan or blower
   g. Maximum tip speed – fpm
   h. Rpm of each motor
   i. Voltage and ampere input of each motor (one reading for each phase
      leg on 3 phase motors).
   j. Pressure in inches w.g. at inlet of each fan or blower.
   k. Pressure in inches w.g. at discharge of each fan or blower.
   l. Pressure drops across system components such as louvers, filters,
      coils, and mixing boxes.
m. Submit actual fan operating point on a copy of the fan Shop Drawing showing operating curve.

n. List following data from installed fan motors.
   1) Manufacturer model and size
   2) Motor horsepower, service factor, and rpm
   3) Volts, phases, cycles and full load amps
   4) Equipment locations

3.06 FINAL ACCEPTANCE

A. At final inspection, balancing agency will recheck specific and random selections of data recorded in the certified test-and-balance report in the presence of Engineer.

B. Points and areas for recheck: selected by Engineer.

C. Measurements and test procedures: same as original test and balance.

D. Selections for recheck, specific plus random, will not normally exceed 15 percent of total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If specific rechecks are more than 5 percent deviation from the report or specified flows, rebalance systems that require specific recheck. If 5 percent or 5 of the random checks, whichever is less, exceeds a 10 percent deviation from specified flows, report will be rejected. In the event report is rejected, readjust and test all systems, record new data, submit a new certified test-and-balance report, and perform a new inspection test.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.08 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.09 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 23 10 00

FACILITY FUEL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Complete equipment, piping and accessories as required for a complete diesel fuel system serving an emergency generator.

   1) Fuel Tank Accessories
   2) Pipes, tubes, and fittings.
   3) Piping specialties.
   4) Joining materials.
   5) Specialty valves.
   6) Leak detection and monitoring system.
   7) Labels and identification.

B. Related Requirements

1. 26 32 13.13 Diesel Engine Driven Generator Sets

1.02 DEFINITIONS

A. Diesel and Fuel Oil are used interchangeably in this document.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.

2. Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. For valves, include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Certifications of compliance with applicable standards such as UL, FM, ASME etc.

5. Information on manufacturers coating system.

6. Certification that steel tank manufacturer participates in Steel Tank Institute (STI) Quality Assurance Program.


8. Complete wiring diagrams according to Underwriters Laboratory (UL) standards.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
   1. Basic plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved. Detail shall be sufficient for Owner and Engineer to understand any installation challenges and maintenance and accessibility.

B. Brazing certificates.

C. Welding certificates.

D. Manufacturers installation and startup instructions.

E. Field quality-control reports.

F. Sample Warranty:

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Pipe Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code.
E. Manufacturer and installer shall be regularly engaged in similar work. Installer must be certified to complete the work in the State.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Packing, Shipping, Handling, and Unloading
   1. Identify products with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

D. Acceptance at Site
   1. Coordinate deliveries of mechanical materials and equipment to minimize construction Site congestion. Limit each shipment to the items and quantities needed for the smooth and efficient flow of installations.

1.08 WARRANTY

A. Piping and Specialties: Shall be warranted free from defects and installation errors for a period of not less than 1 year.

1.09 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 TANK MONITORING AND INSTRUMENTATION

A. Requires interstitial leak detection, overfill alarm (@ 95%) and continuous level monitoring.

B. Refer to specification 26 32 13.13 Diesel Engine Driven Generator Sets.

2.02 REMOTE FILL STATION

A. Provide 5 gallon, single door remote spill container for containment of small spills when truck hose is connected.
B. Provide two-point alarm console to interface with generator fuel tank level switch and for annunciation and normally open 120V solenoid overfill prevention valve to alarm at shut off fill once the generator fuel tank reaches 90% full.

C. Single 2” NPT top discharge connection. Provide check valve, isolation valve and Camlock style connection with end cap.


E. Basis of Design: Ace: Fuelsafe Remote Fill System or equal.

2.03 FUEL TANK SPECIALTIES

A. Emergency Vents: UL listed, sized in accordance with NFPA 30. Morrison Bros. Model 244 or equal.

B. Overfill Prevention Valve: Designed to prevent overfilling of tank and automatically provide positive shutoff during pressurized fill. UL listed, compliant with NFPA 30. 2” body, Polypro float type. Morrison Bros. Model 9095SA or equal.

C. Ball Valves: Full port, quarter turn, Blowout Proof Stem, 600psig non-shock CWP, PTFE seats, chrome plated ball. UL 842, 125 listed. Morrison Bros. Model 691 or equal.

D. Swing Check Valve: Brass body and cap and internals, metal to metal seal, PTFE gaskets. 200 psi CWP. Morrison Bros Model 246A or equal.

E. Double Outlet Vent Tee: Aluminum construction atmospheric vent tee with 20 mes SS screen to keep debris out. Morrison Bros. Model 155 or equal.

F. Inline Strainer: Wye shaped, Brass body, 80 mesh Stainless screen. Min 200PSIG WCP. Provide with 1/2” blowdown valve (brass body, ball valve).

2.04 DIESEL PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.


C. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

D. Painting: All diesel piping (indoor and outdoor) shall be painted with an industrial grade epoxy paint, safety yellow in color.

E. Copper pipe/tube will not be allowed.
PART 3 – EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction to allow for mechanical installations.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping free of sags and bends.

E. Install fittings for changes in direction and branch connections.

F. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

G. Connect branch piping from top or side of horizontal piping.

H. Install unions in pipes NPS 2” and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.

I. Do not use fuel-oil piping as grounding electrode.

J. Install sleeves and sleeve seals for piping penetrations of walls, ceilings, and floors. Provide a sch 40 steel sleeve and rubber link seal type device.

K. Provide electrical grounding in accordance with NFPA 70.

3.02 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   1. Apply approved thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.03 HANGER AND SUPPORT INSTALLATION

A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1-1/4 and Smaller: Maximum span, 60 inches minimum rod size, 3/8 inch
2. NPS 1-1/2: Maximum span, 80 inches minimum rod size, 3/8 inch
3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

B. Support vertical steel pipe at each floor and at spacing not greater than 10 feet.

C. Where piping is run along walls or floor, provide clips at 5ft intervals to securely attach to structure.

3.04 PIPING INSTALLED ON FLOOR

A. Where piping must cross a portion of the floor and presents a tripping hazard, provide steel ramp to conceal and protect piping from tripping hazard and impact. 10,000 lb rating.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Pressure Test Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:

1. Diesel/Fuel-Oil Distribution Piping: Minimum 50psig for 1 hr.
2. Isolate storage tanks during all pressure testing.

C. Inspect and test fuel-oil piping according to NFPA 30, and according to requirements of authorities having jurisdiction.

D. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.

E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.

3.06 OWNER TRAINING

A. Provide owner training demonstrating the proper function and maintenance of all components.

B. Demonstrate proper operation, common failures modes and their remedies.

3.07 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.08 CLEANING

A. Cap ductwork during construction to protect from dust and debris. Thoroughly clean interior of ductwork and air systems.

B. Cleaning filters, strainers, and mechanical systems prior to final acceptance.

3.09 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 23 23 00

REFRIGERANT PIPING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, install, test and make ready for operation; field refrigerant piping for direct expansion HVAC systems, condensate drainage piping and related appurtenances as specified and as indicated on the Drawings.

B. Refrigerant piping shall be sized, selected, and designed either by the equipment Manufacturer or in strict accordance with the Manufacturer’s published instructions. The schematic piping diagram shall show all accessories such as stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators, and driers to make a complete installation.

1.02 DEFINITIONS

A. Refrigerating System: Combination of interconnected refrigerant-containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.

1. Low side means the parts of a refrigerating system subjected to evaporator pressure.

2. High side means the parts of a refrigerating system subjected to condenser pressure.

B. Brazed joint: A gas-tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 449 C (840 F) but less than the melting temperatures of the joined parts.

1.03 APPLICABLE PUBLICATIONS

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

B. Air Conditioning, Heating, and Refrigeration Institute (ARI/AHRI)

1. 495 Standard for Refrigerant Liquid Receivers

2. 730 Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers
3. 750 Thermostatic Refrigerant Expansion Valves
4. 760 Performance Rating of Solenoid Valves for Use with Volatile Refrigerants

C. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE)
   2. ANSI/ASHRAE 17 Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves (ANSI)
   3. 63.1 Method of Testing Liquid Line Refrigerant Driers (ANSI)

D. American National Standards Institute (ANSI)
   1. ASME (ANSI) A13.1 Scheme for Identification of Piping Systems
   2. Z535.1 Safety Color Code

E. American Society of Mechanical Engineers (ASME)
   1. ANSI/ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)
   2. ANSI/ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500 (ANSI)
   3. ANSI/ASME B31.5 Refrigeration Piping and Heat Transfer Components (ANSI)
   4. ANSI/ASME B40.100 Pressure Gauges and Gauge Attachments
   5. ANSI/ASME B40.200 Thermometers, Direct Reading and Remote Reading

F. American Society for Testing and Materials (ASTM)
   2. B32 Standard Specification for Solder Metal
5. B280 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

G. American Welding Society, Inc. (AWS)
   1. A5.8/A5.8M Standard Specification for Filler Metals for Brazing and Braze Welding

H. Federal Specifications (Fed. Spec.)
   1. Fed. Spec. GG

I. Underwriters Laboratories (U.L.)
   1. U.L.207 Standard for Refrigerant-Containing Components and Accessories, Nonelectrical
   2. U.L.429 Standard for Electrically Operated Valves

1.04 SUBMITTALS

A. Submit in accordance with Division 01.

B. Shop Drawings
   1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for components noted below:
      a. Tubing and fittings
      b. Valves
      c. Flexible metal hose
      d. Pipe and equipment supports
      e. Refrigerant
      f. Soldering and brazing materials

C. Certification: Copies of certificates for welding procedure, performance qualification record, and list of welders' names and symbols.

D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

1.05 QUALITY ASSURANCE

A. Refer to Section 23 05 00 Common Work Results for HVAC.
B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.

C. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.

D. Products shall comply with UL 207 or UL 429.

PART 2 – PRODUCTS

2.01 PIPING AND FITTINGS

A. Refrigerant Piping: For piping up to 100 mm (4 inch) use copper refrigerant tube, ASTM B280, cleaned, dehydrated, pressurized with dry nitrogen, plugged and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the Manufacturer.

B. Water and Drain Piping: Schedule 80 PVC. Optional drain piping material: Copper water tube, ASTM B88M, Type B or C (ASTM B88, Type M or L). PVC fittings shall be solvent cemented type using solvent cement conforming to ASTM D2564.

C. Fittings, Valves, and Accessories

   a. Brazed Joints, Refrigerant Tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.


3. Refrigeration Valves
   a. Stop Valves: Brass or bronze alloy, packless or packed type with gas tight cap, frost proof, back seating.

2.02 GAUGES

A. Temperature Gauges: Comply with ASME B40.200. Industrial-duty type and in required temperature range for service in which installed shall be used. Gauges shall have Celsius scale in 1-degree (Fahrenheit scale in 2-degree) graduations and with black number on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 1525 mm (5 feet) of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 1525 to 2135 mm (5 to 7 feet) above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 2135 mm (7 feet) above the finished floor.
B. Vacuum and Pressure Gauges: Comply with ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 90 mm (3-1/2 inches) in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

1. Suction: 101 kPa (30 inches Hg) vacuum to 1723 kPa (gage) (250 psig).
2. Discharge: 0 to 3445 kPa (gage) (0 to 500 psig).

2.03 MOISTURE AND LIQUID INDICATORS

A. UL listed, with copper, brass, or copper-plated steel body, flared or solder ends, extended fittings in units up to at least 1-1/8” to allow brazing without removing the cartridge, sight glass, color coded paper moisture indicator that is replaceable without breaking piping connections for units up to 1-1/8” size, and plastic cap; maximum working pressure of 500 psi, and maximum temperature of 200ºF.

B. Acceptable Manufacturers:

1. Sporlan
2. Henry Valve Company
3. Alco Valve

2.04 VALVES

A. BA-14: Refrigerant Ball Valve: 3/8” thru 3-1/8”, 500 psi, -40ºF to +300ºF, full-port up to 2-1/8” size, blow-out proof, PTFE seals, brass ball with equalizing orifice, visible position indication, seal cap, extended copper connections, replaceable stem seals, compatible with all CFC, HCFC, and HFC refrigerants.

B. Acceptable Manufacturers:

1. Henry Valve Company
2. Superior Valve
3. Alco Valve

2.05 CHECK VALVES

A. CK-10: 1/4” thru 3-5/8”, 500 psi, globe or angle pattern, brazed, brass body, cleaned-dried-plugged and tagged at factory for refrigerant service.
B. Acceptable Manufacturers:
   1. Henry Valve Company
   2. Mueller

2.06 PRESSURE RELIEF VALVES
   A. RV-5: Straight Thru or Angle Type: Brass body and disc, Teflon seat, factory sealed and stamped with ASME UV and National Board Certification NB; selected to ANSI/ASHRAE 15.

2.07 FILTER-DRIERS
   A. Replaceable Cartridge Angle Type: ANSI/AHRI 710, UL listed, brass or epoxy-coated steel shell, molded desiccant high-water capacity filter core(s); maximum working pressure of 500 psi; maximum temperature of 275°F; maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.
   
   B. Permanent Straight Thru Type: ANSI/AHRI 710, UL listed, steel shell with molded desiccant filter core, maximum working pressure of 500 psi, maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

2.08 SUCTION FILTERS
   A. Replaceable Cartridge Angle Type: UL listed for 500 psi up to 2-18" size, and 400 psi for larger sizes, steel shell that passes 1000-hour salt spray test with copper fittings, replaceable pleated filter element(s); maximum pressure drops of 3 psi with R410a or 2 psi with R134a at system flow rate, capable of accepting molded desiccant core for cleanup after compressor burnout, access valve in the removable end plate. Install with side refrigerant inlet.

2.09 SOLENOID VALVES
   A. Valve: AHRI 760; pilot operated; copper or brass body and internal parts; synthetic seat; stainless steel stem and plunger assembly; extended solder ends to permit installation without disassembly; maximum working pressure of 500 psi; normally closed. Maximum pressure drop at system flow of 5 psi for R410a and 3 psi for R134a.
   
   B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, surge protector and color-coded lead wires, integral junction box, Class F temperature rated, ANSI/UL 429.
2.10 EXPANSION VALVES

A. Angle or Straight Thru Type: ANSI/AHRI 750; materials suitable for system refrigerant, external equalizer, adjustable super heat setting, balanced port design, suitable for horizontal or vertical installation, with replaceable capillary tube and remote sensing bulb.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10°F super heat. Select to avoid being undersized at full load or excessively oversized at part load.

2.11 RECEIVERS

A. All receivers shall have capacity to hold the entire refrigerant charge when 90% full at 90°F per ASHRAE 15-78.

B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 450 psi working pressure, with tappings for inlet, outlet, and relief valve or fusible plug.

2.12 SUCTION ACCUMULATORS

A. All accumulators shall have capacity to hold 50% of the refrigerant charge when 90% full at 90°F per ASHRAE 15-78, pressure drop equivalent to under 0.5°F at peak capacity, a finish that survives a 500-hour salt spray test, vertical design with dip tube and screened oil inlet orifice, and a hot gas boil-out coil to evaporate liquid refrigerant.

B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 400 psi pressure rating, with tappings for inlet, outlet, and pressure relief valve or fusible plug.

2.13 REFRIGERANTS AND OILS

A. Provide EPA approved refrigerant and oil for proper system operation.

2.14 PIPE INSULATION FOR DX HVAC SYSTEMS

A. Fiberglass insulation:

1. Install where noted on the drawings.

2. At a minimum provide the following:

   a. Refrigerant pipes, 1 inch thick.
   b. Condensate drainage pipes, 1 inch thick.
3. Acceptable Manufacturers:
   a. Knauf Fiber Glass
   b. Manville Products Corp.
   c. Owens-Corning Fiberglass Corp
   d. Engineer Approved Equal

B. Approved Alternate Insulation Material: Flexible elastomeric insulation:

1. Install where concealed and in mechanical and equipment rooms and where noted on the drawings.

2. At a minimum provide the following:
   a. Refrigerant pipes, 1/2 inch thick.
   b. Condensate drainage pipes, 1 inch thick.

3. Acceptable Manufacturers:
   a. Armacell
   b. Isoclima (Pre-Insulated)
   c. PDM, Gelcopper (Pre-Insulated)
   d. Engineer Approved Equal

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5.

1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.

2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.

3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally, locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
4. Install hangers and supports per ASME B31.5 and the refrigerant piping Manufacturer's recommendations.

B. Joint Construction

1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
   a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
   b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
   c. Swab fittings and valves with Manufacturer recommended cleaning fluid to remove oil and other compounds prior to installation.
   d. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.

C. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators, and other equipment tightly capped until assembly.

D. Pipe relief valve discharge to outdoors for systems containing more than 45 kg (100 lbs.) of refrigerant.

E. Firestopping: Refer to Division 07.

3.02 PIPE AND TUBING INSULATION

A. Install per Manufacturer’s recommendations.

B. Apply two coats of weather-resistant finish as recommended by the Manufacturer to insulation exposed to outdoor weather.

3.03 SIGNS AND IDENTIFICATION

A. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.
3.04 FIELD QUALITY CONTROL

A. Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.

B. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of Resident Engineer. If the test fails, correct defects and perform the test again until it is satisfactorily done, and all joints are proved tight.

1. Every refrigerant-containing part of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gauges, control mechanisms, and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.

2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20°C (68°F) minimum.

3.05 SYSTEM TEST AND CHARGING

A. System Test and Charging: As recommended by the equipment Manufacturer.

END OF SECTION
SECTION 23 31 00

HVAC DUCTS & CASTINGS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, fabricate, and install all ductwork, including fittings, accessories, dampers, hangers and any incidental Work or components required to provide complete air supply, return and exhaust ductwork systems as shown on the Drawings and as specified herein. Design, furnish and install seismic restraints and braces for all ductwork and accessories.

B. In general, ductwork shall consist of any passageway made of sheet metal or other material substantially air tight, used for the conveying of air, gas or materials. Included are fittings, transitions, bracing, fasteners, sealers, supports and accessories such as access panels, access doors, turning vanes and manual air balancing dampers. All ductwork shall be of size and material as specified herein and as shown on the drawings. All duct sizes indicated on the drawings are clear, inside dimensions. Where ductwork is lined with fiberglass, duct sizes shown on the drawings are clear, inside dimensions to the duct liner material.

C. Any change in duct sizes, offsets, transitions and fittings required to accommodate job conditions shall be submitted to the Engineer for approval.

D. All ductwork, piping, and equipment shown on the drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The drawings shall be taken in a sense as diagrammatic.

E. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The Contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.02 REFERENCE STANDARDS

A. Reference Standards:

1. AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

2. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
a. ASTM A653 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the Hot Dip Process

3. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
   a. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   b. NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials

4. SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

5. UNDERWRITERS LABORATORIES (UL)
   a. UL 723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03 SUBMITTALS

A. Submit, in accordance with Division 01, General Requirements.

1. Standard shop and field installation details for transitions, elbows, takeoffs, discharge nozzles, turning vanes, access panels and doors, volume control and splitter dampers, hangers and volume extractors. When SMACNA references are used, the specific methods for the Project shall be clearly defined. Where SMACNA has more than one option, the option to be used shall be indicated.

2. Ductwork materials, joining methods, reinforcing, and material gauges. Where options are allowed by SMACNA, the proposed option shall be clearly defined. Indicate proposed materials and methods for ductwork and equipment hangers.

B. Closeout and Maintenance Material Submittals: per Division 01, General Requirements.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Division 01, General Requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01, General Requirements.
B. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

C. All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

D. All equipment shipped that is exposed such as on a flatbed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt, and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

E. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.06 COORDINATION

A. The drawings indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.

B. The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural Engineer.

C. The Contractor shall assume full responsibility for coordination of the HVAC systems, including scheduling, and verification that all structures, ducts, piping, and the mounting of equipment are compatible.

D. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

PART 2 – PRODUCTS

2.01 VIBRATION ISOLATION FOR DUCTWORK

A. Flexible fabric connectors for vibration isolation shall be airtight, watertight, fire retardant, 6 inches wide with 3-inch metal edges. Metal edges and fasteners shall be the same material or greater corrosion resistance as the duct.

B. Flexible connections for conventional indoor HVAC systems shall be glass fabric coated with polychloroprene. Fabric must comply with Underwriters Laboratories Standard UL214 and NFPA Bulletin 90A. Connections shall be Ventglas by Ventfabrics or Engineer approved equal.
C. Furnish flexible connectors at each inlet and outlet of every fan, air-handling unit and ERV. Flexible connections shall be integrally flange molded arch type units constructed of EPDM rubber ¼-inch thick, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service. The flexible connections shall be designed to minimize the transmission of vibration from the fans to the ductwork at the suction and discharge connections. Expansion or Contractor flexible connections shall be designed to allow 1-inch movement.

D. Working length or “live” length shall be as designed by the Manufacturer to allow up to 1 inch of movement. Ends shall be flanged, with flanges matching duct connection flanges. Corners on rectangular expansion joints shall be molded and free of patches or splices. The flexible connections shall be suitable for outdoor service and temperature ranges from -10 to 125 F, and pressure to 5 psig. Specially fabricated split Type 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the EPDM rubber flanged with Type 316 stainless steel bolts are tightened.

E. Acceptable Manufacturers
   3. Proco Products Incorporated.
   4. Engineer Approved Equal.

2.02 FLAME AND SMOKE RATINGS

A. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc., shall have flame spread ratings not over 25 (fire resistive) and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with the Federal Standard 00136B, National Bureau of Standards Radiant Energy Fire Test and the National Fire Code of the NFPA.

B. These requirements apply to all circumstances whether the materials are field applied or applied by a Manufacturer in shop, or elsewhere, prior to delivery to the project.

2.03 SOUND CONTROL

A. The selection of ductwork and accessories shall be such as not to create noise that will exceed the levels of permissible noise exposures for occupational areas as established by the OSHA and other Federal, State and local safety and health standards, codes and ordinances.
2.04 HANGERS, SUPPORTS, AND ANCHORS

A. Furnish supports, hangers and other devices necessary to support firmly and substantially the equipment and ductwork described in this Section. Ductwork support systems shall include restrains as required by the applicable building codes to withstand seismic loading.

B. All equipment, ductwork, and supports that are installed outdoors shall be designed and installed to meet wind loadings as required by the International Mechanical Code, the Building Code in the state of the project location, all other applicable codes, and the requirements specified herein.

C. Rectangular, Round and Flat Oval Ductwork Spacing and size of hangers shall be as called for in the SMACNA standards, except as limited below.

1. Rectangular ductwork 48-in wide and larger shall be supported by adjustable threaded rod hangers.

2. Round ductwork 37 inches and larger shall be supported by two adjustable threaded rods at each support.

D. All hangers shall be of same material as ductwork which they serve.

E. All hanger hardware and fasteners shall be of the same material as the duct they serve or shall be of a material with equal or greater corrosion resistance. Where materials other than the duct material are used, they must be approved by the Engineer before installation.

F. Perforated band iron or wire for supporting ducts shall not be permitted.

G. Where C clamp type hangers are used, furnish with a retainer strap.

H. The following methods of hanger attachment to the building structure are NOT allowed. The numbers and letters refer to hanger methods shown in Figure 4-1, 4-2 and 4-3 of the 1985 edition of the HVAC Duct Construction Standards Metal and Flexible as published by SMACNA.

1. "T"- wrap around strap on open web joist.

2. "W" - bent over band on open web joist.


4. "17" - bent wire in metal deck.

I. Design of hangers shall include the effect of all loads applied to the duct as well as the load of the duct. These loads include, but are not limited to wind, snow and internal dirt or liquid buildup.
J. Hangers shall not be supported from roof decking or bulb tees. Where required, provide supplemental steel to span between the building structures.

2.05 DUCTWORK MATERIAL

A. Ductwork shall be constructed of the materials specified using the gauges or thicknesses, reinforcing and construction methods in accordance with SMACNA standards. Unless otherwise specified, all components of the duct systems shall be constructed of the same material as the ductwork. This is to include braces and turning vanes. Provide duct materials for each area as specifically indicated on the Drawings.

1. Galvanized steel ductwork shall be constructed of hot dip galvanized sheet steel, per ASTM A653.

2.06 DUCTWORK CONSTRUCTION

A. All ductwork shall be substantially built with joints and seams smooth on the inside and given a neat appearance on the outside. Inside surfaces and joints shall be smooth and free from pockets, burrs, and projections. All joints shall be substantially airtight with laps made in the direction of air flow and no flanges projecting into the air stream.

B. Pressure Classes

1. Pressure classes for determination of sheet metal gauge and reinforcing shall be as defined by the latest issue of the SMACNA: Industrial Duct Construction Standards.

2. For systems with fans a shut off static pressure 2 in w.g. or less design pressure shall be equal to the maximum pressure indicated for the fans or air handling units on the schedules and the pressure class shall be the same for the entire length, including branches, of the specific duct system.

C. Rectangular Ductwork (Sheet Metal)

1. Ductwork shall be constructed as shown on the drawings in accordance with the specified SMACNA: Construction Standard.

2. Cross breaking shall conform to SMACNA standard. Cross breaking shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross break shall be of the required height to assure rigidity for each panel.
3. Alternate Construction: Factory fabricated joint systems may be offered as an alternate form of construction. The system offered shall meet all requirements of SMACNA. Alternate joint systems shall be "Ductmate System" as manufactured by Ductmate Industries, Inc., installed in accordance with the Manufacturer's recommendations. The system shall be sealed for zero leakage and angle attachment to the main duct section shall be by tack welding. The use of screws is not allowed.

D. General Service Duct Connectors

1. Provide a flexible duct connector approximately 6 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 UL 214 and is classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.07 DAMPERS

A. Dampers: Manual

1. Backdraft Dampers

   a. Provide gravity backdraft dampers with extruded aluminum, 6063-T52 alloy, 0.081-inch thick 1 inch by 4 inches by 1 inch channel frame on all sides. Blades shall be extruded aluminum of same material and thickness. Seals shall be extruded silicone rubber leg at blade edges and expanded polyurethane on jambs. Shafts shall be 1/2 inch diameter extruded aluminum, pin-lock design. Bearings shall be oilite bronze with linkage installed in jamb out of the airstream. Counterbalance shall be mounted externally on extended shaft and assist opening. Where backdraft dampers are installed in aluminum, stainless steel, or PVC ductwork, match materials of construction to ductwork. Meet above requirements.
2. **Manual Volume & Balancing Dampers**
   
a. 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. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multi-leaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. 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. Dampers to match same type material as ductwork dampers are installed in.

3. Subject to compliance with requirements, provide dampers of one of the following manufacturers:
   
   
b. Arrow Louver and Damper (Division of Arrow United Industries, Inc.)
   
c. Mastek
   
d. Engineer Approved Equal

B. **Dampers: Automatic**

1. **Rectangular Automatic Control Dampers**
   
a. Provide control dampers that meet the following minimum construction standards: Frame shall be 16 gauge structural channel with tabbed corners for reinforcement. The blades shall be single skin, 16 gauge with three longitudinal grooves for reinforcement. Blade edge seals shall be PVC coated polyester fabric suitable for -25 F to 180 F (-32 C to 83 C) mechanically locked into the blade edge. Adhesive or clip-on type seals are unacceptable.
b. Jamb seals shall be flexible metal, compression type to prevent leakage between blade end and damper frame. Blade end overlapping frame is unacceptable. Bearings shall be corrosion resistant, molded synthetic sleeve type turning in an extruded hole in the damper frame. Axles shall be hexagonal positively locked into the damper blade. Linkage shall be concealed out of airstream, within the damper frame to reduce pressure drop and noise. Submittal must include leakage, pressure drop, maximum velocity and maximum pressure data based on AMCA Publication 500. Dampers shall be equipped with factory installed damper position indication switch package. The switch package shall include two position indication switches linked directly to the damper blade to provide full open and full closed damper blade position. The switch package shall provide the capability to interface with the control system and provide remote damper blade position status.

c. Dampers shall have 120VAC direct coupled, spring return damper actuators, manufactured by Belimo or Engineer approved equal. Control shall be fully open/fully closed from an auxiliary contact. The actuators shall have true spring return operation for reliable fail-safe operation and positive close off. Actuator shall be spring close, power open. Provide damper position switches, as required based on the sequence of operation.

d. Damper construction shall match the materials of the connecting duct work.

e. Position switches shall comply with the following:
   1) Position switches shall be mounted on the damper shaft crank arm.
   2) Switches shall provide open and closed indication.
   3) Switches shall be single pole double throw, rated for 2 amps at 120 VAC.

f. Provide dampers in accordance with the following table:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Control Operation</th>
<th>Drawing #</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOD-1</td>
<td>Open/Close</td>
<td>H-101</td>
</tr>
<tr>
<td>MOD-2</td>
<td>Open/Close</td>
<td>H-101</td>
</tr>
<tr>
<td>MOD-3</td>
<td>Open/Close</td>
<td>H-101</td>
</tr>
</tbody>
</table>
Subject to compliance with requirements, provide dampers from one of the following:

1) Ruskin Mfg. Co.
2) Arrow Louver and Damper (Division of Arrow United Industries, Inc.)
3) Louvers & Dampers, Inc.
4) Engineer Approved Equal

C. Thermally Broken & Insulated Dampers

1. Provide thermally insulated damper with thermally broken frame for all outside air, exhaust air and other dampers in duct systems connected to the exterior or unconditioned spaces. Damper frame shall not be less than 0.080” in thickness. Damper frame shall be 4” deep x 1”, with mounting flanges on both sides of frame. Frame shall be assembled using stainless steel screws. Entire frame shall be thermally broken by means of polyurethane resin pockets complete with thermal cuts.

2. Damper materials of construction shall match the connecting duct work.

3. Blades shall be air-foil profiles, internally insulated with expanded polyurethane foam and thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55 (tested to AAMA 1502.7 Test Method).

4. Blade and frame seals shall be extruded silicone, for reduced air leakage at colder temperatures. Blade and frame seals shall be secured in an integral slot within the aluminum extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals shall not be acceptable.

5. Bearings shall be composed of a Celcon inner bearing (fixed around a 7/16" aluminum hexagon blade pivot pin) rotating within a polycarbonate outer bearing inserted in the frame.

6. Adjustable 7/16" hexagonal drive rod, U-bolt fastener, and hexagonal retaining nuts shall stainless steel.

7. Dampers shall be designed for operation in temperatures ranging from -40°F (-40°C) to 212°F (100°C).

8. Dampers shall be rated Leakage Class 1A at 1 in w.g. (0.25 kPa) static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
9. Dampers shall be custom made to required size, without blanking off free area.

10. Dampers shall be available with either opposed blade action or parallel blade action.

11. Dampers shall be available as Flanged to Duct install type.

12. Installation of dampers must be in accordance with the manufacturer’s instructions.

13. Intermediate structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. Refer to the manufacturer’s Installation Guidelines.

14. Acceptable level of quality shall be TAMCO Series 9000 BF Thermally Insulated Damper with Thermally Broken Frame, as manufactured by T. A. Morrison & Co., Inc or Engineer Approved Equal.

2.08 ACCESS DOORS

A. 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.

B. Access doors shall be minimum 24 inches by 24 inches in ducts 26 inches and larger. Where the duct size is less than 26 inches, the largest door that can be accommodated shall be used. Access doors shall be of the same material as the duct, pan type construction for metal ductwork, with smooth edges and fitted seals, constructed and installed for air tight fit with ease of opening and closing. Doors shall be substantially butt hinged, with heavy sash locks and substantial door pulls. Door openings and door frames shall be reinforced with bar stock or angle. Where ductwork is installed with duct liner or exterior duct insulation, the access door shall be of the insulated type. Access doors shall be factory fabricated. Use insulated type doors in insulated ducts.

C. Hand hole access panels shall be 12 inch by 12 inch, constructed of the same material as the ductwork, with peripheral gaskets and sash locks. Provide hinges or chain for attachment to duct.

2.09 FASTENERS

A. Sheet metal screws, drive cleats, cinch bands, and other fasteners shall be fabricated from materials matching the ductwork in which they are installed. Where a material other than the duct material is used, it shall be approved by the Engineer before installation.
2.10 LABELS

A. The service of each duct along with an arrow indicating direction of flow shall be provided on each duct system. Labels shall be located not more than 26 linear feet apart and shall also be provided at both sides of wall penetrations, at each damper, and each equipment connection.

B. Labels shall contain the service spelled out, the duct size, and the equipment number of the equipment served. Label locations shall have unobstructed view from normal viewing locations.

C. Numbers and letters shall be die-cut from 3.5 mil vinyl film and pre-spaced on carrier film. Adhesive and finish shall be protected with one-piece removable liners. Colors shall be white letters on black backgrounds.

D. The system for preparation and application of letters shall be Type B a.s.i./2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Letters shall be 3-in high Optima Bold, upper case using Grid 2 spacing. Direction arrows are to match. The instructions of the Manufacturer shall be followed in respect to storage, surface preparation and application of letters.

E. Each piece of equipment is to be provided with an identification label listing the unit number and the areas served. Labels shall be as specified above.

PART 3 – EXECUTION

3.01 INSTALLATION OF DUCTWORK

A. Fabricate and erect all ductwork where shown on the drawings, as specified herein, and in accordance with SMACNA standards. Rigidly support and secure ductwork.

B. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

C. Wherever ducts are divided, maintain the cross sectional area. All such changes must be approved and installed as directed by the Engineer or as approved on shop or erection drawings.

D. During installation, temporarily close the open ends of ducts to prevent debris and dirt from entering. Install work in accordance with the overall approved progress schedule and in cooperation with all other trades so there will be no delay to other trades.
E. Cross break sheet metal in accordance with SMACNA duct construction standard. Apply cross breaking to the sheet metal between the standing seams or reinforcing angles. The center of the cross break shall be of the required height to assure each panel section being rigid.

F. Beading as specified in SMACNA will be acceptable in lieu of cross breaking.

G. The drawings of the air ducts and air risers show the general location for installation of the ducts and risers. Should additional offsets or changes in direction be made, these changes must be considered in the original bid and shall be installed at no additional cost to the Owner.

H. All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building. Ducts shall be transformed or divided as may be required. Wherever this is necessary, maintain the cross sectional area. All of these changes, however, must be approved and ducts installed as directed by the Engineer or as approved on shop or erection drawings.

I. The taper of all transformations shall be not more than 15 degrees.

J. Secure casing to curbs according to SMACNA "Duct Construction Standards."

3.02 HANGERS

A. Rectangular, Ductwork: Spacing and size of hangers shall be as recommended in the SMACNA standards except as noted in PART 2.

B. Install hangers plumb and securely suspended from supplementary steel or inserts in concrete slabs. Sufficiently thread lower ends of hanger rods to allow adequate vertical adjustment. Do not use building siding or metal decking to hang ductwork.

C. Ducts shall not be supported from furring, hung ceilings or from another duct or pipe.

D. C clamp type hangers shall be supplied with a retainer strap.

E. Ductwork shall not come in contact with any of the ceiling construction or any other equipment in the ceiling cavity.

F. Duct support at flexible connections shall be adjustable for ease of aligning the duct to the piece of equipment.

3.03 SEALING OF DUCTWORK

A. All ducts regardless of size or duty shall be sealed.
B. General: Unless otherwise indicated, seal all ductwork joints and seams using sealant in accordance with the instructions of the sealant manufacturer and this Section.

C. Application of Sealant: Thoroughly clean all seams, joints, etc, of dirt, oil, grease, or other coatings which might interfere with the adhesion of the duct sealant before the sealant is applied.

D. Uncured sealant may be forced into the slotted side of the seam or joint before shop or field assembly and the joint or seam completed while the sealant is still uncured. Excess sealant shall be removed from both the inside and outside of the duct before it sets.

E. Duct Tape: The use of duct tape alone for sealing ductwork is prohibited.

F. Sealant shall be either in liquid form or a mastic with a maximum flame spread of 25 and a maximum rate of fuel contributed, and smoke developed of 50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.

G. Sealing systems shall be suitable for the environment. The following schedule is to be used to select the sealant.

1. Indoor, dry galvanized round and rectangular duct is to be sealed with Iron Grip 601 or equal.

2. Indoor, dry, stainless steel, aluminum and PVC coated is to be sealed with FTA 20 adhesive and DT-Tape gypsum or equal.

3. All other areas unless otherwise noted are to be sealed with FTA 50 adhesive and DT-Tape gypsum or equal.

4. All sealers listed are manufactured by Hardcast Inc and are to define the type of sealer. Other equal sealants are acceptable.

H. Installed duct systems shall be tested in accordance with the SMACNA - HVAC Air Duct Leakage Test Manual.

3.04 DUCTWORK FITTINGS AND ACCESSORY ITEMS

A. Duct Elbows: Changes in direction and offsets shall be made in a gradual manner to facilitate streamline flow of air. All elbows shall have a centerline radius of not less than 1 1/2 times the width of the duct in the plane of the elbow. For rectangular ductwork where full radius elbows cannot be installed, provide abrupt elbows equipped with shop installed turning vanes unless noted otherwise on the drawings.
B. Flexible Fabric Connectors

1. Install flexible connectors for vibration isolation at all duct connections to fans, fan units or blowers, air handling units, and air conditioning unit ventilators. Make connections substantially airtight at all seams and joints.

2. Where the construction of the flexible connection or vibration isolator results in a cross-sectional area of the connection which is less than 90 percent of the adjacent ductwork, the size of the connection shall be increased to provide a cross sectional area equal to or greater than 90 percent of the adjacent duct.

3. Provide flexible duct connections at both the intake and discharge connections for all fans and air handling units except as noted below.
   a. Wall and roof fans that have integral motor/fan wheel isolation.
   b. Air handling units where the fan is isolated from the intake and discharge connections by internal flexible connections or separations, and the unit is mounted without vibration isolators between the unit and the support structure.

4. Ductwork spacing and alignment for flexible connections shall be aligned to the tolerances of the flexible connection Manufacturer, or plus/minus 1/4 inch, whichever is less. Bolts shall be torqued to the Manufacturer's recommendations. Do not over tighten.

5. Where flexible connections are used as expansion joints, the Manufacturer's pre-compression recommendations must be followed. When the temperature at installation differs from the temperature in the pre-compression recommendation, a correction shall be made.

C. Dampers

1. Install manual volume control dampers wherever it may be necessary to regulate air volume for system air balancing and where shown on the drawings.

2. Install splitter dampers, where shown on the Drawings, to regulate air volume for system air balancing.

D. Access Doors

1. Hinged access doors shall be installed where listed below, wherever shown on the drawings, and wherever access may be required for service, maintenance, and adjustment.
2. Provide access doors at the following locations (minimum requirements):
   a. Motorized dampers, linkage side
   b. Duct mounted temperature controllers
   c. Smoke detectors
   d. Plenums
   e. Fire dampers
   f. Manual dampers and splitters
   g. Inlet side of centrifugal fans
   h. Inlet and outlet ducts to fans and air handlers.
   i. Inlet side of all heating coils.

3. Where access doors are required in ductwork located above ceilings, coordinate the location of the access doors to clear the ceiling support system and to be accessible through the ceiling grid.

4. 12 inch by 12 inch handhole access panels may be substituted for access doors when ductwork dimensions are less than 14 inch by 14 inch.

3.05 DUCTWORK TERMINATIONS AT MASONRY OR CONCRETE

A. Where ducts terminate at masonry or concrete openings, place a continuous 2-1/2 inch by 2-1/2 inch by 3/16 inch angle of the same material as the duct around the ductwork. Bolt the angle to the construction and make airtight by applying caulking compound on the angle before it is drawn down tight to construction.

B. Fasten plenums to concrete curbs with 3 inch by 3 inch by 1/4 inch continuous angle. Concrete curbs are provided under another division. Mount angle on a continuous bead of caulking compound and anchor to the curb on 16 inch centers. Terminate duct at the curb and bolt to the angle. Seal the duct to the curb with a continuous bead of caulking compound. Apply neoprene filler strip to level curb surface as necessary.

3.06 DUCTWORK GENERATED NOISE

A. All ductwork shall be free from pulsation, chatter, vibration, or objectionable noise. After system is in operation, should these defects appear, correct by removing, replacing, or reinforcing the work. No discreet tones will be allowed.
3.07 TEST PORTS

A. Where shown on the drawings and where required for testing and balancing, provide instrument insertion ports. Size and location of ports shall be coordinated with the Contractor performing air balancing. Seal ports with plastic snap lock plugs. When the ductwork will be insulated, extend the port to the face of the insulation and seal the vapor barrier to the port. When the ductwork is lined, extend the port into the duct to the inner surface of the duct liner.

B. In round ductwork provide 2 ports 90 degrees on centers. In rectangular ductwork provide ports as required by AABC or NEBB for a full traverse measurement.

C. As a minimum, ports shall be provided in the following connections:
   1. All duct mains.
   2. All duct branches unless all connections are diffusers, registers, or grilles and the total can be calculated by summing the readings for all of the connections.
   3. All connections to tanks or hoods where there is no other access for taking a measurement.

D. A main duct is defined as one of the following:
   1. A duct emanating from a fan or plenum.
   2. All other ducts are considered branch ducts.

3.08 CLEANING OF DUCTWORK

A. Maintain all ductwork, fans, coils, air filters, outlets, and other parts of the ductwork systems in a clean condition during installation.

B. Clean complete ductwork systems prior to testing and air balancing. Secure cheese cloth over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

3.09 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01, General Requirements.

3.10 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01, General Requirements.
3.11 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01, General Requirements.

END OF SECTION
SECTION 23 34 00

HVAC FANS

PART 1 – GENERAL

1.01 SCOPE OF WORK
A. Provide fans as shown on the Drawings and as specified.

1.02 RELATED SECTIONS
A. Division 26 Electrical

1.03 QUALITY ASSURANCE
A. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
B. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code.”
C. Classification for Spark Resistant Construction Conform to AMCA 99.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
A. Product Data: Submit the following:
   1. Complete materials list of all items to be provided, including Supplier and estimated delivery schedule.
   2. Submit Shop Drawings for all products and materials in accordance with Division 01 requirements.
   3. Submit catalog cuts, complete parts listing showing materials of construction with applicable ANSI, ASTM, AMCA, manufacturer’s Specifications and product data to demonstrate compliance with requirements.
   4. Submit details of construction including extent of shop assembly of unit and manufacturer’s recommended installation procedures.
5. Within 30 days of receipt of approved Shop Drawings, submit for review operation and maintenance manuals in accordance with Division 01 requirements. In addition to requirements specified in Division 01, operation and maintenance manuals shall also include detail drawing/schematic of the propeller fan being provided, complete parts list including part numbers, list of recommended spare parts, maintenance and lubrication schedules, motor horsepower/efficiency and nameplate information.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling and Unloading

1. Lift and support units with manufacturer’s designated lifting or supporting points.

2. Disassemble and reassemble units as required for movement into final location as specified in manufacturer’s written instructions.

3. Roof fan units: shipped in International Safe Transit Association (ISTA) certified transit tested packaging.

4. Deliver fan units as a factory assembled unit, to extent allowable by shipping limitations, with protective crating and covering.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corp.

2. Loren Cook

3. PennBarry

4. Or Engineer’s Approved Equal
2.02 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required:


2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency shall be factory tested and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51—Laboratory Methods of Testing Fans for Rating.

2.03 INDUSTRIAL DIRECT DRIVE SIDEWALL MOUNTED PROPELLER FANS WITH WALL HOUSING (EF-1)

A. General:

1. Fan arrangement shall be either supply or exhaust, see Fan Schedule

2. Base fan performance at standard conditions (density 0.075 lbs./ft³).

3. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.

4. Fans are to be equipped with lifting lugs.

5. Each fan shall be sidewall mounted with direct drive according to drawings.

6. Fan shall be equipped with manufacturer’s wall housing and backdraft damper for louver mounting construction.

7. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be as selected by the Engineer. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

B. Fan Housing and Outlet

1. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. The housings on all fan sizes shall be of continuously welded heavy gauge steel. All interior and exterior surface steel shall be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be selected by the Engineer. No uncoated metal fan parts will be allowed.

3. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.

C. Fan Wheel

1. Propeller shall be aluminum blade riveted to steel hub

2. A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft

3. Statically and dynamically balanced in accordance with AMCA Standard 204-05

4. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

D. Fan Motors and Drive

1. Motor enclosures shall be of open driproof design.

2. Motors are permanently lubricated, sleeve bearing type on sizes 8-12 and ball bearing type on sizes 14-24 to match with the fan load and furnished at the specific voltage and phase.

3. Motors shall be accessible for maintenance.

2.04 DIRECT DRIVEN CEILING MOUNTED EXHAUST FANS (EF-2)

A. General:

1. Fan arrangement shall be exhaust

2. Base fan performance at standard conditions (density 0.075 lbs./ft^3).

3. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.

4. Normal operating temperature up to 130 Fahrenheit.

5. Fans are to be equipped with lifting lugs.

6. Fans shall be UL listed for above bathtub exhaust.

7. Each fan shall be permanently affixed with manufacturer’s engraved nameplate.
B. Fan Wheels:
   1. The fan wheel shall be forward curved centrifugal type.
   2. Fan wheel shall be constructed of galvanized steel.
   3. The wheel shall be statically and dynamically balanced in accordance to AMCA Standard 204-05.

C. Fan Motors:
   1. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets.
   2. Motors shall be permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.
   3. Motor shall be mounted on vibration isolators and be accessible for maintenance.
   4. Motors shall be provided with thermal overload protection.

D. Fan Housing:
   1. Housing shall be constructed of heavy gauge galvanized steel.
   2. Interior shall be lined with 0.5 inches of acoustical insulation.
   3. Housing profile shall be as low as 10 ½ inches.

E. Dampers:
   1. Fan shall be provided with spring loaded aluminum backdraft damper.

F. Grill:
   1. Provide factory standard plastic grill.

G. Disconnect Switch:
   1. Fan shall be provided with NEMA 1 rated disconnect switch.

H. Outlet:
   1. Provide factory standard round outlet.
   2. Provide factory standard duct collar.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Provide in accordance with NFPA 70.

B. Install fans level and plumb, in accordance with manufacturer’s written instructions. Support units using vibration control devices.

C. Remove shipping blocking and bracing.

D. Verify unit is secure on mountings and supporting devices and connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

E. Adjust damper linkages for proper damper operation.

F. Clean unit cabinet interiors to remove foreign materials, construction dirt, and dust. Vacuum clean fan wheel and cabinet.

G. Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants as required.

H. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field Tests and Inspections

1. Test fan for proper operation when connected to space thermostat. Exhaust fans operate when room temperature is above set point.

3.03 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 23 81 26

SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish, install, test and make ready for operation; Mini-Split AC/Heat Pump Units, controllers, accessories and all appurtenances as specified, as indicated in the Schedules and as shown on the Drawings.

1.02 SUBMITTALS

A. Submit in accordance with Division 01 to demonstrate conformance with specified features and scheduled ratings.

1.03 QUALITY ASSURANCE

A. System shall be rated in accordance with A.R.I. Standard 270.

B. System shall be certified in accordance with the unitary air conditioner equipment certification program, based on A.R.I. 210/240.

C. System shall be UL listed.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be stored and handled in accordance with Manufacturers’ recommendations.

1.05 WARRANTY

A. Provide 10 year warranty unless stated otherwise.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Mini-Split AC/Heat Pump Unit

1. Mitsubishi Electric (Basis of Design)

2. LG

3. Fujitsu

4. Engineer Approved Equal
B. Refer to the schedules on the Drawings for additional details and requirements

2.02 AC/HEAT PUMP UNIT

A. System Description

1. The system shall consist of a slim silhouette, compact, wall mounted indoor fan coil section with wired remote controller and a slim silhouette, horizontal discharge, outdoor unit which shall be of an inverter driven heat pump design.

B. Quality Assurance

1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

3. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute’s (AHRI) Standard 240 and bear the AHRI Certification label.

4. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

5. A dry air holding charge shall be provided in the indoor section.

6. System efficiency shall meet or exceed 20 SEER and 10 HSPF when part of a 1:1 (indoor/outdoor) system.

C. Delivery, Storage, and Handling

1. Unit shall be stored and handled according to the Manufacturer’s recommendations.

2. The wired controller shall be shipped inside the carton with the indoor unit and able to withstand 105 F storage temperatures and 95% relative humidity without adverse effect.
D. Warranty

1. The units shall have the Manufacturer’s parts and defects warranty for a period ten (10) years from date of installation. The compressor shall have a warranty of 10 years from date of installation.

E. Indoor Unit

1. General

   a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board, fan and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit shall be charged with dry air before shipment from factory.

2. Unit Cabinet

   a. The casing shall have a white finish – Munsell 1.0Y 9.2/0.2.

   b. Multi-directional drain connection and refrigerant piping, offering three (3) direction pipe alignments for all refrigerant piping and two (2) direction pipe alignments for condensate draining shall be standard.

   c. There shall be a separate, metal back-plate that secures the indoor unit firmly to the wall. The back plate shall be securely attached to the wall.

F. Fan

1. The indoor unit fan shall be an assembly with a line-flow fan direct driven by a single motor.

2. The fan shall be statically and dynamically balanced and be powered by a motor with permanently lubricated bearing and internal overload protection.

3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).

4. An integral, motorized, multi-position, horizontal air sweep flow louver shall provide for uniform air distribution, up and down.

5. Indoor fan shall operate at 3 selectable speeds: High, Medium and Low.

G. Filter

1. Return air shall be filtered by means of easily removed, washable, filter.
H. Coil

1. The indoor unit coil shall be of nonferrous construction with smooth plate fins on copper tubing.

2. Single refrigeration circuit with externally equalized expansion valve.

3. The tubing shall have inner groves for high efficiency heat exchange.

4. All tube joints shall be brazed.

5. The coils shall be pressure tested at the factory.

6. A sloped, corrosion resistant condensate pan with drain shall be provided under the coil.

I. Integral Condensate Pump:

1. Packaged unit matched to evaporator unit including float switch, pump, motor assembly, check valve, and reservoir.

2. Provide alarm to indicate high level reservoir.

3. Unit shall be powered from evaporator unit with appropriate field connections available.

J. Electrical

1. Unit electrical power shall be as indicated on the Schedules on Drawings.

2. The system shall be equipped with A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 2-wire connection plus ground.

3. The indoor unit shall not have any supplemental electrical heat elements.

K. Control

1. The unit shall have a wired controller to perform input functions necessary to operate the system.

2. The wired controller shall have a Power On/Off switch, Mode Selector – Cool, Dry, Heat, Auto Modes – Temperature Setting, Timer Control, Fan Speed Select, and Auto Vane selector.

3. The indoor unit shall perform Self-diagnostic Function and Check Mode switching.
4. Temperature changes shall be by 1 F increments with a range of 59 – 89 F.

5. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

6. The indoor units shall be capable of working with single-zone or multi-zone outdoor units.

7. The system shall be capable of automatically restarting and operating at the previously selected conditions when the power is restored after power interruption.

8. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off, System/Mode function.

L. Outdoor Units

1. Unit Cabinet: The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.

2. Fan: The unit shall be furnished with a direct drive propeller type fan. The outdoor unit fan motor shall be a direct current (DC) motor and have permanently lubricated bearings. The fan motor shall be mounted for quiet operation. The fan shall be provided with a raised guard to prevent contact with moving parts. The outdoor unit shall have horizontal discharge airflow.

3. Coil: The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing. The coil shall be protected with an integral metal guard, and corrosion resistant coating.

4. Refrigerant flow from the outdoor unit shall be regulated by means of an electronically controlled, precision, linear expansion valve.

5. The outdoor unit shall be capable of heating operation at a temperature of minus 13 °F.

M. Compressor

1. The compressor motor shall be direct current (DC). The compressor shall be of a high performance hermetic; inverter driven, variable speed, rotary type. The outdoor unit shall have an accumulator. The compressor shall be equipped with an internal thermal overload.
2. There shall be no need for line size changes, traps shall not be used, and no additional refrigerant oil shall be required.

3. The compressor shall be equipped with vibration isolation.

N. Electrical

1. The unit electrical power shall be as indicated in the schedules on the Drawings.

2. The outdoor unit shall be controlled by the microprocessor located in the indoor unit and outdoor unit.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install the system in accordance with the Manufacturer's instructions and the drawings.

B. Provide control wiring per the Manufacturer's recommendations.

3.02 TESTING

A. Provide verification of installation site conditions as part of start-up testing and training.

3.03 PERSONNEL TRAINING

A. Train operating personnel in operating, adjusting, and maintaining the split air conditioning system.

END OF SECTION
SECTION 23 82 39

UNIT HEATERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide electric heaters and convectors in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 23 05 00 Common Work Results for HVAC
2. Section 23 05 53 Identification for HVAC Piping and Equipment
3. Division 26 Specifications for Electrical Work

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. Underwriters Laboratories (UL)

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01, General Requirements.

B. Manufacturer instructions for each type of product installed

C. Closeout and Maintenance Material Submittals: per Division 01, General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01, General Requirements.
1.07 **DELIVERY, STORAGE, AND HANDLING**
   A. Provide in accordance with Division 01, General Requirements.

1.08 **SITE CONDITIONS**
   A. Existing Conditions: per Division 01 General Requirements.

1.09 **WARRANTY**
   A. Provide 5-year warranty for heating elements.

**PART 2 – PRODUCTS**

2.01 **INDUSTRIAL ELECTRIC UNIT HEATERS**
   A. Acceptable Manufacturers
      1. Q-Mark
      2. Modine
      3. Reznor
      4. Trane
      5. Or equal
   B. Furnish electric unit heaters that are UL listed for wall or ceiling mounting.
   C. Cabinet: 18-gauge cold rolled steel, welded, and phosphate coated to resist corrosion as indicated on the schedules on the Drawings.
   D. Provide with removable side, front, and back panels by removing 4 screws from inside the control compartment without dismounting the heater, permitting full access to elements and fan motor areas.
   E. Provide with individual adjustable louvers with 30 degree downward stops to provide desired control of discharge air.
   F. Locate control compartment at the bottom of cabinet and provide with swing-down hinged cover to permit full access for cleaning and servicing without dismounting the heater.
   G. Terminate heater and control wiring inside control compartment.
   H. Cabinet finish: neutral grey polyester powder paint, corrosion resistant coatings as indicated on the schedules on the Drawings.
I. Heating elements: non-glowing design consisting of 80/20 nickel-chromium resistance wire, embedded in magnesium oxide and enclosed in a metal sheath to which metal plated fins are copper brazed. Paint elements with aluminized paint for corrosion resistance as indicated on the schedules on the Drawings and cover entire discharge area for uniform heating.

J. Furnish permanently lubricated, impedance protected, enclosed fan motor for units rated for 7.5 kW and below with unit bearing design suitable for horizontal or vertical operation with high starting and running torques.

K. Furnish permanently lubricated, thermal protected, enclosed fan motor for units rated for 10 kW or above, with double bearing design with high starting and running torques.

L. Fan blade: aluminum and directly connected to the fan motor, designed specifically for unit heater application.

M. Fan control: bimetallic snap-action type and shall activate fan motor after heating elements reach operating temperature and continue to operate the fan motor after thermostat is satisfied and until the heating elements cool.

N. Build a thermal cutout into the system to automatically shut off the heater in the event of overheating and reactivate when temperature returns to normal.

O. Provide with factory installed, heavy duty, 3-pole contactor providing quiet, efficient operation, making external contacts and additional wiring unnecessary.

P. Provide with line-voltage remote adjustable thermostat.

Q. Provide wall mounting or ceiling mounting brackets. Do not provide pole mounts. Bracket materials: manufacturer’s standard materials or as indicated on the Drawings.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine areas to receive propeller electric unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before propeller unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.02 INSTALLATION OF UNIT HEATERS

A. Install where indicated on Drawings in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that the unit heaters comply with requirements and serve the intended purposes.

B. Provide minimum access space around unit heaters for service as recommended by the manufacturer and as shown in the manufacturer’s installation manual.

C. Install electrical devices furnished by the manufacturer not specified to be factory-mounted.

D. Electrical wiring installation: shall be in accordance with manufacturer's submittal and installation requirements and in accordance with Division 26 Specifications for electrical Work.

E. Provide wiring, accessories, and supports, as indicated for a complete and functional installation.

3.03 ADJUSTING AND CLEANING

A. Start-up in accordance with manufacturer's instructions.

B. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.04 FIELD QUALITY CONTROL

A. Verify operation of each unit heater by measuring input voltage and current simultaneously for period of ten minutes of continuous operation.

B. Start and verify proper operation of each unit heater in accordance with the manufacturer’s installation manual

3.05 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01, General Requirements.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01, General Requirements.

END OF SECTION
SECTION 23 90 00

LOUVERS AND VENTS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide fixed metal wall louvers and motor operated dampers in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Architectural Manufacturers Association (AAMA)
   a. 2605-02 Voluntary Specification Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Architectural Extrusions and Panels

2. Air Conditioning, Heating and Refrigeration Institute (AHRI)
   a. ARI 650 Standard for Air Outlets and Inlets

3. Air Diffusion Council (ADC)
   a. ADC 1062 Certification, Rating and Test Manual

4. Air Movement and Control Association (AMCA)
   a. AMCA 500 Test Method for Louvers, Dampers and Shutters

5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
   a. ASHRAE 70 Method of Testing for Rating the Air Flow Performance of Outlets and Inlets
6. National Fire Protection Association (NFPA)
   a. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems

7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

8. National Electrical Manufacturers Association (NEMA)

9. Underwriters Laboratories (UL)

B. Definitions

1. Louver Terminology: per AMCA 501 for definitions of terms for metal louveres not otherwise defined in this section or referenced standards.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product data

1. Leakage, pressure drop, and maximum pressure data

2. Materials, construction, dimensions, and installation details

3. Product test reports evidencing compliance of units with performance requirements indicated.

4. Product certificates signed by louver manufacturers certifying that products furnished are licensed to bear AMCA seal based on tests made in accordance with AMCA Standard 500 and complying with AMCA Certified Ratings Program

5. Motor operated dampers manufacturer's product data to include:
   a. Leakage, pressure drop, and maximum pressure data
   b. Materials, construction, dimensions, and installation details
C. Shop Drawings of louver units and accessories including plans, elevations, sections, and details showing profiles, angles, spacing of louver blades; unit dimensions related to wall openings and construction; free areas for each size indicated; and profiles of frames at jambs, heads and sills.

1. Where installed products are indicated to comply with certain structural design loadings, include structural computations, material properties, and other information needed for structural analysis which has been prepared by, or under the supervision of a qualified professional engineer.

D. Qualification statements

E. Closeout and maintenance material submittals: per Division 01 General Requirements.

**1.06 QUALITY ASSURANCE**

A. Provide in accordance with Division 01 General Requirements.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

**1.07 DELIVERY, STORAGE, AND HANDLING**

A. Provide in accordance with Division 01 General Requirements.

**1.08 SITE CONDITIONS**

A. Existing conditions: per Division 01 General Requirements.

**PART 2 – PRODUCTS**

**2.01 GENERAL**

A. Check actual louver openings by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of the Work.

1. Where field measurements cannot be made without delaying the Work, guarantee opening dimensions and proceed with fabrication of louvers and vents without field measurements. Coordinate wall construction to ensure that actual opening.

**2.02 RAIN RESISTANT STATIONARY LOUVERS**

A. General: Except as otherwise indicated, provide manufacturer’s standard rain resistant stationary louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated.
B. Performance: Provide louvers that have maximum free area, and minimum pressure drop of each type as listed in manufacturer’s current data, complying with louver schedule.

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation.

D. Louvers shall possess stationary horizontal blades designed to prevent the penetration of wind driven rain. Louver blades shall be contained within a 7-inch frame. Extended sill shall be provided to capture and drain water to exterior of building. Louver components (heads, jambs, sill and blades) shall be factory assembled by the louver manufacturer. Louver sizes too large for shipping shall be built up by the contractor from factory assembled louver sections to provide overall sizes required. Louver design shall limit span between visible mullions to 5 ft. and shall withstand a wind load of 20 lbs. per sq. ft. (equivalent of a 90-mph wind).

E. Louvers shall be extruded 6063 T5 aluminum alloy construction as follows:

1. Frame: 0.125-inch wall thickness, caulking surfaces provided.
2. Blades: 0.125-inch wall thickness, installed vertically on approximately 1-inch centers.
3. Extended Sill: 0.125-inch wall thickness, with upturned side panels to prevent water leakage
4. Screen: 5/8-inch by 0.040-inch square mesh aluminum bird screen in removable frame.
5. Finish: Before paint application, louvers shall be thoroughly cleaned and pretreated. Cleaning includes complete submersion in alkali cleaner, detergent deoxidization, amorphous chrome phosphate conversion coating and acidulated final rinse. Kynar 500® or Hylar 5000® finish shall be applied to provide 1.2 mils (30µm) factory applied, baked-on film-build in accordance with AAMA 2605-02. Color: submitted for approval.

F. Acceptable manufacturers

1. Greenheck (basis of design)
2. Construction Specialties, Inc.
3. Louvers & Dampers, Inc.
4. Ruskin
5. Or approved equal

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1. Verify damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

PART 3 – EXECUTION

A. Louvers

1. Coordinate louver location and size with building manufacturer.

2. Locate and place louver plumb, level, and in proper alignment with adjacent work.

3. 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.

4. Form closely fitted joints with exposed connections accurately located and secured.

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

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

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

8. Install concealed gaskets, flashings, joint fillers, joint sealants and insulation, as louver installation progresses where required to make louver joints weathertight.

3.02 ADJUSTING AND PROTECTING

A. Protect louvers and vents from damage of any kind during construction period including use of temporary protective coverings where needed and approved by louver manufacturer. Remove protective covering at time of Substantial Completion.
B. Restore louvers and vents damaged during installation and construction period, so that no evidence remains of correction work. If results of restoration are unsuccessful, as judged by the Owner, remove damaged units and replace with new units.

   1. Clean and touch-up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.03 FIELD QUALITY CONTROL

   A. Provide in accordance with Division 01 General Requirements.

3.04 CLEANING

   A. Periodically clean exposed surfaces of louvers and vents, which are not protected by temporary covering, to remove fingerprints and soil during construction period; do not let soil accumulate until final cleaning.

   B. Before final inspection, clean exposed surfaces with water and with a mild soap or detergent not harmful to finishes. Rinse thoroughly and dry surface.

3.05 CLOSEOUT ACTIVITIES

   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide the labor, tools, equipment, and materials necessary to furnish and install all electrical work as specified herein and in accordance with the Drawings and applicable reference standards listed in Article 1.03.

2. Coordinate with the local electric utility company to provide electrical services as shown on the Drawings.

3. In general, electrical Work shall include but not be limited to the following:

   a. All motor wiring, safety disconnects, and motor starters unless integral with equipment

   b. Power distribution equipment

   c. Power outlets and equipment connections

   d. Wiring devices

   e. Motor controls not provided by other divisions

   f. Control wiring not provided by other divisions

   g. Complete grounding system

   h. Standby Power Systems

   i. Service Entrance work

   j. Lighting – Building interior and exterior

   k. All support material and hardware for raceway and electrical equipment

   l. Branch circuit wiring

   m. Installation, termination & labeling of all cable and signal wiring for instrumentation and process control equipment.

   n. Building wall, floor and roof penetrations for raceways

   o. Start up, acceptance testing test reports and instruction of systems operation to the Owner
p. Install and wire all electrical equipment and devices for the following items furnished by others:
   1) SCADA Control Panel

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. Electrical equipment, materials, installation and workmanship shall comply with all state and local building codes, safety and fire law Regulations at the location of the Work and shall conform to the latest edition of the applicable codes and standards of the organizations listed:

   a. National Electrical Code (NEC) with Massachusetts Amendments.
   b. Underwriters' Laboratories (UL)
   c. Institute of Electrical and Electronics Engineers (IEEE C2)
   d. American National Standards Institute, Inc. (ANSI)
   e. National Fire Protection Association (NFPA)
   f. National Electrical Manufacturers Association (NEMA)
   g. Insulated Power Cable Engineers Association (IPCEA)
   h. Association of Edison Illuminating Companies (AEIC)
   i. Occupational Safety Health Act (OSHA)
   j. Americans with Disabilities Act (ADA)

2. Where the Contract requires the Work or any part of the same, to be above the standards required by applicable Laws, ordinances, rules and Regulations and other statutory provisions pertaining to the Work, such Work shall be performed and completed in accordance with the Contract requirements.

3. Should any changes in the Specifications and Drawings be necessary to conform to the requirements of any of the above mentioned codes or standards, the Contractor shall so notify the Owner’s Representative.

B. Drawings required by Governing Authorities: Prepare any detailed diagrams or Drawings which may be required by the governing authorities.
C. Permits, Certificates, Inspections, Fees and Utility Costs

1. The Contractor shall obtain and make payments for all permits, licenses, and certificates that are required for the associated Work.

2. Following completion of the Work, the Contractor shall obtain certificates of approval from the responsible agencies concerned with the Work.

3. Arrange for timely inspections required for Work under this section.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

B. The electrical work shall be coordinated with the Work of other trades to prevent interferences and so that the progress in construction of the building will in no way be retarded.

C. Coordinate with all local utility companies and make all installations for their services in accordance with all utility company requirements.

D. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members and mechanical or other equipment, furnish and install all required supports and wiring to clear the encroachment for a complete installation.

E. Any Work installed contrary to or without acceptance by the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed to the Contractor for making these changes.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Furnish manufacturer's product data, test reports, and materials certifications as required.

C. Follow the procedures specified in Division 01 Section “Submittals” and in addition, the Contractor shall prepare and submit a complete submittal list to the Engineer. The submittal list shall include all submittal items covered in the Division 26 Specification sections.
D. Shop Drawings shall be submitted to the General Contractor who shall review and approve them prior to submittal to the Engineer for approval. Shop Drawings shall identify the specific equipment and material being supplied; the quantity being supplied; and all accessories, dimensions, descriptions, mounting and connection details, wiring diagrams, elementary control diagrams, equipment interface diagrams and any other information necessary to determine compliance with the Plans and Specifications. Fabrication and installation shall be in accordance with the approved Shop Drawings.

E. As-built copies of all Shop Drawings shall be submitted to the Engineer.

F. Submit copies of reports, permits, and easements necessary for installation, use, and operation.

G. Submit copies of reports of tests, inspections, and meter readings as specified.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 WARRANTY

A. Special Warranty/Extended Correction Period

B. Compile and assemble the warranties specified in Division 26 into a separate set of vinyl covered three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Information to include:

1. Product or equipment list
2. Date of beginning of warranty or bond
3. Duration of warranty or bond
4. Names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services
1.10 DRAWINGS

A. The Specifications supplement the Drawings and provide information pertaining to the methods and materials to be used in the execution of the Work. When a discrepancy occurs between the two, the stricter of the two shall govern.

B. All electrical equipment such as junction and pull boxes, panelboards, switches, controls and such other apparatus as may require maintenance and operation from time to time shall be made easily accessible and properly labeled.

C. The Contractor shall examine all Contracts and reference Drawings, and verify and properly coordinate the placement of outlets. Contractor shall also check all Drawings including mechanical Drawings and Shop Drawings for apparatus for which he must rough-in and to which he must connect.

1.11 RECORD DRAWINGS

A. The Contractor shall maintain a complete and separate set of prints of Drawings and Specifications at job Site for duration of the Contract. The Contractor shall record Work completed and all changes from original Contract. Drawings shall clearly and accurately include Work installed as a modification or as an addition to the original design.

B. At completion of Work and prior to final request for payment, the Contractor shall submit a complete set of reproducible Record Drawings showing all systems as actually installed.

1.12 JOB CONDITIONS

A. Existing Conditions

1. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.

2. Prior to all Work of this section, carefully inspect the installed Work of all other trades and verify that all such Work is complete to the point where this installation may properly commence.

3. Verify that the electrical installation may be made in complete accordance with all pertinent codes and Regulations and the original design.

B. Coordination

1. Coordinate the installation of electrical items with the schedules for Work of other trades to prevent unnecessary delays in the total Work.
2. Coordinate with all local utility companies and make all installations for their services in accordance with all utility company requirements.

3. Any changes shall be done at the Contractor’s expense.

4. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members and mechanical or other equipment, furnish and install all required supports and wiring to clear the encroachment for a complete installation.

5. Any Work installed contrary to or without acceptance by the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed to the Contractor for making these changes.

C. Accuracy of Data

1. The Drawings are diagrammatic and functional only, and are not intended to show exact circuit layouts, number of fittings, components and place in satisfactory operational power, lighting, and other electrical systems shown. Install additional circuits, components and material wherever needed to conform to the specific requirements of the equipment whether or not indicated or specified.

2. Information and components called for in the Specification but not shown on Plans or vise versa shall apply and shall be provided as though required expressly by both.

3. The locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Field measurements shall take precedence over scaled dimensions from Drawings. Exact locations shall be as accepted by Engineer during construction. Obtain in the field all information relevant to the placing of electrical work and, in case of any interference with other Work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the Work in an acceptable manner.

4. The Drawings and the Specifications are intended to comply with all pertinent codes, Regulations and standards. In the event of discrepancy, the Contractor shall immediately notify Engineer in writing of discrepancies and apply for an interpretation.

5. In case of difference between building codes, Specifications, state Laws, industry standards and the Contract Documents, the most stringent shall govern. Should the Contractor perform any Work that does not comply with the requirements of the applicable building codes, state Laws, and industry standards, he shall bear all cost arising in correcting these deficiencies.
6. Verify size and ratings of motors and other electrically operated devices supplied by others.

7. Check with Engineer before installation of Work for outlets not specified as to location or for Work that interferes with other trades.

1.13 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Use all means necessary to protect electrical system materials before, during and after installation and to protect the installed Work and materials of all other trades.

B. In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Engineer and at no additional cost to the Owner. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the Engineer, at the cost and expense of the Contractor, or shall be replaced by the Contractor at his own expense.

C. Protect the Work of other trades. Restore any damage caused to other trades to the condition existing prior to damage at no additional cost to the Owner.

D. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, the manufacture shall be required to ship his material in sections sized to permit passing through such restricted areas in the building.

1.14 WORK PERFORMANCE

A. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required Work, the following requirements are mandatory:

1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.

2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.

3. Before initiating any Work, a job specific Work plan must be developed by the Contractor and the Owner. The Work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, and safety equipment to be used and exit pathways.

4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Owner.
1.15 DEFINITIONS

A. As used in this Specification, “provide” means “furnish and install”, “furnish” means “to purchase and deliver to the Project Site complete with every necessary appurtenance and support and to store in a secure area in accordance with manufacturer’s instructions”, and “install” means “to unload at the delivery point at the Site or retrieve from storage, move to point of installation and perform every operation necessary to establish secure mounting and correct operation at the proper location in the Project”.

B. Finished Areas: In general, areas with carpet or tile floors, lay-in or fixed ceiling tile, special architectural ceiling treatment, or tiled, plastered, or paneled walls shall be considered finished areas.

C. Interior: For the purposes of this Specification, interior is any area within the boundaries of the foundation of any building within the superstructure or other structures not classified as a building.

1.16 TEMPORARY POWER

A. Furnish, install, maintain, and remove the temporary electrical power and lighting systems, including lamps, and pay for all labor, materials, and equipment required. All such temporary electrical work shall meet the requirements of the National Electrical Code, the local utility company, and OSHA.

B. Make all necessary arrangements with the local utility company as to where the temporary electric service can be obtained.

C. Secure and pay for all required permits and back charges for Work performed by others, and other expenses incidental to the installation of the temporary electric service.

1.17 POSTED OPERATING INSTRUCTIONS:

A. 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:

1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

3. Safety precautions.

4. The procedure in the event of equipment failure.
5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

B. 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.

1.18 MANUFACTURER’S NAMEPLATE

A. 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.

1.19 FIELD FABRICATED NAMEPLATES

A. 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 name of the equipment, function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, black with white letters. 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. All electrical equipment shall be labeled with the following:

1. Panel Name
2. Fed from “Panel Name” & “CKT #”
3. Amps
4. Volts
5. Phase

1.20 ARC FLASH LABEL

A. Provide arc flash labels for all electrical equipment with operating voltages greater than 50 volt per NEC 110.16.

1.21 WARNING SIGNS

A. Exterior warning and caution signs shall be weather resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gauge, galvanized steel backing, with colors, legend, and size appropriate to the location.
B. Interior warning and caution signs shall be aluminum signs with preprinted baked enamel finish and punched for fasteners. Colors, legend, and size appropriate to location.

1.22 WIRE AND CABLE MARKERS

A. Underground line marking tape shall be permanent, bright colored, continuous printed, metal backed, plastic tape compounded for direct burial service not less than 6 inches wide. Printed legend indicative of general type of underground line below.

B. Wire labels for wires smaller than No. 4. shall be vinyl or vinyl cloth, self-adhesive, wraparound, wire markers with preprinted numbers and letters. Wire sizes No. 4 and larger and multi conductor cables shall be marked with one-piece, nylon locking marker ties equal to Panduit PLM Series.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials and equipment shall be listed by UL unless it can be demonstrated that no UL standards exist for a specific item or class of equipment.

B. All other materials, not specifically described but required for a complete and operable electrical installation, shall be new, first quality of their respective kinds, Specification grade or better, and as selected by the Contractor subject to the acceptance by the Engineer.

C. All materials and equipment furnished and installed on this Project shall meet the most stringent efficiency standards of the local utility to qualify for the maximum rebate.

2.02 MATERIAL AND CONSTRUCTION REQUIREMENTS

A. Unless otherwise shown or specified, all enclosures, motors, wiring and other materials and all construction methods shall conform to the following:

1. Corrosive Atmospheres - All Work located in corrosive atmospheres, shall be of such construction that the corrosive agent cannot enter into and damage the electrical work. All materials in these areas shall be non-corrodible or finished with an inert coating. Stainless steel, or reinforced PVC electrical enclosures and PVC coated rigid conduit and fittings are required. In addition, provide gas tight seals in all conduits passing from or into corrosive areas (similar to Crouse Hinds Type EYS), to minimize migration of corrosive fumes to other building areas.

2. See Section 26 05 33, Raceways and Boxes for Electrical Systems for enclosure requirements.
2.03 INTERCHANGEABILITY

A. In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays and other items is essential. All similar items shall be of the same manufacturer, type, model and dimensions.

B. For ease of maintenance and parts replacement, to the maximum extent possible, use equipment of a single manufacturer.

C. Engineer reserves the right to reject any submittal which contains equipment from various manufacturers if suitable materials can be secured from fewer manufacturers and require source of materials be unified to maximum extent.

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 COORDINATION

A. Prior to all Work of this section, carefully inspect the installed Work of all other trades and verify that all such Work is complete to the point where this installation may properly commence.

B. Field verify all locations and dimensions to ensure that the equipment will be properly located, readily accessible, and installed in accordance with all pertinent codes and Regulations, the Contract Documents, and the referenced standards.

C. The Work shall be carefully laid out in advance, and where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary for the proper installation, this Work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.

D. In the event any discrepancies are discovered, immediately notify the Owner’s Representative in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 INSTALLATION

A. Install all equipment and fixtures in complete accordance with the manufacturer’s recommendations and all pertinent codes and Regulations.

B. Thoroughly inspect all items of equipment and any items dented, scratched, or otherwise damaged in any manner shall be replaced or repaired and painted to match original finish. All items so repaired and refinished shall be brought to the attention of the Engineer for inspection and acceptance.
C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete or supported from or on other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building and equipment which must be placed in service before further construction can take place.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

F. The final routing of raceways shall be determined by structural conditions, interferences with other trades and by terminal locations on apparatus. The Engineer reserves the right of a reasonable amount of shifting at no extra cost up until time of roughing in the Work.

G. Where circuits are shown as “home-runs” all necessary fittings and boxes shall be provided for a complete raceway installation.

H. In general, wiring and raceway systems for security alarm, fire alarm, telephone and intercommunications systems are not indicated on the Drawings but shall be furnished and installed under this section.

I. Each lighting and each receptacle circuit shall have its own neutral, dedicated to that circuit. A common neutral for more than one signal phase circuit is not allowed.

J. Surface mounted panel boxed, junction boxes, conduits, etc., shall be supported by spacers to provide a clearance between wall and equipment.

K. Upon completion of all installation, lamping, and testing, thoroughly inspect all exposed portions of the electrical installation and completely remove all exposed labels, soils, markings and foreign material.

3.03 MARKING AND LABELING

A. All panelboards, indoor transformers, cabinets, control panels and other specified equipment shall be labeled with engraved laminated plastic plates with engraved letters. Punch tapes with mastic backings are not acceptable.

B. All starters, disconnect switches and other specified equipment shall be marked with engraved laminated plastic plates and engraved letters. Where individual switches are circuit breakers in power or distribution panel boards do not have cardholders, they shall be marked with ½” high labels.
C. All empty conduits shall have labels tied to the pull string at each end of each empty conduit, marked as to identification of each end. Junction boxes with circuits provided for future use shall be labeled with appropriate circuit designation.

D. All panelboards directories shall be filled out with typewritten identification of each circuit.

### 3.04 WIRE AND CABLE MARKERS

A. Tag control circuit conductors at both ends and at junction box splices using wire and cable markers with identification numbers as designated on equipment wiring diagrams. Provide typed listing to identify conductors by number and use.

B. Identify spare conductors, individually, at both ends and at junction box splices with number between 1 and 999. Do not duplicate numbers.

C. Identify wire numbers on terminal block marking strips.

D. Provide permanent plastic name tag indicating load for each feeder for all junction boxes, handholes and manholes. Label all process motor wires to yard equipment in handholes and manholes.

### 3.05 TEST & SETTINGS

A. Provide the services of an independent Testing Agency to perform the specified tests outlined in their respective specification sections.

B. Provide necessary material, equipment, labor and technical supervision to perform and complete the Electrical Acceptance Tests as required.

C. Acceptance tests as herein specified are defined as those tests and inspections required to determine that the equipment involved is acceptable as delivered to the job Site, that the equipment may be energized for final operational tests and is in accordance with the Specifications.

D. Final acceptance of the equipment and/or workmanship will depend upon performance characteristics as determined by the subject tests, in addition to complete operation tests, on all electrical equipment to show that it will perform the functions for which it was designed.

E. If the test and inspection data submitted should indicate deficiencies in the operation of the electrical apparatus or in the manufacturer thereof, the Contractor shall promptly implement the necessary adjustments, corrections, modifications and/or replacements necessary to be made to meet the specified requirements.
F. Upon completion of the remedial Work, the Testing Agency shall repeat all of the tests on components previously found deficient on the first test or any additional test if they be required. It shall be the responsibility and obligation of the Contractor to have all remedial Work accomplished as may be required by second and/or additional tests.

3.06 CLEANING

A. When all Work is complete and has been tested and accepted by the Owner’s Representative, the Contractor shall clean all light fixtures, equipment, and exposed surfaces that have been directly affected by this Work. The Contractor, insofar as the Work is concerned, shall at all times keep the premises in a neat and orderly condition and at the completion of the Work shall properly clean up and remove from the Site any excess materials.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.08 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.09 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide labor, tools, equipment, and materials necessary to install wires, cables, and connectors in accordance with the Plans and in accordance with this section and applicable reference standards listed in Article 1.03.

2. Section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

B. Related Requirements

1. Section 26 05 00 common work results for electrical

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. National Fire Protection Association (NFPA) 70

2. National Electrical Code (NEC)

3. Underwriters Laboratories (UL)

   a. UL Standard 83 Thermoplastic Insulated Wires and Cables
   b. UL Standard 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
   c. UL Standard 854 Service Entrance Cable

4. National Electrical Manufacturers Association (NEMA)

   a. WC 5 Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
b. WC 7 Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

c. WC 8 Ethylene Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

5. Institute of Electrical and Electronic Engineers (IEEE) Compliance

a. Standard 82 Test Procedure for Impulse Voltage Tests on Insulated Conductors

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product data

1. Product data for electrical wires, cables, and connectors

2. Product data for Megger insulation testing instrument

3. Report sheets for Megger testing

C. Manufacturer Reports

1. Furnish manufacturer's product data, test reports, and materials certifications as required

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Deliver wire and cable properly packaged in factory fabricated type containers, or wound on NEMA specified type wire and cable reels.

C. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.
1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General

1. Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with Project's installation requirements, NEC and NEMA standards.

2. Provide color-coding for phase identification as specified herein.

3. Provide factory applied nylon or polyvinyl chloride (PVC) external jackets on wires and cables for pulls in raceways over 100 feet in length, for pulls in raceways with more than three equivalent 90 degree bends, for pulls in conduits underground or under slabs on grade, and where indicated.

B. Service & Distribution Wiring

1. 98 percent conductivity copper

2. 600 volt insulation, type XHHW

3. U.L. listed for underground use in wet locations at 75 degrees C

4. Use XHHW for #4 and larger and THHN/THWN or XHHW for #6 and smaller

C. Building Wiring

1. 98 percent conductivity copper

2. 600 volt insulation, type, THWN/THHN, or XHHW

3. Stranded conductor: 14 AWG and larger

4. Minimum branch circuit: 12 AWG

5. Minimum 10 AWG for 120-volt circuits more than 100 feet long

6. Minimum 10 AWG for 277-volt circuits more than 230 feet long
D. Control Wiring

1. Control wiring for digital/discrete signal wiring, shall be 600V, minimum 14 AWG, THHN/THWN, copper stranded, unless specifically indicated otherwise.

2. Instrument cable for analog signal wiring (4-20mA DC) shall be shielded, 2-conductor, 300 volt rated, minimum 18 AWG, Belden No. 8760, Alpha Wire, or approved equal. Provide 600 volt rated cable where cable occupies the same enclosure and/or raceway with voltages greater than 300 volt as specified below.

3. Single Shielded Pair Instrument Cable

   a. Tinned copper, XLPE insulated stranded conductors, 18 AWG minimum, twisted pair with overall shield, stranded tinned 18 AWG copper drain wire and overall PVC jacket. Rated for 600 volts minimum and conforming to UL 1581. Cables shall be rated for tray cable (TC) use where installed within a cable tray.

   1. Multi-paired Shielded Instrument Cable

      a. Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, twisted pairs with shield over each pair, stranded tinned No. 18 AWG copper drain wire, and overall PVC outer jacket. Rated for 600 volts minimum and conforming to UL 1581 or UL 13. Cables shall be rated for tray cable “TC” use where installed within a cable tray.

E. Variable Frequency Drive (VFD) Cable

1. VFD load-side power cable shall be shielded type specifically listed for use with Variable Frequency Drives.

2. VFD cable shall be UL listed with 600V black XLPE insulation.

3. Cables shall be stranded type with number and sizes of conductors as indicated on the Drawings.

4. VFD cable for cable sizes #2 and smaller shall be provided with three (3) stranded tinned-copper circuit conductors, one (1) full-sized insulated ground, overall duofoil circuit conductors, three (3) symmetrical bare copper grounds and two (2) 100% spiral copper tape shields.
6. Cable shall be equal to Belden Series 295XX, or Engineer approved equal.

F. Splices

1. No. 10 and smaller with 600-volt pressure type insulated connector of wire-nut type, or equal; soldered and crimped type not allowed. Ideal type wire nut Buchanan type B-Cap and Minnesota Mining (3M) type Scotchlok.

2. No. 8 and larger with solderless lugs or solderless connectors of lock-tite or similar type properly taped with plastic insulating tape, Minnesota Mining Co. #33, or equal, then two half-lap servings of friction tape, Manson, or equal.

3. Wire connector systems for use with underground conductors shall be UL listed specifically for such use.

4. Service entrance conductors shall be installed without splices. Electrical equipment feeders shall be spliced only where shown or specifically approved. Control and metering conductors shall be installed without splices.

5. All splices shall be made only by specific permission of the Engineer and then only in manholes or pull boxes and shall be sealed watertight with a heat-shrunk insulation.

6. Tighten electrical connectors and terminals in accordance with manufacturer’s published torque tightening values. Where manufacture’s torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

7. Use UL listed splice for all underground wires, ducts buried, in conduit and in ducts. Connectors and splices shall be waterproof.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 WIRE AND CABLE INSTALLATION

A. All wire and cables shall be installed in conduit of size and type indicated on the Drawings and Specifications.

B. Install electrical cables, wires, and connectors in compliance with NEC.
C. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

D. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips, which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

E. Conceal all cable in finished spaces.

F. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible.

G. Conductors shall be sized such that voltage drop does not exceed 3 percent for branch circuits or 5 percent for feeder/branch circuit combination.

H. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

I. All feeder and branch circuit wiring shall be color coded at all termination and splice locations. System neutrals shall be designated in addition to phase conductors. Equipment grounds shall be green.

J. The number of conductors shown on the Drawings is not necessarily the correct number required. As many conductors as are required in each case shall be installed. In general, grounding conductors are not scheduled.

K. In general, wiring for the following systems shall be installed in separate conduits. Do not mix categories in a single raceway.

1. 120 volt power wiring
2. 120 volt control wiring, including, digital input and output signals
3. 24 volt DC control wiring, including, digital input and output signals
4. 24 volt DC analog control wiring (4-20mA)
5. Communications wiring
6. Special & Emergency Systems
L. Conductors 600 volts and below shall be color coded in accordance with the following:

<table>
<thead>
<tr>
<th>CONDUCTOR</th>
<th>120 / 208 COLOR</th>
<th>480 / 277 COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>Phase B</td>
<td>Red</td>
<td>Orange</td>
</tr>
<tr>
<td>Phase C</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>White / Gray</td>
</tr>
<tr>
<td>Equipment Grounds</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. The Contractor shall test each electrical circuit after permanent cables are in place with terminators installed, but before cable or wire is connected to equipment or devices to demonstrate that each circuit is free from improper grounds and short circuits.

C. The Contractor shall Megger Test the insulation resistance between phases and from each phase to ground for each of the following feeder and motor branch circuits:

1. Secondary Service Entrance
2. Power Distribution Equipment
3. Generator and ATS
4. Transformers
5. Variable Frequency Drives
6. Motors

D. The Megger Testing shall be witnessed by the Engineer. The Engineer shall be notified at least 48 hours in advance of testing.

E. Measure the insulation resistance with a digital Megger insulation testing instrument in accordance with manufacturer’s recommendations. All test instruments are to be provided by the Contractor.

F. If any insulation resistance measures less than 50 megohms, the cable shall be considered faulty with the cable failing the insulation test. In moist environments, bag the ends of the cable to prevent a faulty Megger test.
G. Any cable which fails the insulation tests or which fails when tested under full load conditions shall be replaced with new cable for the full length and retested at no additional cost to Owner.

H. The below grade service or feeder splice shall be water immersion Megger tested in the presence of the Engineer. Each splice shall be immersed in a grounded water immersion bath for 24 continuous hours prior to and during the test. Criteria for failure shall be as described for cable above.

3.03 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Provide labor, tools, equipment, materials and appurtenances necessary to furnish and install grounding materials in accordance this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. National Electrical Code (NEC), as applicable to electrical grounding and bonding, Art. 250.

2. Underwriters Laboratories (UL)
   a. UL 467 Electrical Grounding and Bonding Equipment

3. Institute Of Electrical And Electronic Engineers (IEEE) IEEE 81 and 142
   b. 141-1993 IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
   c. 142-2007 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.
B. Product Data

1. Provide product data for all grounding equipment and appurtenances, including but not limited to; wires, connectors, lugs, clamps, ground rods, bonding jumpers and accessories.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. Provide each electrical grounding system with assembly of materials required for complete installation including wires/cables, connectors, lugs, clamps, ground rods, bonding jumpers and accessories.

B. Provide electrical grounding conductors for grounding connections matched to power supply wiring materials and sized according to NEC.

C. Provide electrical connectors, lugs, clamps, bonding jumpers and accessories as recommended by the respective manufacturer for the particular application, unless other indicated.

D. Ground Rods: Solid copper clad, 3/4-inch diameter by 10 feet long.

E. Insulated Conductors: Green in color.

F. Ground Bus. Bare annealed copper bars of rectangular cross section, ¼-inch x 3-inch x length as required, with 98 percent conductivity, rigidly attached to structure.

G. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2-inches wide, except as indicated.

H. Pressure Connectors: High conductivity plated units.

I. Bolted Clamps: Heavy-duty units listed for the application.
J. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GROUNDING & BONDING

A. Ground main service entrance ground bus or lug to neutral of incoming service, to enclosure, to building steel, to ground rods/grounding ring, to rebar in concrete footing, and to main cold water pipe. Install grounding bushings or service conduits. Use exothermic style ground connections to the ground rods and building steel.

B. Use of conduit system for ground conductor shall not be allowed.

C. Provide and install 600 volt insulated bonding conductors throughout the distribution system with connection to bonding (or grounding) terminal on each panel and panel board with connections to other equipment where specifically indicated and noted.

D. Bonding conductors shall be continuous where possible. Where splices are required, provide compression connectors of approved pattern. Insulate connectors to equivalent thickness of conductors.

E. Provide grounding system for grounded circuit conductors of dry type transformer secondaries in accordance with NEC. Use exothermic style ground connections to building steel. Enclose grounding conductors in schedule 40 PVC conduit.

F. Provide equipment grounding conductors in all conduits containing power, control, or instrumentation conductors on the load side of the service equipment or on the load side of a separately derived system.

G. Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except that larger sizes indicated or shown on the Contract Documents shall take precedence. Use of metallic conduit systems for equipment grounding as recognized by the NEC shall not be permitted under this specification.

H. Install grounding bushings on conduits at both primary and secondary entrances to transformers. Ground transformer enclosures to bushings.
I. Install bonding jumper for flexible metal conduit unless fittings are approved for grounding or otherwise comply with NEC.

1. Size jumper to match over-current device.

2. Green insulation.

3. Connect to grounding bushing at each end.

J. Ensure that entire electrical system is electrically continuous and permanently and effectively grounded, including all electrical equipment and motors.

1. Locate ground rods with a minimum of two rod length from each other and at least the same distance from any other grounding electrode. Connect ground conductors to ground rods by means of exothermic welds except at test wells and as otherwise indicated. Drive rods until tops are 24 inches below finished floor or final grade except as otherwise indicated.

K. Route grounding electrode conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

L. Ensure that grounding electrode conductor connections to interior piping, structural members, and the like are accessible for periodic inspection during the life of the structure.

3.02 BONDING FOR OTHER TRADES

A. Signal raceways, water piping, heating piping and metallic air ducts shall be bonded together and to the grounding conductor with No. 8 soft drawn bare solid conductors. Connections to pipes shall be made with cast clamps of like material as the pipes to which attached, to ducting terminated in a secure manner by best practical means, bonding across any flexible or insulated connections.

B. All bonding conductors shall be installed in a neat manner properly shaped for contour of surface involved and properly supported. At locations remote from the main service entrance panel boards, bond to the largest raceway nearby.
3.03 FIELD TESTING

A. Provide the services of an independent Testing Agency to perform the specified tests for the following systems:

1. Ground resistance. The Testing Company shall perform all testing in accordance with National Electrical Testing Association (NETA) standards and procedures. All testing results shall be submitted on NETA forms and the testing data shall be certified by the respective Agency. Test results shall indicate recommended action for a sub-par test results. Results shall list recommended test values that should be obtained for new installation.

A. Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the three-point fall of potential method in accordance with Section 9.03 of IEEE 81. Simple moisture addition is not acceptable.

B. Ground/resistance maximum values shall be as follows:

1. Equipment rated 500 kVA and less: 10 ohms.
2. Equipment rated 500 kVA to 1000 Kva: 5 ohms.
3. Equipment rated over 1000 kVA: 3 ohms.

C. Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY
   A. Section Includes
      1. Provide the labor, tools, equipment, and materials necessary to furnish and
         install raceways, boxes, and supporting devices in accordance with the
         Plans and applicable reference standards listed in Article 1.03.
   B. Types of products specified in this section include
      1. Conduit, Raceways & Fittings
      2. Supporting Devices
      3. Boxes and Fittings
   C. Related Requirements
      1. Section 26 05 00 Common Work Results For Electrical
      2. Section 26 05 43 Underground Ducts and Raceways for Electrical
         Systems

1.02 PRICE AND PAYMENT PROCEDURES
   A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES
   A. Reference Standards
      1. Underwriters Laboratories (UL)
      2. National Electrical Code (NEC)
      3. National Electrical Manufacturers Association (NEMA)

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination, sequencing, and scheduling: per Division 01 General
      Requirements.
1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Furnish manufacturer's product data, test reports, and material certifications as required.

C. Product data for cabinets and enclosures.

D. Shop Drawings for floor boxes and boxes, enclosures and cabinets that are to be shop fabricated (non-stock items)

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 CONDUIT, RACEWAYS & FITTINGS

A. Provide conduit with 3/4 inch diameter minimum, except where specifically shown smaller on the Drawings.

B. Conduit, connectors, and fittings shall be approved for the installation of electrical conductors.

C. Refer to Table 3.01A for approved conduit installation guidelines.

1. Electrical Metallic Tubing (EMT)
   
a. EMT shall be rigid metallic conduit of the thin wall type in straight lengths, elbows, or bends and must conform to NEMA C80.3 and the requirements of UL 797.
   
b. Couplings and connectors shall be steel compression fittings. Where EMT enters outlet boxes, cabinets, or other enclosures, connectors must be the insulated-throat type, with a locknut. Fittings must meet the requirements of NEMA FB 1.

2. Rigid Galvanized Steel Conduit
a. Rigid steel conduit (RGS), including couplings, elbows, bends, and nipples, shall conform to the requirements of UL 6 and NEMA C80.1. Steel fittings shall be galvanized by the hot-dip process.

b. Fittings for rigid steel conduit shall be threaded and shall conform to NEMA FB 1.

c. Gaskets shall be solid for fittings sized 1-1/2 inches and less. Conduit fittings with blank covers shall have gaskets except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

d. Covers shall have captive screws and be accessible after the Work has been completed.

3. Rigid Aluminum Conduit

a. RAC, including couplings, elbows, bends, and nipples, shall conform to the requirements of UL 6 and ANSI C80.5.

b. Fittings for rigid aluminum conduit shall be threaded and shall conform to NEMA FB 1. Fittings shall be galvanized by the hot dip process, unless manufacturer dictates aluminum for specific application.

c. Gaskets shall be solid for fittings sized 1-1/2 inches and less. Conduit fittings with blank covers shall have gaskets except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

d. Covers shall have captive screws and be accessible after Work has been completed.

4. PVC Coated Rigid Metal Conduit

a. Rigid galvanized metal conduit coated with 40 mils thick polyvinylchloride coating.

b. Fittings, elbows, supporting devices and accessories shall include factory applied 20 mils thick polyvinylchloride coating and be manufactured by the same as that of the conduit.

c. Use tools as recommended by the manufacturer so as not to damage PVC coating. Where coating is damaged, touch-up with PVC paint in the field after installation.

5. Rigid Plastic Conduit

a. PVC Schedule 40: Conduit shall be made of polyvinyl chloride compound that shall be homogeneous plastic material free from cracks, holes or foreign inclusions. Conduit shall be rated for use with 90 degree C conductors, UL Listed. Use solvent cement to
join conduits as manufactured the same as the conduit manufacturer.

b. PVC Schedule 80: Heavy wall PVC conduit that shall be made of polyvinyl chloride compound that shall be homogeneous plastic material free from cracks, holes or foreign inclusions. Conduit shall be rated for use with 90 degree C conductors, UL Listed. Use solvent cement to join conduits as manufactured the same as the conduit manufacturer.

6. Flexible Metallic Conduit

a. Flexible metallic (FM) conduit shall meet the requirements of UL1.

b. Liquid tight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

c. Fittings for flexible metallic conduit shall meet the requirements of UL 514B, Type I box connector, electrical, Type III coupling, electrical conduit, flexible steel, or Type IV adapter, electrical conduit.

7. Wireways

a. Wireways and auxiliary gutters for use in exposed, dry locations shall be a prefabricated channel-shaped sheet metal trough with hinged or removable covers, associated fittings, and supports for housing, and protecting electrical wires and cables in accordance with UL 870.

b. Straight sections of trough, elbows, tees, crosses, closing plates, connectors, and hanging brackets shall be constructed from sheet steel of commercial quality not less than 16-gage. Sheet metal component parts shall be cleaned, phosphatized, and coated with a corrosion-resistant gray paint.

c. Straight sections of wireways and auxiliary gutters shall be solid or have knockouts as indicated in both sides and bottom, 3 inches on center.

d. Straight sections shall be not more than 5-feet long, with covers held closed with screws.

8. Conduit Seals

a. Provide factory fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Provide a cast in place water stop wall sleeve with a mechanical pipe seal between the conduit
and the sleeve. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

b. Provide E.Y.S. seal fittings with appropriate potting material where conduits enter or leave a Class 1, Division 1 or 2 environments or a Class 2, Division 1 or 2 environment, and chemical rooms.

2.02 SUPPORTING DEVICES

A. Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot dip galvanized unless material is inherently corrosion resistant.

B. Refer to Table 2.02A for approved supporting device installation guidelines.

1. Conduit Supports

   a. Single run hangers: Galvanized steel conduit straps or clamps, or cast metal beam clamps. Perforated straps and spring steel clips and clamps will not be permitted.

   b. Group run hangers: Minimum 12-gauge galvanized performed U-channel rack with conduit fittings; 25 percent spare capacity

   c. Hanger rods: Threaded steel, 3/8-inch diameter, or as identified on the Drawings

   d. Vertical run supports: Minimum 12-gauge galvanized performed U-channel struts with conduit fittings

2. Equipment and Lighting Supports

   a. 12-gauge galvanized performed U-channel struts with fixture and conduit fittings, as applicable, unless indicated otherwise on the Drawings.

3. Corrosive Area Supports

   a. Clamp Hangers, Pipe Straps, and Clamp Back Spacers for use with PVC-coated rigid metal conduit shall have 40 mil gray PVC exterior coating.

   b. Clamp Hangers, Pipe Straps, etc. for use with PVC nonmetallic conduit shall be of nonmetallic PVC material.

   c. Hanger Rods: 20 mil gray PVC exterior coated rod with threaded ends only 3/8 inch and 1/2 inch sizes as required.

   d. Strut Support: 20 mil gray PVC exterior coating strut. Standard channel, slotted channel, and back to back channel are acceptable.
e. Provide stainless steel supports and accessories in lieu of PVC coated supports when indicated in Table 2.02A below.

**TABLE 2.02A – Supporting Devices**

<table>
<thead>
<tr>
<th>Location/Equipment</th>
<th>Acceptable Support Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Building Electrical Area</td>
<td>Galvanized Steel U-Channel</td>
</tr>
<tr>
<td>Control Building Generator Room</td>
<td>Galvanized Steel U-Channel</td>
</tr>
<tr>
<td>Exterior</td>
<td>Galvanized Steel U-Channel</td>
</tr>
<tr>
<td>Pump Station Wetwells</td>
<td>PVC Coated Strut</td>
</tr>
<tr>
<td>Pump Station Drywells/Vaults</td>
<td>PVC Coated Strut</td>
</tr>
</tbody>
</table>

### 2.03 BOXES AND FITTINGS

A. Boxes must have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70 and UL 514A.

B. In general, boxes that are exposed to weather, process areas, normally wet locations, and locations exposed in mechanical spaces shall be cast-metal. Boxes in all other finished areas shall be sheet metal. Boxes installed in corrosive areas, such as the chemical feed room, shall be nonmetallic.

C. Refer to Table 2.03A for approved enclosure types.

1. Sheet Metal Outlet Boxes
   a. Sheet Metal Outlet Boxes: Standard type galvanized steel, minimum four inch square or octagon by 1-1/2 inch deep.
   b. Luminaire and Equipment Supporting boxes: Rated for weight of equipment supported; include 2 inch male fixture studs where required.
   c. Single Wall Type: Minimum size, four inch square by 1-1/2 inch or 2-1/8 inch deep, except as noted. Provide dry wall device covers raised 3/4 inch minimum to insure flush finish mounting.
   d. Ganged Wall Type: Minimum depth three inches except as noted, ganged as required under common plate to contain devices shown. On 277-volt circuits, ganged boxes for switches shall contain only one circuit or equip box with permanent barriers per NEC Art 404-8.

2. Cast Outlet Boxes
   a. Type FS shallow and type FD deep, cast ferroalloy
   b. Provide number of threaded hubs as required.
c. Use in all exterior, damp and locations exposed in mechanical spaces.

d. Provide gasketed cover and accessories by box manufacturer for complete weatherproofing. Provide correct box to accept weatherproof covers as specified.

3. Sheet Metal Pull & Junction Boxes

a. Sheet metal boxes shall be standard type galvanized steel and must conform to UL 50.

b. Box dimensions shall be minimum four inch square or octagon by 2/1/2 inch deep.

c. Sizes up to 12 by 12 by 6 inches: Provide screw-type or hinged covers.

d. Sizes greater than 12 by 12 by 6 inches: Provide hinged covers.

e. Boxes shall be sized to accommodate all incoming raceways.

4. Nonmetallic Outlet, Device, and Wiring Boxes

a. Conform to NEMA OS 2, Nonmetallic Outlet Boxes, Device Boxes, Covers, and box Supports, and UL 514C, Nonmetallic Outlet Boxes, Flush Device Boxes and Covers. Boxes shall be molded polyvinyl chloride (PVC), or fiberglass units of type, shape, size, and depth to suit location and application.

b. Boxes shall be equipped with threaded screw holes for device and cover plate mounting. Each box shall have a molded cover of matching material suitable for the application and location installed.
TABLE 2.03A – Electrical Enclosure Types

<table>
<thead>
<tr>
<th>Location/Equipment</th>
<th>Acceptable Enclosure Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Building Electrical Area</td>
<td>NEMA 1G</td>
</tr>
<tr>
<td>Control Building Generator Room</td>
<td>NEMA 12</td>
</tr>
<tr>
<td>Exterior</td>
<td>NEMA 4X</td>
</tr>
<tr>
<td>Pump Station Wetwells</td>
<td>NEMA 7 (Explosion Proof) NEMA 4X for Intrinsically Safe Equipment</td>
</tr>
<tr>
<td>Pump Station Drywells/Vaults</td>
<td>NEMA 4X</td>
</tr>
</tbody>
</table>

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 CONDUIT

A. Uses Permitted

1. Use liquid tight flexible metal conduit for the final 24 inches of connections to motors or control items subject to movement or vibration.

2. Use RGS for all exterior aboveground installations unless otherwise noted.

3. Use PVC coated rigid steel conduit, or as scheduled below, for installation in corrosive areas, and other areas as identified on the Drawings.

4. Use Schedule 40 PVC conduit for exterior direct buried installations. Use Schedule 40 PVC conduit for exterior concrete encased installations. Use Schedule 80 PVC conduit for underground installations under driveways. The transition from underground and from concrete encasement to riser shall be PVC coated rigid steel conduit to a minimum of 12 inches above finished floor and/or finished grade elevation. All elbows shall be prefabricated Rigid Steel to prevent wire burn through. Reference specification 26 05 43 ‘Underground Ducts and Raceways for Electrical Systems’ for further requirements.

5. Install conduit seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal. Provide seals for the interior of conduits that penetrate exterior or water bearing walls, consisting of gland type sealing bushings or RTV closed cell silicone foam.

6. Refer to Table 3.01A below for approved conduit types.
TABLE 3.01A – Conduit Types

<table>
<thead>
<tr>
<th>Location/Equipment</th>
<th>Approved Conduit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Building Electrical Area</td>
<td>Electrical Metallic Tubing</td>
</tr>
<tr>
<td>Control Building Generator Room</td>
<td>Rigid Galvanized Steel</td>
</tr>
<tr>
<td>Exterior</td>
<td>Rigid Galvanized Steel</td>
</tr>
<tr>
<td>Pump Station Wetwells</td>
<td>Rigid Aluminum</td>
</tr>
<tr>
<td>Pump Station Drywells/Vaults</td>
<td>Rigid Aluminum</td>
</tr>
</tbody>
</table>

B. Power, lighting, control, emergency light and power, and special-service systems and all related components shall be installed in accordance with NFPA 70, and shall be enclosed in separate conduit or separate conduit systems as indicated on the Drawings and as specified herein.

C. Any run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain no more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting. Field bends shall be made in accordance with the manufacturer's recommendations, which normally require use of a one-size-larger bender than would be required for uncoated conduit. Installed conduit and fittings shall be free of dirt and trash and shall not be deformed or crushed. Empty conduit shall have a pull rope stalled.

D. Conduit shall be installed with a minimum of 3 inches of free air space separation from mechanical piping.

E. Conduit in finished areas shall be installed concealed. Conduit passing through masonry or concrete walls shall be installed in sleeves. Conduit shall be securely clamped and supported at least every 10 feet vertically and 8 feet horizontally. Galvanized pipe straps shall be fastened to structure with bolts, screws, and anchors. Wooden masonry plugs shall not be used.

F. Install exposed conduits, parallel or perpendicular to walls, ceilings, or structural members. Do not run through structural members. Avoid horizontal runs within partitions or sidewalls. Avoid ceiling inserts, lights, or ventilation ducts or outlets. Do not run conduits across pipe shafts or ventilation duct openings and keep conduits a minimum of 6 inches from parallel runs of flues, hot water pipes, or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

G. Do not run conduits exposed on the exterior surface of buildings. Conduits penetrating exterior walls below grade, at grade floors, or below grade floors shall be sealed to prevent moisture migration. The exterior of the conduit shall be sealed with a mechanical pipe seal. The interior conduit seal shall be a gland type seal.
sealing bushing or RTV closed cell silicone foam. Ensure that conduits do not retain water against these seals.

H. Raceways penetrating fire rated walls, floors, and partitions shall be sealed with a fire rated sealant.

I. All conduits shall be supported with materials specifically made for this purpose. Do not use wire hangers. Do not attach any parts of the raceway system to ventilation ducts. Conduit supports shall be attached to the building. Support conduits on each side of bends and on a spacing not to exceed the following: 6 feet for conduits smaller than 1 1/4 inches and 8 feet for conduits 1 1/4 inches and larger. Support riser conduits at each floor level with clamp hangers. All underground conduits shall be securely anchored to prevent movement during placement of concrete or backfill. Use precast separators and heavy gauge wire ties or other approved fasteners.

J. Provide E.Y.S. seal fittings with appropriate potting material where conduits enter or leave a Class 1, Division 1 or 2 environments or a Class 2, Division 1 or 2 environment, and chemical rooms.

K. Conduit connections to boxes and fittings shall be supported not more than 36 inches from the connection point. Conduit bends shall be supported not more than 36 inches from each change in direction. Conduit shall be installed in neat symmetrical lines parallel to the centerlines of the building construction and the building outline. Multiple runs shall be parallel and grouped whenever possible on common supports. Exposed ends of conduit without conductors shall be sealed with watertight caps or plugs.

L. Bonding wires shall be used in flexible conduit for all circuits. Flexible conduit shall not be considered a ground conductor.

M. Liquid tight flexible metallic conduits shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

N. Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit in a manner that will not impair the function of the equipment.

O. A polypropylene pull rope with a tensile strength not less than 130 pounds shall be installed in empty conduit.

P. Electrical conduit may be embedded in concrete according to the provisions of Article 6.3 of ACI 318 Building Code Requirements for Reinforced Concrete, provided the following conditions are met:

1. Outside diameter of conduit shall not exceed 1/3 of concrete thickness. Maximum conduit outside diameter shall not exceed 3 inches when embedded in slab.
2. Conduit shall not be placed closer than three diameters on center. Route conduit to minimize crossing of different conduit runs.

3. Conduit shall not be embedded in structural concrete slabs less than four inches thick.

4. A 1-1/2 inch minimum concrete cover shall be provided for conduits in structural concrete slabs.

Q. Installation of Underground Conduit

1. Minimum of 3/4 inch conduit in or under concrete slab on grade.

2. Where conduits are installed in concrete slabs, on the ground, underground, or exposed to the weather, make all joints liquid tight and gas tight.

3. Bury all underground conduit, except under concrete slabs placed on fill, to a depth of at least 30 inches below finished grade unless otherwise indicated on the Drawings.

4. Slope ducts to drain away from buildings into manholes and/or handholes. Adjust final slopes to coordinate with existing Site utilities.

5. Install on undisturbed soil where possible. Concrete encase conduits as shown on Drawings. Use pit run gravel and sand, placed 8-inch lifts and compacted for backfill.

4. Reference Specification 26 05 43 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS for further requirements.

R. Installation of Rigid Metal Conduit

1. Ends of conduit shall be cut square, reamed and threaded, and joints shall be brought butt-to-butt in the couplings. Joints shall be mechanically tight. Conduit shall be protected against damage and the entrance of water or foreign material during construction.

2. Ninety-degree bends of conduit with a diameter larger than 1 inch shall be made with factory-made elbows. Conduit elbows larger than 2 1/2 inches shall be long radius. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Changes in directions of runs shall be made with symmetrical bends or cast-metal fittings.

3. At connections to sheet metal enclosures and boxes, a sufficient number of threads shall project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be pulled up sufficiently tight to draw the bushing into firm electrical contact with the
Conduit shall be fastened to sheet metal boxes and cabinets with two locknuts where required by NFPA 70 where insulating bushings are used, where bushings cannot be brought into firm contact with the box, and where indicated.

4. Conduit joints shall be made with tapered threads set firmly. Each length of conduit cut in the field shall be reamed before installation. Where conduit is threaded in the field, each threaded end shall consist of at least five full threads. Corrosion-inhibitive compound (cold galvanizing paint) shall be used on all conduit threads or any locations where the original hot galvanized surface has been compromised.

5. Conduit stubbed-up through concrete floors for connections to free-standing equipment except motor-control centers, cubicles, and other such items of equipment shall be provided with a minimum of a 12 inch riser above the floor slab is of sufficient thickness; if not, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.01 SUPPORTING DEVICES

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installations.

C. Conform to manufacturer's recommendations for selection and installation of supports.

D. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

E. Support parallel runs of horizontal raceways together on trapeze type hangers.

F. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

G. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
H. Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

I. Install sleeves in concrete slabs and walls and all other fire rated floors and walls for raceways and cable installations. For sleeves through fire rated wall or floor construction, apply UL listed fire-stopping sealant in gaps between sleeves and enclosed conduits and cables.

3.02 BOXES AND FITTINGS

A. Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right angle bends shall have a pull box installed at a convenient intermediate location.

B. Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

C. Bonding jumpers shall be used around concentric or eccentric knockouts.

D. Installation of Outlet Boxes

1. Use nonmetallic boxes in corrosive areas such as chemical feed area and as designated on the Plans.

2. Use explosion proof boxes in Hazardous areas as identified on the Drawings.

3. Use cast metal boxes in all other locations. Each box with associated covers and fittings shall have a NEMA rating for each location installed.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install underground duct banks, manholes and handholes including all necessary excavation, backfill and surface restoration.

B. Provide underground conduit duct banks with manholes and pullboxes for power, and lighting circuits as shown on the Drawings.

C. Coordination: Duct bank routing when shown on the Drawings is diagrammatic. Coordinate installation with piping and other underground systems and structures and locate clear of interferences. Coordinate manhole and handhole installation with piping, sheet piling and other underground systems and structures and locate clear of interferences.

D. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 33 Raceways And Boxes For Electrical Systems
3. Section 26 05 19 Low-Voltage Electrical Power Conductors And Cables
4. Section 26 05 26 Grounding And Bonding For Electrical Systems
5. Section 26 21 00 Low-Voltage Electrical Service Entrance

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. National Electrical Manufacturers Association (NEMA)
2. The American National Standards Institute (ANSI)
3. The Institute of Electrical and Electronic Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. National Electrical Code (NEC)
7. ANSI A14.3, Safety Requirements for Fixed Ladders
8. OSHA
9. ASTM International (ASTM)
   a. ASTM A 48, Gray Iron Castings
   b. ASTM D756, Procedure E: Accelerated Service Exposure
   c. ASTM G53: Recommended Practice for Operating Light and Water Exposure on Nonmetallic Materials (with a U.V.A. 340 bulb)
   d. ASTM D570, Section 5, 6.1, 6.5: Water Absorption
   e. ASTM D790: Flexural Properties
   f. ASTM D635: Flammability Test

B. Definitions
1. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, used underground, embedded in earth or concrete.
2. Duct bank: 2 or more conduits or other raceway installed underground in the same trench or concrete envelope.
3. Handhole: An underground junction box in a duct or duct bank with cover accessible from grade.
4. Manhole: an underground utility structure, large enough for a person to enter, with facilities for installing and maintaining cables. Where required manholes shall comply with the Utility Companies requirements.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
A. Submit in accordance with Division 01 General Requirements.
B. Shop Drawings

1. Layouts showing the proposed routing of duct banks and the locations of manholes, handholes and areas of reinforcement

2. Profiles of duct banks showing crossings with piping and other underground systems

3. Typical cross sections

4. Installation procedures

5. Manufacturer's technical information for manholes, handholes and accessories proposed for use

6. Drawings showing interior and exterior manhole and handhole dimensions and details of openings, jointing, inserts, reinforcing, size and locations of openings, and accessory locations

7. Certificate of concrete and steel used in underground pre-cast concrete utility structures, according to ASTM C858

8. Product Data for nonmetallic conduit and manhole accessories

C. Record Drawings

1. Layouts showing the actual routing of duct banks including the dimensions and depth of the top of duct bank below grade. Record Drawings for duct banks should also include cross sections of the duct bank indicating the circuit, use, conduit size, orientation and number of conduits.

2. Locations of manholes, handholes, and areas of reinforcement

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.
PART 2 – PRODUCTS

2.01 DUCT BANK CONDUIT

A. Duct: Schedule 40 and Schedule 80 PVC conduit and fittings in accordance with Division 26, Section Raceways and Boxes for Electrical Systems.

B. Rigid Steel Conduit: Rigid steel conduit and fittings in accordance with Division 26, Section Raceways and Boxes for Electrical Systems.

2.02 HANDHOLES

A. The pull/splice box underground enclosures shall be constructed of polymer concrete consisting of sand and aggregate bound together with a polymer resin. Internal reinforcement may be provided by means of steel, fiberglass, or a combination of the two. Handholes for installation in roadways shall concrete reinforced H20 traffic rated.

B. Enclosure

1. The enclosure must be manufactured with an open or closed bottom and a removable cover. The enclosures shall be green or concrete gray in color.

2. The enclosures shall be designed to be installed flush to grade with the cover fitting flush to the box.

3. The enclosures shall be suitable for installation in either direct or buried native soil, embedded in concrete, or embedded in asphalt surfacing. (A concrete collar is required for installation in asphalt).

4. The enclosures shall be of a stackable design for greater installation flexibility.

5. All covers are to be equipped with a minimum of two stainless steel lockdown mechanisms. All covers shall have a logo recessed into the cover and it shall read ELECTRIC.

6. All enclosure covers will have some type of recessed access point to allow removal of the cover with a hook. The access points will be placed in such a location to allow for the greatest amount of leverage and safety possible.

7. Enclosures shall be designed and suitable for installation and use through a temperature range of minus 40°C (minus 40°F) to 60°C (140°F).

8. A certified copy of all test reports must be signed and stamped by a registered professional Engineer and submitted prior to shipment of products.
C. Material Requirements

1. Permanent deflection of any surface shall not exceed 10 percent of the maximum allowable static design load deflection.

2. The covers shall be skid resistant and have a maximum coefficient of friction of 0.50 on the top surface of the cover. Coatings will not be allowed.

3. Any point on the covers must be able to withstand a 70 foot-pound impact administered with a 12-pound weight having a “C” tup (ASTM D-2444) without puncturing or splitting. The test shall be performed with the cover resting on a flat, rigid surface such as concrete or a 1 steel plate.

4. Covers shall have molded lettering, ELECTRIC or COMM as applicable.

5. Fastening devices used to secure the cover to the box shall be capable of withstanding a minimum torque of 15 foot-pounds and minimum straight pullout strength of 750 pounds.

6. The material is tested according to the requirements of ASTM D543, Section 7, Procedure 1, for chemical resistance. The manufacturer is responsible for proof of compliance with the latest version of the ASTM standards.

7. Comply with the following acceptance standards.
   a. ASTM D756
   b. ASTM G53
   c. ASTM D570
   d. ASTM D790
   e. ASTM D635

D. Acceptable level of quality for handholes: equivalent to Strongwell Quazite, or approved equal.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 GENERAL

A. Concrete shall be measured, mixed and placed, and compacted as required in Division 03.

B. Provide not less than 3 inches of concrete between the outside of a duct and the earth. Provide not less than 2 inches of concrete between adjacent ducts. Refer to Drawings for spacing requirements. Provide side forms for each duct bank.

C. All duct line concrete pours shall be continuous between manholes or handholes and between manholes or handholes and structures.

D. Where duct lines pass through concrete walls, concrete envelopes shall be extended through the finished flush with inside surfaces. Watertight construction joints of an approved type shall be provided.

E. Duct banks shall be reinforced when laid on backfill covering new pipelines, roads, parking lots or any are subject to vehicular traffic. Beneath these areas, install reinforcing bars as shown on the Drawings, extending 10 feet beyond area needing protection.

F. Duct lines shall be laid in trenches on mats of gravel not less than 6 inches thick and well graded.

G. All electrical duct banks shall be colored red for safety purposes.

H. Install raceways to drain away from buildings. Raceways between manholes or handholes shall drain toward the manholes or handholes. Raceway slopes shall not be less than 3 inches per 100 feet.

I. Make raceway entrances to buildings and vaults with hot dipped rigid galvanized steel conduit not less than 10 feet long. Conduits which are not concrete encased for runs below floor slabs in slab-on-grade construction shall be hot dipped rigid galvanized steel conduit. Conduits which are concrete encased for runs below floor slabs in slab-on-grade construction shall be encased under the slab to their respective equipment.

J. Raceway terminations at manholes shall be with end bells for PVC conduit and insulated throat grounding bushings with lay-in type lugs for metal conduit.
3.02 PROJECT CONDITIONS AND COORDINATION

A. Coordination with other Underground Utilities
   1. Locate all existing underground utilities through the use of an underground utility piping location Services Company. Locate the existing underground utilities and piping before any excavation is to begin.
   2. Coordinate conduit routing, duct bank and manholes with other new and existing underground utilities. Revise locations and elevations as required to suit field conditions and ensure that conduits, duct runs, manholes, and handholes do not interfere with existing and new underground utilities and piping.

3.03 INSTALLATION

A. Provide excavation and backfilling required for ductbank manhole and handhole installation.

B. Make duct bank installations and penetrations through foundation walls watertight.

C. Assemble duct banks using non-magnetic saddles, spacers, and separators. Position separators to provide 3-inch minimum separation between the outer surfaces of the ducts.

D. Firmly fix ducts in place during pouring of concrete. Carefully spade and vibrate the concrete to insure filling of all spaces between ducts.

E. Make bends with sweeps of not less than 48-inch radius or 5 degree angle couplings.

F. Make a transition from non-metallic to PVC coated rigid steel conduit where duct banks enter structures or turn upward for continuation above grade. Terminate the ducts in insulated grounding bushings. Continue ducts inside buildings with steel, metallic conduit.

G. Where ducts enter manholes and handholes, terminate the ducts in suitable end bells.

H. Provide expansion/deflection fittings in accordance with the requirements specified in Division 26, Section Raceways and Boxes for Electrical Systems.

I. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.
J. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3 inches per 100 feet.

K. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately 1/4 inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand or gravel have been left in the duct.

L. Install a bare stranded copper duct bank ground cable in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground cable to building and station ground grid or to equipment ground buses. In addition, connect ground cable to steel conduit extensions of the underground duct system. Provide ground clamp and bonding of each steel conduit extension, where necessary to maintain continuity of the ground system. Terminate ground conductor at last manhole or handhole for outlying structures.

M. Install a warning ribbon approximately 12 inches below finished grade over all underground duct banks. The identifying ribbon shall be a PVC tape, 3 inches wide, yellow color, permanently imprinted with CAUTION BURIED ELECTRIC LINE BELOW in black letters.

N. Plug and seal all empty spare ducts entering buildings and structures. Seal all ducts in use entering buildings and structures. Seal shall be watertight, O-Z/Gedney Type Dux Duct Sealing Compound or equal.


P. Install handholes where shown on Drawings. Verify final locations in field.

Q. Complete installation of handholes so that structures are watertight.

R. Conduits shall extend 3 inches above concrete slab surface, unless otherwise indicated. Conduits shall be bushed to protect cables and provide means for grounding.
S. Duct Bank Conduit Spacers: Non-metallic, snap together intermediate and bottom pieces, sized for conduit diameter and code spacing. Carlon Span-Loc or approved equal. Separators shall be compatible with the conduit utilized. The joints of the conduits shall be staggered by rows and layers to provide a duct line having the maximum strength. During construction, partially completed duct lines, shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduits plugs. As each section of a duct line is completed, a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit, shall be drawn through each conduit, after which a brush having the diameter of the duct, and having stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand and/or gravel; conduit plugs shall then be immediately installed. Provide a plastic pull rope, having a minimum of 3 additional feet at each end, in all spare ducts.

3.04 DUCT BANK INSTALLATION

A. All bends shall have a radius greater than 36 inches or 12 times conduit inside diameter whichever is greater.

B. Install duct with minimum slope of 4 inches per 100 feet. Slope duct away from building entrances.

C. Install no more than equivalent of three 90-degree bends between pull points.

D. Provide suitable fittings to accommodate expansion and deflection where required.

E. Use suitable separators and chairs installed not greater than 4 feet on centers. Conduit separation shall be per code, and not less than 3 inches.

F. Securely anchor duct to prevent movement during concrete placement. Use re-bar holders at spacers and secure with No. 4 re-bar driven into the earth at a minimum of 1 foot.

G. Connect to manhole wall using No. 6 re-bar dowels. Dowels shall be located at each corner, and 12 inches on center. Insert dowels minimum 3 inches into manhole and 3 feet into duct bank.

H. Tops of concrete-encased ducts shall be

1. Not less than 24 inches and not less than shown on the Drawings, below finished grade

2. Not less than 30 inches and not less than shown on the Drawings, below roads and other paved surfaces
I. Tops of Direct Burial Ducts and Conduits

1. Not less than 24 inches and not less than shown on the Drawings, below finished grade

2. Not less than 30 inches and not less than shown on the Drawings, below roads and other paved surfaces

3.05 PRE-CAST MANHOLE INSTALLATION

A. Install and seal pre-cast sections in accordance with manufacturer’s instructions.

B. Install manholes plumb.

C. Attach cable racks to inserts after manhole installation is complete.

D. Provide 12 inches minimum 3/4” crushed stone under manholes, and 12 inches gravel fill around manholes.

E. Conduit/Ductwork penetration shall be grouted and sealed. Penetration shall be watertight.

3.06 CABLE PULLING

A. The inspection, handling, storage, temperature conditioning prior to installation, bending and training limits, pulling limits, and calculation parameters for installation of all cables must comply with the manufacturer’s recommendations. For ease of installation and prevention of cable damage, the Contractor shall utilize quadrant blocks located properly along the cable run. Failure to comply with any of the above shall make this Contractor responsible for any cable failures that occur within the manufacturer’s Warranty Period.

B. Cable lubricant shall be soapstone, graphite, or talc for rubber or plastic jacketed cables.

C. Lubricants for assisting in the pulling or jacketed cables shall be those specifically recommended by the cable manufacturer.

D. Cable pulling tensions shall not exceed the maximum pulling tensions recommended by the cable manufacturer.

E. All medium voltage cables shall be individually fire/arc proofed.
3.07 CABLE TERMINATING

A. Terminations of insulated power and lighting cables shall be protected from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Terminations shall be made using materials and method as indicated or specified herein or as designed by the written instruction of the cable manufacturer and termination kit manufacturer.

3.08 GROUNDING

A. Duct banks shall be grounded with a bare stranded copper ground wire that is run within the duct bank and is bonded and grounded at both ends. When ductbank is used for wetwells, drywells or vaults with no metal connection a ground rod should be driven for connection to the copper ground wire.

B. Install a bare stranded copper duct bank ground cable in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground cable to building and station ground grid or to equipment ground buses. In addition, connect ground cable to steel conduit extensions of the underground duct system, and handholes. Provide ground clamp and bonding of each steel conduit extension, where necessary to maintain continuity of the ground system.

3.09 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.10 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.11 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 22 00

LOW VOLTAGE DRY-TYPE TRANSFORMERS
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide low-voltage dry-type distribution transformers in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 26 Grounding And Bonding For Electrical Systems

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. NFPA 70, Article 100
2. IEEE C2

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Product Data: Include data on features, components, ratings and performance for each type of transformer specified. Include dimensioned Plans, sections and elevation views. Show minimum clearances and installed devices and features.

C. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.
D. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements

E. Factory Test Reports: Certified copies of manufacturer's routine factory tests required by referenced standard

F. Sound-Level Test Reports: Certified copies of manufacturer's sound-level tests applicable to equipment for this Project

G. Field Test Reports: Indicate and interpret test results for tests specified in Part 3.

H. Maintenance Data: For transformers and components to include in maintenance manuals

I. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: Per Division 01 General Requirements for listing and labeling and as follows.

1. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in OSHA Regulation 1910.7

2. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.

3. The Terms "listed" and "labeled": As defined in NFPA 70, Article 100.

4. Subparagraph below is required by some Federal agencies.


6. Comply with NFPA 70.

1.07 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Cover transformer-ventilating openings to keep out dust. Store in a warm dry location with uniform temperature or apply temporary heat according to manufacturer's recommendations within the enclosure of each ventilated type transformer.
C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet or snow if handled in inclement weather.

D. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering transformers that may be incorporated into the Work include, but are not limited to, the following:

1. Square D; Schneider
2. Cutler-Hammer/Eaton Corp.
3. GE Electrical Distribution & Control
4. Hammond Co.
5. Siemens Energy & Automation, Inc.
6. Approved Equal

2.02 TRANSFORMERS, GENERAL

A. Description: Factory assembled and tested, air-cooled units of types specified, designed for 60 Hz service.

1. Cores: Grain-oriented, non-aging silicon steel
2. Coils: Copper - Continuous windings without splices, except for taps
3. Internal Coil Connections: Brazed or pressure type
4. Enclosure: Class complies with NEMA 250 for the environment in which installed
5. Low Sound Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91
2.03 GENERAL PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

A. Comply with NEMA ST 20 and list and label as complying with UL 1561

1. Cores: One leg per phase

2. Windings: One coil per phase in primary and secondary

3. Enclosure: Indoor, ventilated, drip-proof

4. Insulation Class: 180 or 220 degrees C class for transformers 15 kVA or smaller; 220 degrees C class for transformers larger than 15 kVA

5. Rated Temperature Rise: 150 degrees C maximum rise above 40 degrees C, for 220 degrees C class insulation; 115 degrees C maximum rise for 185 degrees C class insulation

6. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings; Taps, 3 through 15 kVA shall be two 5-percent taps below rated high voltage; Taps, 15 through 500 kVA shall be six 2.5-percent taps, 2 above and 4 below rated high voltage.

7. Transformers shall meet or exceed the energy efficiency requirements of US Department of Energy Candidate Standard Level 3 (CSL-3).
   b. Shall meet or exceed DOE 10CFR Part 430 CSL-3 efficiency requirement tested per NEMA TP-2: 15kVA: 97.6%, 30kVA: 98.1%, 45kVA: 98.3%, 75kVA: 98.6%, 112.5kVA: 98.8%, 150kVA: 98.9%, 225kVA: 98.9%, 300kVA: 99.0%.

2.04 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506

B. Ratings: Continuous duty - If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum

C. Description: Self-cooled, 2-windings
2.05 VIBRATION ISOLATOR

A. Vibration Isolator shall consist of rigid steel frames containing minimum 1-1/4 inch (32mm) thick neoprene elements at the top and steel spring. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. The spring element shall be seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc from side to side before contacting the cup bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30 degree capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc. or approved equal.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Comply with safety requirements of IEEE C2

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air

C. Identify transformers and install warning signs according to Division 26 Section Electrical Identification.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.02 GROUNDING

A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to supervise the field assembly and connection of components and the testing and adjusting of transformer components and accessories.
C. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing

D. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed Satisfactory Test label to tested component

E. Schedule tests and provide notification at least 7 days in advance of test commencement

F. Report: Submit a written report of observations and tests. Report defective materials and installation

G. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.

2. Inspect bolted electrical connections for tightness according to manufacturers’ published torque values or, if not available, those specified in UL 486A and UL 486B.

H. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 24 16

PANELBOARDS
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide the labor, tools, equipment, and materials necessary to install panelboards in accordance with this Section and applicable reference standards listed in Article 1.03.

2. This section includes power distribution panelboards, and lighting and power panelboards rated 600 volts or less.

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical

2. Section 26 05 33 Raceways And Boxes For Electrical Systems

3. Section 26 05 26 Grounding And Bonding For Electrical Systems

4. Section 26 43 00 Surge Protective Devices

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. NEMA PB 1 – Panelboards

2. NEMA PB 1.1 – Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

3. NEMA AB 1- Molded Case Circuit Breakers

4. UL 50 – Enclosures for Electrical Equipment

5. UL 67 – Panelboards

6. UL 489 – Molded – Case Circuit Breakers and Circuit Breaker Enclosures
8. CSA Standard C22.2 No. 5-M91 – Molded Case Circuit Breakers
12. NFPA 70 – National Electrical Code (NEC)
13. ASTM – American Society of Testing Materials

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

1. Product data for each type panelboard specified
2. Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

B. Furnish manufacturer's product data, test reports, and materials certifications as required.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.
PART 2 – PRODUCTS

2.01 MANUFACTURER

A. Acceptable panelboard manufacturers

1. Square D Company
2. General Electric Co.
3. Eaton/Cutler Hammer
4. Siemens
5. Or equal

2.02 POWER DISTRIBUTION PANELBOARDS

A. Panelboard Interior

1. Power Distribution Panelboards shall be rated 600 Vac or 250 Vdc maximum. Continuous main current ratings as indicated on associated schedules not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.

2. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated schedules not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII.

3. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
4. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 100 through 600 amperes shall be aluminum. Bussing rated 800 amperes and above shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel-mounting pan by fasteners.

5. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.

6. A solidly bonded equipment ground bar shall be provided.

7. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter-mounted neutral will not be acceptable.

8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label, and Short Circuit Current Rating shall be displayed on the interior or in a booklet format. Leveling provisions shall be provided for flush mounted applications.

B. Group Mounted Circuit Breakers through 1200A

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

3. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.

4. Line-side circuit breaker connections are to be jaw type.

5. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
C. Electronic Trip Molded Case Standard Function 80% Rated Circuit Breakers

1. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup, Ground Fault Delay, and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

2. Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule or drawings.

3. Local visual trip indication for overload, short circuit and ground fault trip occurrences.

4. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

5. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

D. Thermal Magnetic Molded Case Circuit Breakers

1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.

2. Circuit protective devices shall be molded case circuit breakers. Circuit breakers shall be standard interrupting. Ampere ratings shall be as shown on the drawings.

E. Enclosures

1. Type 1 Boxes

   a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel is not acceptable.

   b. Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.

   c. Maximum enclosure dimensions shall be 44” wide and 9.5” deep.
2. Type 1 Trim Fronts
   a. Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.
   b. Trim front shall be hinged 1-piece with door available in flush or surface mount as indicated on the panel schedules. Trim front door shall have rounded corners and edges free of burrs. A clear plastic directory cardholder shall be mounted on the inside of the door.
   c. Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.

3. Type 3R, 5 and 12:
   a. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel
   b. All doors shall be gasketed and be equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners. A clear plastic directory cardholder shall be mounted on the inside of door. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.
   c. Maximum enclosure dimensions shall not exceed 44” wide and 14.5” deep.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

A. Lighting and Appliance Panelboards shall be designed for three phase, four wire, solid neutral, 60-hertz service rated for 480/277 volt or 120/208V service as indicated. Where main circuit breakers are indicated on the Drawings, provide main circuit breaker type interiors. Back-fed branch circuit breakers shall not be utilized for main circuit breakers.

B. Panelboards shall be flush or surface mounted, etc., as indicated by panel schedule; code gauge galvanized steel boxes and enameled steel fronts sized for minimum 6” minimum side, top and bottom gutters, or greater as required by NEC.

C. Each panel shall have door in door trim with full length piano hinge to allow for access to wireways.
D. Each panel shall have door provided with cylinder lock and latch allowing for common key access to each panel. Each panel shall have fully typed out directory indicating outlets, fixtures, devices and locations served by the intended circuit. Panelboards for use as service disconnecting means shall additionally conform to UL 869.

E. Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto. Panelboards shall have fully capacity neutral bus, ground bus and bolt-on circuit breakers.

F. Circuit breakers shall be molded-case, thermal-magnetic, quick-make, quick-break, bolt-in type. Interrupting rating of circuit breakers shall be as indicated. Provide with suitable handle locks where indicated. Where interrupting rating is not indicated, panels for 120/208 volts service shall have breakers with 10,000 ampere RMS minimum interrupting rating at 240 volts, main circuit breakers where indicated shall have 25,000 ampere RMS minimum interrupting rating at 240 volts. Panels for 480/277 volt service shall have breakers with 14,000 ampere RMS minimum interrupting rating at 480 volts.

2.04 SPD DEVICES

A. Refer to Section 26 43 00 “Surge Protective Devices" for specific requirements.

B. IEEE C62.41, integrally mounted, plug-in style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

C. Minimum single-impulse current rating shall be as follows:
   1. Line to Neutral: 100,000A
   2. Line to Ground: 100,000A
   3. Neutral to Ground: 50,000A

D. Protection modes shall be as follows:
   1. Line to neutral
   2. Line to ground
   3. Neutral to ground

E. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55dB at 100kHz.
F. Accessories shall include the following.

1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.

2. Audible alarm activated on failure of any surge diversion module.

2.05 ENCLOSURES

A. Reference Specification 26 05 33 “Raceways and Boxes for Electrical Systems” for approved Enclosure Types.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PANELBOARDS

A. Install panelboards and accessory items in accordance with NEMA PB 1.1, General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less, and manufacturers' written installation instructions.

B. Mounting Heights: Top of trim shall be 6’ 2" above finished floor, except as indicated.

C. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Obtain approval before installing. Number branch circuit devices accordingly to correspond to circuit directory.

D. After substantial completion, conduct load balancing measurements and circuit changes. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

E. Make equipment grounding connections for panelboards as indicated.

F. Provide ground continuity to main electrical ground bus indicated.

G. Electrical Tests: Include the following items performed in accordance with manufacturer's instructions.

1. Ground resistance test on system and equipment ground connections.

2. Test main and subfeed overcurrent protective devices.
3.02 CLEANING
   A. Upon completion of installation, inspect all panelboards and transformers. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish.

3.03 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING
   A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 27 26
WIRING DEVICES
(FILED SUB-BID REQUIRED)

PART 1 - GENERAL

1.01 SUMMARY

A. Provide labor, tools, equipment, and materials necessary to furnish and install wiring devices in accordance with this Section and applicable reference standards listed in Article 1.03.

B. This section includes the following.
1. Flush Wiring Devices
2. Control Relays
3. Motor Control Relays/Contactors
4. Control Stations
5. Door Intrusion Switches
6. Thermostats
7. Stand Alone Smoke and Heat Detectors

C. Related Requirements
   a. Section 26 05 00 Common Work Results For Electrical
   b. Section 26 05 19 Low-Voltage Electrical Power Conductors And Cables
   c. Section 26 05 26 Grounding And Bonding For Electrical Systems
   d. Section 26 05 34 Raceways, Boxes & Supporting Devices

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.
1.03 REFERENCES

A. Reference Standards

1. National Electrical Code (NEC)
2. Underwriters Laboratories (UL)
3. National Electrical Manufacturers Association (NEMA)

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Furnish manufacture’s product data, test reports, and materials certifications in accordance with Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 - PRODUCTS

2.01 FLUSH WIRING DEVICES

A. Wall Switches

1. Wall Switches shall be specifications grade, toggle operated, quiet type alternating current (ac) switches, NEMA heavy duty class, rated at 20 ampere, 120/277 v. Provide matching two pole, 3-way or 4-way switches as indicated. Switches shall be white in color. Comply with UL 20 and NEMA Standards.

2. Where two or more switches are to be installed at the same location, they shall be mounted in one-piece ganged switch boxes, with appropriate gang cover plate.

3. Provide waterproof switches where indicated.
4. Explosion Proof Switches
   a. Explosion Proof/Dust-Ignition Proof Wall Switches shall be specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved.
   b. Switches shall be tumbler operated equal to Appleton EDS Series, Crouse Hinds, or approved equal.
   c. Switches shall be factory sealed specifically designed to a U.L. standard so that any arcing devices are within a chamber which contains any explosions.
   d. Switches shall be approved for installation without any additional external sealing fittings. Switches shall be specifically designed to accept conduit sizes indicated on the Contract Drawings.

B. Receptacles
   2. Convenience receptacles for interior use shall be specification grade, industrial heavy duty type, 20-ampere, 125-volt ac, 2-pole, 3-wire, back wiring, metal plaster ears, single, duplex (as indicated) grounded, conforming to NEMA FB 11, NEMA WD 1 and to the 5-20R configuration in NEMA WD 6. Receptacles shall be white in color. Provide waterproof in-use covers where indicated and required.
   3. Ground Fault Interrupter (GFI) Receptacles shall be specification grade. Provide 20 ampere, "feed through" type ground fault circuit interrupter, with integral heavy duty NEMA 5 20R duplex receptacles arranged to protect connected downstream receptacles on same circuit. Provide unit designed for installation in a 2 3/4 inch deep outlet box without adapter, grounding type, Class A, Group 1. Receptacles shall be white in color. Provide waterproof in-use covers where indicated and required.
   4. Locking receptacles shall conform to NEMA WD 6. One (1) plug shall be furnished with each locking receptacle.
   5. Receptacles shall meet the requirements for retention of plugs, overload, temperature, and assembly security in accordance with NEMA WD 1.
   6. Special purpose outlets: NEMA heavy duty class, grounding type with matching plug. Coordinate NEMA type with equipment manufacturer.
C. Device Plates

1. Wall plates for flush wall switches and receptacles shall be the appropriate type and size and shall match the wiring devices for which they are intended. Dimensions for openings in wall plates shall be in accordance with NEMA WD 1.

2. Process area: Plates in process areas for receptacles, telephone, etc., shall be galvanized steel, smooth rolled outer edge sized to fit box.

3. Device plates in general areas for receptacles shall be stainless steel.

4. Device Plates in finished spaces (office) shall be impact resistant plastic, white in color.

D. Weatherproof Device Plates

1. Provide weatherproof device plates where indicated and required.

2. Interior and Exterior Wet Locations: Device plates for interior and exterior wet locations shall be die-cast aluminum, gasket, with corrosion resistant screws to match plate cover finish. Provide weatherproof receptacles with vertical “in-use” covers for complete weatherproofing when plug is inserted.

3. Chemical Feed Room: Device plates for installation in the Chemical Feed Room shall be gasketed nonmetallic polyvinyl chloride (PVC), or fiberglass units, for complete weatherproofing and protection against corrosive chemicals. Provide receptacles with vertical “in-use” covers for complete weatherproofing when plug is inserted.

2.02 CONTROL RELAYS

A. Control Relays: Allen Bradley Bulletin 700-H Series, Square D or equal.

B. 120V coil as required or as indicated.

C. Number of poles as indicated or required.

D. Electrically Held, except as noted.

E. Enclosure shall be NEMA-1, except as noted.
2.03 MOTOR CONTROL RELAYS/CONTACTORS

A. Allen Bradley, Square D or equal.
B. 120V and 277V coils as required or as indicated
C. Number of poles as indicated or required.
D. Horsepower rated for connected motor.
E. Electrically Held, except as noted.
F. Enclosure shall be NEMA-1, except as noted.
G. 600V Rated.

2.04 CONTROL STATIONS

A. All control stations shall be industrial, heavy duty type, with oil-tight construction and clearly marked legend plates. Enclosures shall be provided based upon location in accordance with NEMA requirements and as required for the area classifications as indicated and NEMA rating to meet environmental conditions of installed location.

B. Enclosures shall be common or grouped mounted for devices in the same location. Devices shall include front mounted nameplates identifying function.

C. Subject to compliance with requirements, provide control stations by one of the following:
   1. Allen Bradley Company
   2. Appleton Electric Company
   3. Crouse-Hinds Company
   4. Approved equal

D. Selector Switches
   1. Selector Switches shall be non-illuminated, standard knob operated rated for use at 120VAC. The knob operator insert shall be white in color. Units shall be rotary type with round or oval handles and positioning device to securely hold switch in selected position. Where shown on the Drawings selector switches shall be key type.

3. Units shall be 30.5mm selector switches.

E. Pushbuttons

4. Switches shall be non-illuminated momentary or maintained type rated for use at 120 VAC. Switches shall green in color for "START" pushbuttons, and shall be red in color for "STOP" pushbuttons.

5. Provide compatible nameplate for each pushbutton identifying intended functions (I.E. "STOP", "START", ETC.).

6. Emergency stop operators shall be mushroom style, 2-position push-pull type, with number of contacts as indicated on the Contract Drawings. Stations shall be provided with push-pull padlocking attachment and legend plate reading: "Push to Stop, Pull to Start."

7. Units shall be 30.5mm pushbuttons.

2.05 THERMOSTATS

A. Line-Voltage Thermostats: (Exhaust Fan Thermostat)

1. Electric thermostats shall be line voltage type, suitable for the application and location installed. Sensors shall be provided with a two-wire connection to the controller that is polarity and wire type insensitive. Provide with manual adjustment dials, which provide a maximum and minimum range of approximately -10-100F. Unit shall have form C dry contact for low temperature alarm monitoring via the facilities SCADA control panel. Electric thermostats shall be equal to Dayton, Model 2E815, or approved equal.

B. Analog Thermostats: (TT-0301)

1. Analog thermostats shall be of wall mount design with integral wall mounting bracket/mounting plate. The temperature transmitter shall have a temperature range of -40 to 150 degree C (-40 to 302 degree F). The transmitter shall have a 4-20mA (0-10vdc) output for monitoring via the facilities SCADA control panel. Unit power shall be 8-32vdc. Unit shall be equal to IFM Efector600, Model TN2531, or approved equal.
2.06 DOOR INTRUSION SWITCHES

A. Door intrusion switches shall be non-contact interlock position switches with a switching voltage of 120 VAC, 0.2A. Switch shall be UL listed and have a nominal break range of 1.2 inches, minimum lead lengths of 12”, conduit connection of ½” NPT, and a hermetically sealed N.O. contact configuration. Enclosure shall be Nylon 6/6 and NEMA rating of 4X. Intrusion switches shall have a load rating of 84W. Intrusion switch shall be as manufactured by GE, Allen Bradley or approved equal.

B. Overhead Door Switch

1. Overhead door switches shall be specifically listed for use with overhead doors with magnetic contact similar to GE Model 2202, or Engineer approved equal.

2. Floor-mount magnetic contact for overhead doors, cast aluminum housing, 3 in gap size, SPDT contacts, and shall include minimum 18” stainless steel armored cable.

C. Provide door intrusion switches suitable for use in I.S. (Intrinsically Safe) circuits when wired through certified intrinsically safe barriers. I.S. intrusion switches shall be provided in all classified locations as indicated on the Contract Drawings.

2.07 STAND ALONE SMOKE DETECTORS

A. Stand Alone Smoke Detectors shall be powered by 120vac with available battery backup. An LED power on indicator shall be provided for verification that the unit is active.

B. Unit shall be provided with test switch which shall electronically activate the chamber to simulate smoke and check for proper operation. Unit shall be provided with electronic horn with a level of 85 decibels at 10 feet. Unit shall meet the requirements of U.L Standard 217.

C. Unit shall be provided with form C dry-contact for alarming to the facilities SCADA control panel.

2.08 STAND-ALONE HEAT DETECTOR

A. Stand Alone Heat Detectors shall be powered by 120vac with available battery backup. An LED power on indicator shall be provided for verification that the unit is active.

B. Unit shall be provided with test switch which shall electronically activate the detector and check for proper operation. Unit shall be provided with electronic horn with a level of 85 decibels at 10 feet. Unit shall meet the requirements of U.L Standard 217.
C. Unit shall be provided with form C dry-contact for alarming to the facilities SCADA control panel.

2.09 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 - EXECUTION

3.01 WIRING DEVICES

A. Wall Switches and Receptacles

1. Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within 1/16-inch.

2. Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper.

B. Device Plates

1. Device plates and receptacle cover plates for receptacles and light switches shall be suitably labeled, identifying the circuit number and the panel name; for example: RP1-12.

2. Device plates shall be identified on the inside of the plate by circuit number and panelboard.

C. Control Stations

1. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

2. Securely fasten equipment to walls or other surfaces on which they are mounted. Provide independent galvanized steel supports where no wall or other surface exists.

3. Install in conformance with National Electrical Code with Massachusetts Amendments.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
3.03 STARTUP & COMMISSIONING
   A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Provide labor, tools, equipment, and materials necessary to furnish and install enclosed switches and circuit breakers in accordance with this Section and applicable reference standards listed in Article 1.03.

1. Service disconnecting means.
2. Feeder and branch-circuit protection.

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 26 Grounding And Bonding For Electrical Systems

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
3. Underwriters Laboratories (UL)

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

B. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each switch and circuit breaker.
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details.
      b. Current and voltage ratings.
      c. Short-circuit current rating.
      d. UL listing for series rating of installed devices.
      e. Features, characteristics, ratings, and factory settings of individual over-current protective devices and auxiliary components.
      f. Time-current curves, including selectable ranges for each type of circuit breaker.

D. Field Test Reports: Submit written test reports and include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Section 01 70 00 include the following:
   1. Routine maintenance requirements for components.
   2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA AB 1 and NEMA KS 1.

D. Comply with UL #98, Enclosed Switches and UL #508, Industrial Control Equipment.

E. Federal Specification W-S-865- Heavy Duty Switches

F. Comply with NFPA 70.

G. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing conditions: per Division 01 General Requirements.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

C. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C)

D. Altitude: Not exceeding 6600 feet (2000 m)
PART 2 – PRODUCTS

2.01 MANUFACTURERS
   A. Square D Co.
   B. Eaton Corp.; Cutler-Hammer Products
   C. General Electric Co.; Electrical Distribution & Control Division
   D. Or equal

2.02 ENCLOSED SWITCHES
   A. Enclosed, Non-fusible Switch: NEMA KS 1, heavy duty type with lockable handle.
   B. Rating: Voltage and number of poles as required for motor or equipment circuits being disconnected. Switches used for service entrance equipment shall bear a UL label and be rated for service entrance equipment.
   C. Enclosed, Fusible Switch, 800A and Smaller: NEMA KS 1, heavy duty type with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.
   D. Double Throw Safety Switches shall be unfused double throw with center OFF position, quick make, quick break mechanism, visible blades in the OFF position and safety handle. Rating, voltage and number of poles as required for the circuits being disconnected.

2.03 ENCLOSED CIRCUIT BREAKERS
   A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable instantaneous, magnetic trip setting for circuit-breaker frame sizes 150 Amp through 400 Amp.
   B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles. Lugs shall be mechanical style suitable for number, size, trip ratings, and material of conductors.
   C. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
D. Electronic Trip Unit Circuit Breakers (Frame sizes 400 Amp and larger): RMS sensing, interchangeable harmonic trip unit, LED trip indicators with the following field-adjustable settings:

1. Long-time pickup levels and adjustments (L)
2. Short-time pickup levels adjustments (S)
3. Instantaneous trip adjustments (I)
4. Ground fault pickup level, time delay, I2t response and adjustments (G)

E. The circuit breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. Provisions for padlocking the circuit breaker in the OFF position shall be provided. Enclosures shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and prevent turning the circuit breaker ON when the enclosure cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

2.04 DOUBLE THROW SAFETY SWITCHES

A. Unfused, double throw with center OFF position, quick make, quick break mechanism, visible blades in the OFF position and safety handle. Rating, voltage and number of poles as required for the circuits being disconnected.

2.05 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Reference Section 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS for approved enclosure types for each area of installation.

2.06 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard grey paint applied to factory-assembled and tested enclosures before shipping.
PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other structural surfaces on which they are mounted. Provide independent galvanized steel supports where no wall or other structural surface exists.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install in conformance with National Electrical Code.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26.

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

C. For double throw switches identify source of each service identify source of each service.

3.04 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
3.05 FIELD QUALITY CONTROL

A. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

B. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

C. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 29 13
ENCLOSED CONTROLLERS
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY
A. Section Includes
   1. Provide general-purpose controllers and motor starters rated 600 V and less that are supplied as enclosed units in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements
   1. Section 26 05 00 Common Work Results For Electrical
   2. Section 26 05 33 Raceways And Boxes For Electrical Systems
   3. Section 26 05 26 Grounding And Bonding For Electrical Systems

1.02 PRICE AND PAYMENT PROCEDURES
A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES
A. Reference Standards
   1. National Electrical Manufacturers Association (NEMA)
   2. Underwriters Laboratories (UL)

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

B. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each enclosed controller.
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. UL listing for series rating of over-current protective devices in combination controllers.
      e. Features, characteristics, ratings, and factory settings of individual over-current protective devices in combination controllers.
      f. Listing of the motor starters to be furnished with their location and equipment to be controlled and identified.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.
B. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


F. Comply with NEMA Standard ICS2 321 AC General Purpose Class A Controller for Squirrel Cage Induction Motors, 600 volts and less.

G. UL 508, Industrial Control Equipment.

H. Comply with NFPA 70.

I. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, including clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.
1.09 MAINTENANCE

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every five installed, but not less than one set of three of each type and rating.

2. Indicating Lights: Two of each type installed.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manual and Magnetic Enclosed Controllers

1. Square D Co

2. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.


4. General Electrical Distribution & Control.


6. Or equal

2.02 ENCLOSED MANUAL MOTOR STARTERS

A. Description: NEMA ICS 2, general purpose, Class A, with toggle action operated, horsepower rated with thermal and overload element.

B. Provide in enclosure suitable for use with the manual motor starter.

C. Enclosure cover shall include a white ON indicating light.

D. Where indicated on the Drawings manual motor starters rated 600 volt, 3 pole and 240 volt, 2 pole, 20 amp without overload protection shall be provided to be used as disconnects.

E. Enclosures: Flush- or surface-mounted cabinets as indicated or required to suite installation.

1. Reference Specification 26 05 33 “Raceways and Boxes for Electrical Systems” for approved enclosure types.
2.03 ENCLOSED MAGNETIC MOTOR STARTERS

A. Description: NEMA ICS 2, Class A, full voltage, across the line, non-reversing, magnetic coil operated, horsepower rated, NEMA sized, with thermal overload bimetallic protection, unless otherwise indicated. Starter shall consist of one contactor, one overload relay, and a magnetic only circuit breaker.

B. Control Circuit: 120 V; obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Include two primary fuses for 480-volt systems, one secondary fuse and the other secondary leg grounded. For other voltage systems include one secondary fuse and the other secondary leg grounded.

C. Combination Controller: Factory-assembled combination controller and disconnect switch.


2. Disconnecting means shall be provided with an external operating handle mounted in the flange of the enclosure which has a means to lock the handle in the off position. Mechanism shall prevent enclosure door from opening when handle is in the on position.

D. Overload Relay: Ambient-compensated melting alloy, bimetallic type, interchangeable heaters with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Manually reset from outside the enclosure by means of an insulated button with normally open auxiliary contact for remote alarm purposes and separate heater elements sized for the full load ampere and service factor of the actual motors furnished. They shall have a visible trip indicator, a reset mechanism that resets on the upstroke only and a manual weld check which checks the overload contacts for welding. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

E. Contactor contacts shall be silver alloy, double break, and shall be inspectable on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall be inspectable with standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.

F. Contactor coils shall be the encapsulated type, and shall be replaceable on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall be replaceable with standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.
G. Controls: Combination starters shall be provided with hand-off-auto selector switch, start push button, stop push button, red on indicating light (across coil) and green off indicating light. Operating controls, pilot and control devices shall be provided for each starter for proper operation. Pilot and control devices shall be mounted on the enclosure door. The auto position shall enable the motor to perform start/stop operations from remote dry contact from external control panel. Auxiliary contacts to remotely signal temperature control panel run and overload conditions. Provisions to accept remote dry contact from stop station for shutdown of the motor.

H. Enclosures: Flush- or surface-mounted cabinets as indicated or required to suite installation.

1. Reference Specification 26 05 33 “Raceways and Boxes for Electrical Systems” for approved enclosure types for each area of installation.

I. The short circuit withstand rating of the combination starter is to be 65K RMS amperes symmetrical.

2.04 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Hand-Off –Automatic three position selector switch.

E. Control Relays: Auxiliary and adjustable time-delay relays.

2.05 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard grey paint applied to factory-assembled and tested enclosed controllers before shipping.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.03 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks as required.

B. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Securely fasten equipment to walls or other surfaces on which they are mounted. Provide independent galvanized steel supports reasonably close to motor where no wall or other surface exists.

3.04 IDENTIFICATION

A. Identify enclosed controller components and control wiring according to Division 26 requirements.

3.05 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 requirements.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.06 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.

2. Certify compliance with test parameters.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.08 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.09 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
3.10 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

B. Verify that enclosed controllers are installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.11 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS (PROCESS)
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide labor, tools, equipment, and materials necessary to furnish and install variable frequency drives in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Provide field programming and testing of each VFD. Program each VFD based on actual motor sizes and ratings in the field.

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 26 Grounding And Bonding For Electrical Systems

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. National Electrical Code® (NEC®) with Massachusetts amendments.
2. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type.
3. UL 198E - Class R Fuses.
5. NEMA AB 1 - Molded Case Circuit Breakers.
6. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
7. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
8. NEMA KS 1 - Enclosed Switches.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Provide in accordance with Division 01 General Requirements.

B. Furnish manufacturer's product data, test reports, and materials certifications as required.

C. Submit the following in accordance with conditions of contract and Division 1 specification sections:

1. Product Data: Submit manufacturer's data and installation instructions.

2. Wiring Diagrams: Submit power and control wiring diagrams for connections to electrical power panels, feeders, and equipment. Differentiate between portions of wiring which are manufacturer installed and portions, which are field installed.

3. Motor Overloads: Submit for approval motor overload sizes for each new VFD furnished. Overload size shall be based on actual motor nameplate data and power factor correction size; where applicable. Include thermal overload compensation sizing information where motor(s) are operated at temperatures different than the motor controller.

D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications

1. Firms regularly engaged in manufacture of variable frequency drives of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years, or as indicated.

2. Variable Frequency Drives shall be provided by Rockwell Automation, or prior approved equal. Substitutions must be submitted in writing three (3) weeks prior to original bid date with supporting documentation demonstrating that the alternative manufacturer meets all aspects of the specification herein.
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES (VFD)
   A. Variable Frequency Drives shall be equal to Allen Bradley Powerflex 700 or 70, or approved equal.
   B. The VFD shall convert the input AC main power to an adjustable frequency and voltage as defined in the following sections. The VFD shall be UL Listed and labeled as a complete unit, and shall include all accessories and requirements as described in this section and as identified on the Drawings.
   C. Each drive shall have a rating in horsepower (HP) equal to or greater than the motor name plate horsepower and each drive shall have a continuous output current rating equal to or greater than the motor full load amperes (FLA).
   D. Input Power:
      1. The drive is available in two ranges and is self-adjustable to accept an input voltage range between; 380-500 V AC, three phase +/-10%, 525-690 V AC, three phase +/-10%.
      2. Displacement power factor 0.98, lagging, over the entire speed range. The efficiency of the drive is a minimum of 97.5% at full load and speed.
   E. Environment:
      1. Storage ambient temperature range: -40º C to 60º C (-40º to 140ºF).
      2. Operating ambient temperature range without derating: IP21 / Type 10º C to 40º C (0º to 104º F).
      3. The relative humidity range is 5% to 95% non-condensing.
      4. Operating elevation: up to 1000 Meters (3,300ft) without derating.
      5. Shock: 15G peak for 11ms duration
      6. Vibration: 2.0 mm (0.0787 inches) displacement, 1G peak, EN50178 / EN60068-2-6
F. Output Power

1. The output voltage is adjustable from 0 to rated motor voltage (400 V, 460 V, 575 V or 690 V). The output frequency range is adjustable from 0 to 320Hz. The inverter section will produce a pulse width modulated (PWM) waveform using latest generation IGBTs.

G. Motor and Application Data

1. The AC drives shall have the ability to operate variable or constant torque loads. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 60 Hz. The normal duty drive overload current shall be 100% continuous, 110% for 1 minute, and 150% for 3 seconds. The heavy duty drive overload current shall be 100% continuous, 150% for 1 minute, and 200% for 3 seconds.

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<th>Equipment</th>
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<th>Voltage</th>
<th>Application</th>
<th>Duty Type</th>
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<td>480</td>
<td>Constant Torque</td>
<td>Heavy</td>
</tr>
<tr>
<td>Submersible Pump P-0102</td>
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<td>Variable Torque</td>
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<td>50</td>
<td>480</td>
<td>Variable Torque</td>
<td>Normal</td>
</tr>
</tbody>
</table>

H. Hardware

1. The drive hardware employs the following power components.
   a. Diode or fully gated bridge on the input.
   b. AC line reactor on input for all ratings.
   c. Switching logic power supply operating from the DC bus.
   d. MOV protection available on Frame 9 only - phase to phase and phase to ground with ability to remove the phase to ground unit when applicable.
   e. Common Mode Capacitors available on all units. For use on ungrounded systems Frame 9 is orderable without and Frame 10 and higher removable by jumper.
   f. Gold plated plug-in connections on printed circuit boards.
   g. Microprocessor based inverter logic isolated from power circuits.
   h. Latest generation IGBT inverter section.
i. Customer Interface common for all horsepower ratings. LCD digital display standard with choices for programming keypad and operator keys options.

j. The Main Control Board is the same for all ratings to optimize spare parts stocking and exchange.

k. Common control connection for all ratings.

l. Optimized for 2kHz carrier frequency.

m. Device Peripheral Interface (DPI) for connection to common options.

n. Power LED viewable through the control box cover.

o. Status LEDs for communications status, including embedded DPI status, adapter health and communications network status, viewable at HIM mounting plate.

I. Control Logic

1. The drive is programmable or self-adjusting for the following:

a. Operating the drive with motor disconnected.

b. Controlled shut down, when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit and annunciation of the fault condition.

c. Adjustable PWM carrier frequency within a range of 1-6 kHz.

d. Selectable Sensorless Vector or V/Hz mode.

e. Suitable for use on both Normal Duty and Heavy Duty loads.

f. Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S-curve.

g. Multiple acceleration and deceleration rates.

h. All adjustments to be made with the door closed.

i. Adjustable output frequency up to 320Hz.
J. Terminal Blocks

1. Separate terminal blocks are provided for control and power wiring. Power terminal blocks are rated a minimum of 90 °C and marked for both inputs and outputs (L1, L2, L3 and U/T1, V/T2, W/T3).

K. Power Conditioning

1. The drive is designed to operate on an AC supply source that may contain line notching and up to 10% harmonic distortion. An input isolation transformer is not required for protection from normal line transients. If line conditions dictate the use of a transformer, the K factor should be 4.0 or less.

L. Operator Interface

1. Interface to the drive is provided via a removable Human Interface Module (HIM) with integral display. This unit is a 7 line by 21-character backlit LCD display with graphics capability. It is used to display drive operating conditions, fault / alarm indications and programming information with full text support in multiple languages, including but not limited to English, German, French, Italian, Spanish, Portuguese and Dutch.

2. The keypads for these include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), numeric keys for direct entry and an ALT (alternate function) key to allow some of the more common drive programming or operating functions to be accessed directly without knowledge of programming structure. These ALT functions include S.M.A.R.T. Start for fast and easy commissioning, View selection, Auto Manual operation, HIM removal under power, and device selection for programming.

M. Input/Output Capabilities (Control Interface)

1. Analog Inputs/Outputs

   a. Two differential, +/-10V (bi-polar) / 20mA analog inputs, 11 bit plus sign, 160V common mode noise rejection. Both inputs shall be fully user programmable for a variety of uses including frequency command, process loop inputs, and others. Inputs are programmable for function, scaling, offset, signal loss detect and square root.
b. Two single-ended +/-10V (bi-polar) / 20mA analog output, 11 bit plus sign. Both shall be fully user programmable to be proportional to one of 25 process parameters including output frequency, output current, encoder feedback, output power, and others. Programming is available to select either absolute or signed values of these parameters.

c. Input for motor protection thermistor (1.8k Ohm PTC). Drive will provide fault protection if temperature exceeds protection value.

2. Digital Inputs/Outputs

a. Six digital inputs 24Vdc or 120Vac as shown. Inputs shall be configurable as sink or source. All inputs are individually programmable for functions from a list of 57 that include Start(3-wire control, Run(2-wire control), Stop, External fault, Speed select, Jog, Process PU functions, Level-sensitive Run, and others. 24V inputs draw 10mA each and require a 20V minimum for "ON" state and a maximum for 5V "OFF" state. 115Vac inputs draw 5mA each and require a 100V minimum for "ON" state and a maximum of 30V for "OFF" state.

b. One input shall able to be set by a jumper to be a Hardware Enable. In this state, no microprocessor control is involved with disabling the drive outputs.

c. Three relay outputs, (1 form-C, 1 form-B, 1 form-A). Contact output ratings 240Vac/30Vdc, and require a 10mA minimum clearing current. Relays are programmable to 57 different conditions. All outputs shall have timers that control the amount of time before an output changes state. All outputs shall have an on-delay and off-delay timers relative to the function assigned to the input.

N. Features

1. Acceleration/Deceleration: settings provide separate adjustments to allow either setting to be adjusted from 0.0 seconds to 3276.7 seconds. A second set of remotely selectable Accel/Decel settings is accessible through digital inputs. Programming capability allows the user to produce acc/dec profiles with linear or "S-Curve" characteristics that provide changing accel/decel rates. S-Curve profiles are adjustable.
2. Adjustments: digital interface is used for all set-up, operation and adjustment settings. All adjustments are stored in nonvolatile memory (EEPROM). No potentiometer adjustments are used. The drive provides EEPROM memory for factory default values and user stored drive configurations.

3. Auto Economizer: feature automatically reduces the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage is reduced to minimize flux current in a lightly loaded motor thus reducing kW usage. If the load increases, the drive will automatically return to normal operation.

4. Auto / Manual Mode: HIM can utilize the ALT function key to transfer the drive from Automatic mode to Manual mode and back. When in Auto mode, the drive receives its frequency command from the programmed source. When in Manual mode, control of the frequency command is transferred to the HIM speed control keys (or potentiometer). The user has the choice of preloading the HIM with the current “auto” frequency reference before transferring control to allow for smooth transitions without speed “jumps”.

5. Auto Restart: The drive provides up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart. The automatic mode is not applicable to a ground fault, shorted output faults and other internal microprocessor faults. The time between restarts is adjustable from 0.5 seconds to 30.0 seconds.

6. Bus Regulation: DC Bus regulation is available to reduce the possibility of drive overvoltage trips due to regenerative conditions. The drive’s reaction to a Bus voltage increase is programmable to one of 4 options.

7. Communications Interface: The drive has the capability for either internally mounted or externally mounted communications interface cards. Internal cards use drive power and can operate at higher speeds. Externally mounted cards are separately powered and connected to the drive via a cable. The following should be available:
   a. Ethernet communications shall be available.

8. Control Mode: Programming provides the ability to select either Sensorless Vector or V / Hz mode. The sensorless vector mode uses motor nameplate data plus motor operating data such as IR drop, nominal flux current and flux up time to tune the motor / drive for optimum torque performance. The volts per hertz mode can be programmed straight line, preprogrammed fan curve or full custom patterns.
9. Current Limit: Programmable current limit from .1 amps to 150% of drive rated amps. Current limit is active for all drive states; accelerating, constant speed and decelerating. Both the source of the current limit value and the gain for responsiveness adjustment are programmable. The drive employs PI regulation with an adjustable gain for smooth transition in and out of current limit.

10. Fault Memory: last eight fault codes with respective times are stored in the fault buffer. In addition, information about the drive’s condition at the time of the last fault such as operating frequency, output current, dc bus voltage and 28 other status conditions are stored at the time of fault. Information is maintained in the event of a power loss. A power up marker is also provided at each power up time to aid in analyzing fault data. The last eight alarm codes are also stored, without time stamp for additional troubleshooting reference.

11. Flying Start: drive is capable of determining the speed and direction of a spinning motor and adjusts its output to "pick-up" the motor at the rotating speed.

12. Inertia Ride Through: drive can respond to a loss of AC input power by adjusting the output frequency to create a regenerative situation in the motor. This regenerated energy recaptures the mechanical energy and converts it to electrical energy to power the drive logic during the power outage. This allows the drive to retain control of the motor during the power outage. Performance is based on the amount of system inertia and the length of the outage. The bus voltage level required to trigger inertia ride through is adjustable. Inertia Ride Through can be enabled or disable via programming.

13. Memory Storage: drive stores the factory default settings in non-volatile memory (EEPROM) so that the user can return the drive to a known state. Additional memory storage locations in the drive, known as User Sets can also be stored in the drive's non-volatile memory. Three User Set locations are offered. The user can name the sets per the process application and recall the configuration to active drive memory as needed.

14. Motor Overload Protection: drive will provide Class 10 motor overload protection investigated by UL to comply with N.E.C. Article 430. Overload protection is speed sensitive and adjustable. To accommodate a variety of motors with different speed range capabilities, the frequency at which the overload begins to derate is programmable. A parameter is available to directly read the level of accumulated overload.
15. Process PI Control: internal process PI regulator has proportional and integral gain adjustments as well as error inversion and output clamping functions. The feedback can be configured for normal or square root functions. If the feedback indicates that the process is moving away from the setpoint, the regulator will adjust the drive output until the feedback equals the reference. Process control can be enabled or disabled with a hardwired input. Transitioning in and out of process control can be tuned for faster response by preloading the integrator. Protection is provided for a loss of feedback or reference signal. A signal can also be provided to indicate that excess error exists.

16. Ride Through: The control logic is capable of "riding through" a power outage of at least 2 seconds in duration. The inverter section is shut off after an 28% drop in bus voltage to conserve power for the drive logic. The ride through method and trigger point are adjustable by the user.

O. VFD Enclosures

1. Where Enclosed Drives are required or specified, the following requirements shall be met.

2. Unit shall be wall or floor mountable and be NEMA type 12 rated.

3. Unit shall be provided with lockable Main Input Circuit Breaker.

4. The enclosures shall be provided with an input Line Reactor with an Impedance rating of 3% for voltage transient protection, and for a degree of protection from harmonic distortion.

5. Units shall be provided with door mounted HAND/OFF/REMOTE selector switch. The HAND Mode shall provide a local start control. In the REMOTE Mode, the start control shall be provided via a remote contact in the SCADA control panel. Provide an extra set of contacts on the selector switch to monitor the switch position via the facilities SCADA control panel.

6. Provide door mounted 120VAC push-to-test LED pilot lights for ON (green) and OFF (Red) indication.
7. Enclosure shall be provided with a door mounted Operator Interface as follows.
   a. Interface to the drive is provided via a removable Human Interface Module (HIM) with integral display. This unit is a 7 line by 21-character backlit LCD display with graphics capability. It is used to display drive operating conditions, fault / alarm indications and programming information with full text support in multiple languages, including but not limited to English, German, French, Italian, Spanish, Portuguese and Dutch.
   b. The keypads for these include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), numeric keys for direct entry and an ALT (alternate function) key to allow some of the more common drive programming or operating functions to be accessed directly without knowledge of programming structure. These ALT functions include S.M.A.R.T. Start for fast and easy commissioning, View selection, Auto Manual operation, HIM removal under power, and device selection for programming.

8. Where indicated and specified, VFD enclosures shall be furnished with integral Passive Harmonic Filters as follows:
   a. The harmonic filter shall be a Passive Filter as manufactured by MTE Corporation, General Electric, TCI or approved equal. The filter shall be physically sized to meet all requirements as shown on Drawings, and be furnished within a panel rated appropriately for the environment being installed.
   b. The harmonic filter shall treat all characteristic low frequency harmonics generated by a three phase full wave converter load (5th, 7th, 11th, 13th, etc.).
   c. The characteristic harmonics shall be suppressed without need for individual tuning or the requirement to phase shift against other harmonic sources.
   d. The harmonic filter shall be a passive series connected low pass filter consisting of an inductor capacitor network. Active electronic components shall not be used.
   e. The harmonic filter model supplied shall be capable of feeding a three phase input rectifier with or without line reactors, with or without a DC link choke, with or without a combination line reactor and DC link choke.
f. The harmonic filter shall not resonate with the power distribution system, nor attract harmonics from other sources.

g. The filter shall be suitable for use with either a single nonlinear load or multiple nonlinear loads.

h. The filter shall be listed per UL 508.

i. In the operating range from full load to half load the power factor shall be .98 lagging to .95 leading.

j. The harmonic filter in combination with the variable frequency drive shall meet all requirements specified in IEEE 519 for individual and total harmonic voltage and current distortion. The PCC for all voltage and current harmonic calculations and measurements shall be the input terminals of the harmonic filter.

k. Total Demand Distortion (TDD) of the current at the input terminals of the harmonic filter shall not exceed the limits defined in Table 10-3 of IEEE 519.

l. Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10-2 of IEEE-519. The harmonic filter supplier shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.

m. The harmonic filter shall suppress the characteristic harmonics to the levels specified provided that the line voltage unbalance is between 0% and 1%. If the line voltage unbalance is between 1% and 3% per ANSI C84.1-1995 the total harmonic input current distortion at any reduced load or speed condition shall not exceed the full load THID by more than 50% (i.e. if 5% THID required at full load, then not more than 7.5% THID at reduced load when voltage unbalance is more than or equal to 1% and less than or equal to 3%)

n. The full load efficiency of the harmonic filter shall be greater than 98%.

o. When fed from a power distribution system operating at the nominal distribution voltage, the harmonic filter output voltage at no load shall not be more than 4.6% of the nominal RMS and peak distribution voltage.

p. When fed from a power distribution system operating at the nominal distribution voltage, the harmonic filter output voltage at full load shall not be less than the nominal RMS utilization voltage.
q. All wiring shall be copper.

r. At no load the harmonic filter shall not cause the voltage at the PCC to rise by more than 2%.

s. To assure that the voltage source PWM inverters do not experience over voltage trips, the harmonic filter shall not cause the inverter bus voltage to increase by more than 5% when the filter is operating from the nominal distribution voltage.

t. To assure that the filter will not reduce the life of a voltage source inverters bus capacitor, the output current waveform of the harmonic filter and the input current waveform of the inverter shall be consistent with the input waveform of an inverter fed from a drive equipped with a 3% minimum impedance line reactor.

u. The harmonic filter shall be furnished will an integral output contactor. The output contactor shall have a 120Vac coil, and be energized upon the startup of the associated VFD.

v. The harmonic filter shall be handled, stored, and installed in accordance with the manufacturer’s recommended installation practices as found in the manufacturer’s User Manual. Installation shall comply with all applicable local codes.

w. To assure quality control and proper performance, the filter shall be manufactured by an ISO9001:2000 supplier in the supplier’s own manufacturing facility, and not by a contract manufacturer. Filters shall be fully tested prior to shipment.

x. The harmonic filter shall be warranted to be free of defects in materials and workmanship for a period of one year from the date of shipment when applied in accordance with the manufacturer’s recommended installation procedures.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Examine areas and conditions under which VFDs are to be installed, and notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
B. Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the VFD manufacturer shall supervise the installation of all equipment, and wiring.

C. Certified factory start-up shall be provided for each VFD provided. Service Engineers shall be employed by the manufacturer or be certified by the manufacturer and provide start-up services including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

D. Make equipment grounding connections for each VFD in accordance with all applicable codes and as recommended by the manufacturer.

E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the MEC.

F. Wall-mount the enclosures using spacers or standoff(s) (1/4 inch minimum).

G. The VFD’s shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by the Owner, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the Contractor at no additional cost to the Owner.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Prior to energizing motor controller equipment, check with ground resistance tester, phase to phase and phase to ground insulation resistance levels to ensure requirements are fulfilled.

C. Prior to energizing, check circuitry for electrical continuity, and for short circuits.

3.03 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 32 13.13

DIESEL-ENGINE-DRIVEN GENERATOR SETS (LOW-VOLTAGE)
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide diesel-engine-driven generator sets (low-voltage) in accordance with this Section and applicable reference standards listed in Article 1.03.

2. The intent of this Specification is to secure a generator set and automatic transfer switch from a single Manufacturer. The Transfer switch shall be prototype tested, factory built, production tested, and site tested. A transfer switch with the number of poles, voltage, and current ratings shown on the plans and specified shall be provided.

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 33 Raceways And Boxes For Electrical Systems
3. Section 26 05 26 Grounding And Bonding For Electrical Systems

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. The generator set covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards below:

a. CSA C22.2 No14
b. CSA 282
c. CSA 100
d. EN61000-6
e. EN55011
f. FCC Part 15 Subpart B
2. The automatic transfer switch shall conform to the requirements of:

a. UL 1008: Underwriters Laboratories standard for automatic transfer switches
b. CSA: C22.2 No. 178 certified at 600VAC
c. IEC: 947-6-1 certified at 480VAC
d. NFPA 70: National Electrical Code with Massachusetts amendments including use in emergency and standby systems in accordance with Articles 517, 700, 701, 702
e. NFPA 99: Essential electrical systems for health care facilities
f. NFPA 101: Life safety code
g. NFPA 110: Standard for emergency and standby power systems
h. IEEE 241: I.E.E.E. recommended practice for electrical power systems in commercial buildings
i. IEEE 446: I.E.E.E. recommended practice for emergency and standby power systems
j. NEMA ICS10: AC automatic transfer switch equipment (supersedes ICS2-447)
k. UL 50/508: Enclosures
l. ICS 6: Enclosures
m. ANSI C33.76: Enclosures
n. NEMA 250: Enclosures
o. IEEE 472: (ANSI C37.90A): Ringing wave immunity
p. 16. EN55022 (CISPR11): Conducted and radiated emissions (Exceeds EN55011 & MILSTD 461 Class 3)
q. EN61000-4-2: (Level 4): ESD immunity test Class B
r. EN61000-4-3: (ENV50140): Radiated RF, electromagnetic field immunity test
s. EN61000-4-4: Electrical fast transient/burst immunity test

g. ISO8528
h. IEC61000
i. UL508
j. UL2200
k. UL142
l. Designed to allow for installed compliance to NFPA 70, NFPA99 and NFPA 110
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 WORK INCLUDED

A. Installation

1. The Work includes furnishing and installing a complete integrated generator system. The system consists of a diesel generator set with related component accessories, and automatic transfer switch.

B. Fuel System

1. Contractor shall provide a full tank of diesel fuel after the completion of all testing as specified in the contract documents.

C. System Test

1. A complete system load test shall be performed after all equipment is installed. Guidelines in the Start-up Section.

D. Requirements, Codes and Regulations

1. The equipment supplied and installed shall meet the requirements of the NEC with Massachusetts Amendments and all applicable local codes and regulations. All equipment shall be of new and current production by a Manufacturer who has 25 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.
1.06 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Engine-generator submittals shall include the following information:

1. Factory published specification sheet

2. Manufacturer's catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, fuel system filter, etc.

3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories

4. Weights of all equipment

5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems

6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, battery charger, control panel, and remote alarm indications

7. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.

8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion, and telephone influence factor

9. Generator resistances, reactance’s and time constants

10. Generator locked rotor motor starting curves

11. Manufacturer's documentation showing maximum expected transient voltage and frequency dips, and recovery time during operation of the generator set at the specified site conditions with the specified loads

12. Manufacturer's and dealer's written warranty

C. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.07 SYSTEM RESPONSIBILITY

A. Generator Set Distributor

1. The completed engine generator set shall be supplied by the Manufacturer's authorized distributor only.
B. Requirements, Codes, and Regulations

1. Equipment supplied and installed shall meet the requirements of NEC and all-applicable local codes and regulations. All equipment shall be new, of current production. There shall be one source responsibility for warranty; parts and service through a local representative with factory trained service personnel.

C. Automatic Transfer Switch

1. Automatic transfer switch shall be supplied by the generator set manufacturer in order to establish and maintain a single source of system responsibility and coordination.

1.08 WARRANTY

A. Two Year Standby (ISO 8528-1: ESP) Generator Set Warranty

1. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.

1.09 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.11 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.
1.12 PARTS AND SERVICE QUALIFICATIONS

A. Service Facility

1. The engine-generator supplier shall maintain 24-hour parts and service capability within 100 miles of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.

B. Service Personnel

1. The dealer shall maintain qualified factory trained service personnel.

C. Product Support

1. Total Maintenance and Repair Agreement
   a. The authorized Manufacturer’s dealer shall provide an optional total maintenance and repair agreement using qualified factory trained service personnel for a period of 5 years minimum. The dealer shall provide genuine Manufacturer parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance and overhauls as defined in the manufacturer’s Operation and Maintenance Manual. The dealer shall also provide all genuine Manufacturer parts and filters, recommended fluids, dealer labor, travel labor and travel mileage to complete all unscheduled repairs and component replacements during the agreement period.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Caterpillar

B. Cummins Power Generation

C. Kohler

D. Or Equal
2.02 GENERAL REQUIREMENTS

A. Genset Requirements

1. The generator set shall be Standby Duty rated at 175kW, 219kVA, 263Amps 1800RPM, 0.8 power factor, 480/277V, 3-Phase, 60Hz, including radiator fan and all parasitic loads. Generator set shall be sized to operate at the specified load at a maximum ambient of 77ºF (25ºC) and altitude of 500 feet (152.4m). The engine generator set shall be capable of reliably starting the connected loads in the order listed in the table below. This shall be accomplished without exceeding the voltage and frequency specifications listed below:

<table>
<thead>
<tr>
<th>Maximum Allowable Starting Voltage Dip</th>
<th>Maximum Allowable Peak Voltage Dip</th>
<th>Maximum Allowable Frequency Dip</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td>15%</td>
<td>5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load Name</th>
<th>Load Rating (HP/kVA)</th>
<th>Starting Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit Heater 1</td>
<td>5kVA</td>
<td>General Loads</td>
</tr>
<tr>
<td>Transformer for Power and Lighting</td>
<td>15kVA</td>
<td>General Loads</td>
</tr>
<tr>
<td>Step 2:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Water Pump P-0101</td>
<td>10hp</td>
<td>FVNR</td>
</tr>
<tr>
<td>Waste Water Pump P-0102</td>
<td>10hp</td>
<td>FVNR</td>
</tr>
<tr>
<td>Step 3:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storm Water Pump P-0201</td>
<td>50hp</td>
<td>VFD PWM</td>
</tr>
<tr>
<td>Step 4:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storm Water Pump P-0202</td>
<td>50hp</td>
<td>VFD PWM</td>
</tr>
</tbody>
</table>

2. Standby Power Rating:

a. Power is available for the duration of an emergency outage
b. Average Power Output = 70% of standby power
c. Load = Varying
d. Typical Hours/Year = 200 Hours
e. Maximum Expected Usage = 500 hours/year
f. Typical Application = Standby
B. Material and Parts

1. All materials and parts comprising the unit shall be new and unused.

C. Engine

1. The engine shall be diesel fueled, four (4) cycle, water-cooled, while operating with nominal speed not exceeding 1800RPM. The engine will utilize in-cylinder combustion technology, as required, to meet applicable EPA non-road mobile regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. Additionally, the engine shall comply with the State Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified ekW/bHP rating. Utilization of the “Transition Program for Equipment Manufacturers” (also known as “Flex Credits”) to achieve EPA certification is not acceptable. The in-cylinder engine technology must not permit unfiltered exhaust gas to be introduced into the combustion cylinder.

2. Engine Governing

a. The engine governor shall be an electronic Engine Control Module (ECM) with 24-volt DC Electric Actuator. The ECM shall be enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. Speed droop shall be adjustable from 0 (isochronous) to 10%, from no load to full rated load. Steady state frequency regulation shall be +/- 6RPM. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The ECM shall adjust fuel delivery according to exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

2.03 GENERATOR

A. Generator Specifications

1. The synchronous three phase generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. The generator shall meet performance class G2 of ISO 8528. The excitation system shall enable the alternator to sustain 300% (250% for 50Hz) of rated current based on the 125C (Class H) or 105C (Class F) rise rating for ten seconds during a fault condition and shall improve the immunity of the voltage regulator to non-linear distorting loads. The
excitation system shall be of brushless construction and be independent of main stator windings (either permanent magnet or auxiliary windings).

B. Voltage Regulator

1. Digital Voltage Regulator

a. The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.

b. The voltage regulator shall communicate with the Generator Control Panel via a J1939 communication network with generator voltage adjustments made via the controller keypad. Additionally, the controller shall allow system parameter setup and monitoring, and provide fault alarm and shutdown information through the controller. A PC-based user interface shall be available to allow viewing and modifying operating parameters in a windows compatible environment.

C. Motor Starting

1. Provide locked rotor motor starting capability of 213skVA at 35% instantaneous voltage dip as defined per NEMA MG 1. Sustained voltage dip data is not acceptable.

2.04 CIRCUIT BREAKER

A. Circuit Breaker Specifications

1. Provide a generator mounted 100% rated circuit breaker, molded case, manually operated with 400 amp trip, 3 pole, NEMA 1/IP22. Breaker shall utilize a solid state microelectronic trip unit, with adjustable LSI functions. The breaker shall be UL/CSA Listed, connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be provided by the installation contractor.
2.05 CONTROLS - GENERATOR SET MOUNTED

A. Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set.

B. Environmental

1. The generator set control shall be tested and certified to the following environmental conditions:
   a. –40°C to +70°C Operating Range
   b. 95% humidity non-condensing, 30 °C to 60 °C
   c. IP22 protection for rear of controller; IP55 when installed in control panel
   d. 5% salt spray, 48 hours, +38 °C, 36.8V system voltage
   e. Sinusoidal vibration 4.3G's RMS, 24-1000Hz
   g. Shock: withstand 15G

C. Functional Requirements

1. The following functionality shall be integral to the control panel:
   a. The control shall include a 33 x 132 pixel, 24mm x 95mm, positive image, transflective LCD display with text based alarm/event descriptions.
   b. Audible horn for alarm and shutdown with horn silence switch
   c. Standard ISO labeling
   d. Multiple language capability
   e. Remote start/stop control
   f. Local run/off/auto control integral to system microprocessor
   g. Cooldown timer
   h. Lamp test
   i. Push button emergency stop button

D. Digital Monitoring Capability

1. The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units.
a. Engine
   1) Engine oil pressure
   2) Engine coolant temperature
   3) Engine RPM
   4) Battery volts

b. Generator
   1) Generator AC volts (Line to Line, Line to Neutral, and Average)
   2) Generator AC current (Average and Per Phase)
   3) Generator AC Frequency

E. Alarms and Shutdowns
   1. The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by an engine hour stamp that is stored by the control panel for first and last occurrence.
   2. Engine Alarm/Shutdown
      a. Low oil pressure alarm/shutdown
      b. High coolant temperature alarm/shutdown
      c. Loss of coolant shutdown
      d. Overspeed shutdown
      e. Overcrank shutdown
      f. Emergency stop depressed shutdown
      g. Low coolant temperature alarm

F. Inputs and Outputs
   1. Programmable Digital Inputs
      a. The Controller shall include the ability to accept eight (8) total with six (6) programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.
2. Programmable Relay Outputs
   
a. The control shall include the ability to operate eight (8) total with six (6) form A (normally open) programmable relay output signals, integral to the controller. Relay shall be rated for a maximum of 2A @ 30VDC.

b. Two sets of contacts rated for a maximum of 2A @ 30VDC shall be made available for each of the following statuses:
   1) Generator Running
   2) Generator Fail

G. Maintenance
   
1. All engine, voltage regulator, control panel, and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control:
   
a. Engine running hours display
   b. 20 events are stored in control panel memory

2.06 COOLING SYSTEM

A. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110ºF ambient air entering the room or enclosure (If an enclosure is specified). The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

2.07 FUEL SYSTEM

A. Fuel System
   
1. The fuel system shall be integral with the engine. In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted. Flexible fuel lines shall be minimally rated for 300 °F and 100psi.
B. Fuel Sub Base Tank

1. Provide a double wall sub-base tank constructed to meet all local codes and requirements. A fuel tank base of 24 hour capacity shall be provided as an integral part of the enclosure. It shall be contained in a rupture basin with 110% capacity. The tank shall meet UL142 standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided. Tank dimensions to match according to what is shown on the drawings.

2. Provide a high level float switch in the sub base tank set for 90% fill level of the tank, upon activation of float switch, a signal shall be sent to the filler control panel for shut-off of fuel to tank.

2.08 EXHAUST SYSTEM

A. Silencer

1. A critical grade silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the manufacturer's recommendation. Mounting shall be provided by the contractor as shown on the drawings. The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.

2. The complete exhaust system shall be internal to the sound attenuated enclosure. Units with roof mounted or externally exposed silencers are not acceptable.

2.09 STARTING SYSTEM

A. Starting Motor

1. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.

B. Jacket Water Heater

1. Jacket water heater shall be provided and shall be sized to insure that genset will start within the specified time period and ambient conditions.
C. Batteries

1. Batteries - A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system.

D. Battery Charger

1. Battery Charger - A current limiting battery charger shall be furnished to automatically recharge batteries. The charger shall be dual charge rate with automatic switching to the boost rate when required. The battery charger shall be mounted on the genset package or inside the genset enclosure/room.

2.10 PERFORMANCE AND CONSTRUCTION – ATS

A. The automatic transfer switch shall be of double throw construction operated by a reliable solenoid driven mechanism. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.

B. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.

C. The contact structure shall consist of a main current carrying contact, which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes above 400 Amps.

D. The transfer switch manufacturer shall submit test data for each size switch, showing it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity. Each ATS shall be in strict accordance and listed to UL 1008 withstand standards, including “Any Breaker” ratings. Minimum UL listed withstand and close into fault ratings shall be as indicated in Table 2.10A below. ATS’s which offer only “specific coordinated breaker” ratings (as opposed to “any breaker” ratings) do not meet this specification and are not acceptable.

<table>
<thead>
<tr>
<th>Size (Amps)</th>
<th>“Any Breaker” Rating</th>
<th>Current Limiting Fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 to 150</td>
<td>10,000</td>
<td>200,000</td>
</tr>
<tr>
<td>225 to 400</td>
<td>35,000</td>
<td>200,000</td>
</tr>
<tr>
<td>600 to 1200</td>
<td>65,000</td>
<td>200,000</td>
</tr>
<tr>
<td>1600 to 4000</td>
<td>100,000</td>
<td>200,000</td>
</tr>
</tbody>
</table>

(all values at 480V RMS symmetrical, less than 20% power factor)

TABLE 2.10A – MINIMUM UL LISTED WITHSTAND AND CLOSE INTO FAULT RATINGS
E. A dielectric test at the conclusion of the withstand and closing tests shall be performed.

F. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation between a normal and emergency source that are 120 degrees out of phase at 480 volts, 600% of rated current at .50 power factor. This certification is to ensure that there will be no current flow between the two isolated sources during switching.

G. All relays shall be continuous duty industrial type with wiping contacts. Coils, relays, timers and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness and keyed disconnect plugs for maintenance.

H. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

I. A manual handle shall be provided for maintenance purposes with the switch de-energized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.

J. Switches composed of molded case breakers, lighting contactors or components thereof will not be acceptable.

K. The current rating shall be a continuous rating when the switch is installed in an enclosure, and shall conform to NEMA temperature rise standards.

L. The unit shall be rated based on all classes of loads, i.e., resistive, tungsten, ballast and inductive loads. Switches rated 400 amperes or less shall be UL listed for 100% tungsten lamp load.

M. Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.

N. Unless specified otherwise on the drawings, the switch shall be mounted in a NEMA 1 enclosure.

O. The automatic transfer switch must be equipped with a solenoid production scheme that removes any attempts of operating the solenoids after (3) consecutive trials until manual intervention by an operator.
2.11 CONTROLS - ATS

A. The control panel shall be opto-isolated from electrical noise and provided with the following inherent control functions and capabilities: Easy-to-view, backlit LCD display with long lasting LED indicators

1. Control panel shall display voltage and frequency of both sources.
2. The user shall be able to view the last 16 recorded events.
3. Capability for external communication and network interface
4. Adjustments to all settings shall be made from the front of the panel without opening the door.

B. The transfer switch shall be equipped with a microprocessor based control panel. The control panel shall perform the operational and display functions of the transfer switch. The display functions of the control panel shall include ATS position, source availability, sequence indication and diagnostics.

C. All programmable and control functions shall be pass code protected and accessible through the keypad.

D. The control panel shall be provided with a simple user interface for transfer switch monitoring, control and field changeable functions and settings.

E. Touch pad test switch with Fast Test/Load/No Load selection capability to simulate a normal source failure.

F. The controller shall include a built in synchroscope to display the phase angle differential and ensure disturbance-free transfer operation between sources.

G. The controller shall provide digital timer adjustments with 1-second resolution. Voltage and Frequency shall be adjustable to 1% resolution to facilitate accurate transfer.

H. To ensure reliable and consistent user operation the controls must be equipped with nonvolatile memory and allow automatic daylight savings time adjustment.

I. A single controller capable of all transfer modes, open/delayed/closed and bypass isolation, shall be provided. Real time display of transfer status and active timers must be supplied.
2.12 SEQUENCE OF OPERATION

A. The ATS shall incorporate adjustable three phase under/over voltage and
   frequency sensing on the normal source.

B. When the voltage of any phase of the normal source is reduced to 80% of nominal
   voltage, for a period of 0-10 seconds (programmable) a pilot contact shall close to
   initiate starting of the engine generator.

C. The ATS shall incorporate adjustable three phase under/over voltage and
   frequency sensing on the emergency source.

D. When the emergency source has reached a voltage value of +/- 10% of nominal
   and achieved frequency within +/- 5% of the rated value, the load shall be
   transferred to the emergency source after a programmable time delay.

E. When the normal source has been restored to not less than 90% and not more than
   105% of nominal voltage on all phases, the load shall be retransferred to the normal
   source after a time delay of 0 to 60 minutes (programmable; set at 30
   minutes). The generator shall run unloaded for 5 minutes (programmable) and
   then automatically shut down. The generator shall be ready for automatic
   operation upon the next failure of the normal source.

F. If the engine generator should fail while carrying the load, retransfer to the normal
   source shall be made instantaneously upon restoration of proper voltage (90%) on
   the normal source.

G. Inspection and operational tests shall be conducted by the contractor in the
   presence of the engineer, to indicate that the switch satisfies the specifications.

H. The transfer switch shall be equipped with a microprocessor based control panel.
   The control panel shall perform the operational and display functions of the
   transfer switch. The display functions of the control panel shall include ATS
   position and source availability.

I. The digital display shall be accessible without opening the enclosure door and
   shall be provided with a 4 line by 20 character LCD display screen with touch pad
   functions and display menus. The programming functions shall be pass code
   protected.

J. The control panel shall be provided with menu driven display screens for transfer
   switch monitoring, control and field changeable functions and settings.
K. The control panel shall be opto-isolated from electrical noise and provided with the following inherent control functions and capabilities:

1. Multipurpose display for continuous monitoring and control of the ATS functions and settings: All field changeable functions shall be pass code protected and accessible through the keypad.

2. Built-in diagnostic display that includes the capturing of historical data, such as number of transfers and time on emergency power source, for ease of troubleshooting.

3. Capability for external communication and network interface through an RS485 serial port.

4. Touch pad test switch with Fast Test/Load/No Load positions to simulate a normal source failure.

5. Time delay to override momentary normal source failure prior to engine start: Field programmable 0-10 seconds (adjustable by increments of 0.1 second) factory set at 3 seconds.

6. Time delay on retransfer to normal source, programmable 0-60 minutes (adjustable by increments of 0.1 minute) factory set at 30 minutes: If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.

7. Time delay on transfer to emergency, programmable 0-5 minutes, factory set at 1 second.

8. An in-phase monitor shall be provided. The monitor shall compare the phase angle difference between the normal and emergency sources and be programmed to anticipate the zero crossing point to minimize switching transients.

9. Auxiliary contacts (1 N.O.) shall be provided to indicate normal and emergency source availability.

10. A load/no load clock exerciser shall be incorporated within the microprocessor and shall be programmable to start the engine generator set and transfer the load (when selected) for exercise purposes on a weekly basis. The exerciser shall contain a lithium battery for memory retention during an outage.
11. A timed auxiliary contact (1 N.C.) adjustable 0-60 seconds shall be provided to allow motor loads to be disconnected prior to transfer in either direction.

12. Provide a momentary pushbutton to bypass the time delays on transfer and retransfer and programmable commit/no commit control logic.

2.13 ATS FEATURES

A. In addition to the operational elements required to satisfy the sequence of operation and other functions specified herein, the following ATS features shall be provided:

1. Adjustable time delay to override momentary normal source failure prior to engine start: Field programmable 0-10 seconds factory set at 3 seconds.

2. Adjustable time delay on retransfer to normal source, programmable 0-60 minutes factory set at 30 minutes: If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.

3. A time delay on transfer to emergency, programmable 0-5 minutes, factory set at 1 second

4. An in-phase monitor shall be provided. The monitor shall compare the phase angle difference between the normal and emergency sources and be programmed to anticipate the zero crossing point to minimize switching transients.

5. An exerciser timer with momentary test pushbutton shall be incorporated within the microprocessor and shall be capable of starting the engine generator set and transferring the load (when selected) for exercise purposes on a daily, weekly or monthly basis. The exerciser shall contain a battery for memory retention during an outage.

6. Provide a momentary pushbutton to bypass the time delays on transfer and retransfer and programmable commit/no commit control logic.

7. A set of customer contacts shall be provided to indicate both emergency and normal source position.

8. An adjustable over/under frequency and voltage sensor for both emergency and normal sources

9. Visual indication of switch position and source acceptability shall be provided for both emergency and normal sources.
10. An engine start contact with an adjustable cool down timer
11. A three phase Voltage Imbalance Monitor shall detect an imbalance and initiate a transfer to the alternate source. Adjustable 5-20% of nominal with a time delay of 10-30 seconds for nuisance conditions.
12. Heater and Thermostat (HT) – Recommended for NEMA 3R applications
13. Communications interface card RS-485 Modbus
14. Test Switch (6A) – Maintained
15. Digital Meter (M90) - Measures and displays true RMS volts, amps, frequency, kW, kVA, kVAR and PF w/Modbus RS485
16. Digital Meter (M91) Measures and displays true RMS volts, amps, frequency, kW, kVA, kVAR, PF and THD w/Modbus RS485
17. Additional Auxiliary Contacts (A4) - Closed when the transfer switch is in Source 1 position.
18. Alarm panel (CTAP) – Alarm on transfer to emergency w/silence button & light
19. Disconnect Switch (DS) - Inhibits transfer in either direction when in inhibit. (Std on 600A and above)
20. Protective Cover (OCVR) - Lockable see-through microprocessor and meters cover for NEMA 3R or 12.M
21. Battery Charger (B9) – 5 amp float charger. Specify input/output voltage
22. Fan Contact (F) – Contact closes when engine runs
23. Analog Metering - Individual 2% ammeter, voltmeter or frequency meters with selector switches as specified
24. Inhibit transfer (Q3) – Provides additional relay (specify voltage) to inhibit transfer to Emergency
25. Inhibit transfer (Q7) – Provides additional relay (specify voltage) to inhibit transfer to Normal
26. Load Shed (R15) – Provisions to transfer source 2 or Emergency to normal or neutral (delayed switches only) position. Specify voltage
27. Engine Mode Switch (SW1) – Three-position engine selector switch (auto/test/off)
28. Keyed Engine Mode Switch (SW1K) – Three position keyed engine selector switch (auto/test/off)

29. Prime Source Selector (SW3) – Provide a source selector switch that selects source 1 or source 2 as the preferred source

30. Prime Source Selector (SW3K) – Provide a keyed source selector switch that selects source 1 or source 2 as the preferred source

31. Automatic or Manual Selector (S5) – Provide ability to manually transfer to Normal source

32. Automatic or Manual Selector (S12) – Provide ability to manually transfer to Normal or Emergency sources

33. Additional Auxiliary Contact (A3) - Closed when the transfer switch is in Source 2 position

34. Additional Auxiliary Contact (A4) - Closed when the transfer switch is in Source 1 position

35. Programmable Clock Exerciser (CDP) – This will replace the timer exerciser and allow for a 365 day cycle

36. Peak Shave/Remote Test (Q2) - The controller shall accept a remote peak shave or test input to signal the transfer switch to the emergency position

37. Phase Rotation Sensing (R16) – Rotation shall be monitored on both sources

2.14 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes.

3.02 SERVICE

A. The supplier of the ATS shall be the same as that of the engine generator set and shall maintain a national service organization that is factory trained and certified for transfer switch equipment. In addition, the genset dealer organization shall be available 24 hours per day, 365 days per year.
3.03 START-UP AND TESTING

A. The transfer switch manufacturer shall perform a complete functional test on the switch, controller and accessories prior to shipping from the factory. A certified test report shall be available upon request.

B. Coordinate all start-up and testing activities with the Engineer and Owner. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following: Perform a 4 hour load bank test at a 1.0PF at full nameplate rating. Loadbank, cables and other equipment required for this test to be supplied by the genset supplier.

3.04 OPERATION AND MAINTENANCE MANUALS

A. Provide two (2) sets of operation and maintenance manuals covering the generator, switchgear, and auxiliary components. Include final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

3.05 TRAINING

A. On-Site Training

1. Provide on-site training to instruct the owner's personnel on the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals, and emergency service procedures.

2. Training shall be provided in two (2) complete separate sessions to accommodate plant staff of varying shifts.

3. The instruction shall be dedicated and intensive and shall be provided by competent instructors fully familiar with the equipment.

4. The instructions shall be presented in an eight hour session. The Field Service engineer will provide instructions on the operation and maintenance of the generator engine, alternator, battery system, circuit breaker, control system, and appurtenances.

5. The Owner will provide a suitable classroom environment on site for the instruction session.

6. The owner may elect to record the training sessions for future reference.

7. Training shall be scheduled with at least seven (7) working days advance notice.

8. Provide both classroom training and hands-on equipment operation covering the following:
a. Safety precautions
b. Features and construction of generator and accessories
c. Routine inspection, test and maintenance procedures
d. Routine cleaning
e. Routine preventative maintenance
f. Interpretation of readings of indicating and alarm devices
g. Review operating and maintenance manuals
h. Review troubleshooting operations

3.06 WARRANTY
A. The automatic transfer switch shall be warranted against defective workmanship for a period of two years, including both parts and labor.

3.07 FIELD QUALITY CONTROL
A. Provide in accordance with Division 01 General Requirements.

3.08 STARTUP & COMMISSIONING
A. Provide in accordance with Division 01 General Requirements.

3.09 CLOSEOUT ACTIVITIES
A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 43 00

SURGE PROTECTIVE DEVICES
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide materials and installation requirements for an integrated Surge Protective Device ( SPD ), in a Low Voltage Motor Control Centers ( MCC’s ), Low Voltage Switchboards, Low Voltage Switchgear, and Panelboards, and other equipment as indicated in accordance with this Section applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 33 Raceways And Boxes For Electrical Systems
3. Section 26 05 26 Grounding And Bonding For Electrical Systems
4. Section 26 24 16 Panelboards

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

2. NFPA 70 (NEC)
4. UL 1283 - Electromagnetic Interference Filters

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 SURGE PROTECTIVE DEVICE

A. Internal SPD

1. SPD shall be Listed in accordance with UL 1449 Second Edition 2005 and UL 1283, Electromagnetic Interference Filters.

2. Integrated surge protective devices (SPD) shall be Component Recognized in accordance with UL 1449.

3. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform.

4. SPD shall provide suppression for all modes of protection: L-N, L-G, and N-G in WYE systems.
5. Manufacturer of SPD shall be the same as manufacturer of the service entrance and distribution equipment in which devices are installed and shipped. Distribution equipment shall be fully tested and certified to the following UL standards.

   a. UL 67 - Panelboards
   b. UL 845 - Motor Control Centers
   c. UL 857 - Busway
   d. UL 891 - Switchboards
   e. UL 1558 - Low Voltage Switchgear

6. Recommended SPD ratings

   a. Minimum surge current ratings per phase of equipment shall be as follows:

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>SURGE RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear</td>
<td>200kA</td>
</tr>
<tr>
<td>Switchboards</td>
<td>160kA</td>
</tr>
<tr>
<td>Power Panels</td>
<td>160kA</td>
</tr>
<tr>
<td>Lighting Panels</td>
<td>160kA</td>
</tr>
<tr>
<td>Receptacle Panels</td>
<td>120kA</td>
</tr>
</tbody>
</table>

   **TABLE 2.01A – MINIMUM SURGE CURRENT RATINGS**

   b. UL 1449 clamping voltage must not exceed the following:

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>L-N</th>
<th>L-G</th>
<th>N-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>240/120</td>
<td>800/400V</td>
<td>800/400V</td>
<td>400V</td>
</tr>
<tr>
<td>208/120</td>
<td>400V</td>
<td>400V</td>
<td>400V</td>
</tr>
<tr>
<td>480/277</td>
<td>800V</td>
<td>800V</td>
<td>800V</td>
</tr>
<tr>
<td>600/347</td>
<td>1200V</td>
<td>1200V</td>
<td>1200V</td>
</tr>
</tbody>
</table>

   **TABLE 2.01B – MAXIMUM CLAMPING VOLTAGE LIMITS**

   c. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE Category C High transients without failure or degradation of clamping voltage by more than 10%.

7. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.

8. SPD constructed of one self-contained suppression module per phase.
9. Provide visible indication of proper SPD connection and operation provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module. Provide a push-to-test button to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.

10. SPD shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.

11. A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete SPD or module.

12. Terminals shall be provided for necessary power and ground connections.

13. The SPD shall be equipped the following items:
   a. A transient voltage surge counter shall be located on the diagnostic panel on the front cover of the enclosure. The counter shall be equipped with a manual reset and battery backup to retain memory upon loss of AC power.
   b. A remote monitoring device shall be provided to directly connect to the SPD with a dry contact connector for simple installation. The device will have indicator lights and an audible alarm to monitor for normal and fault conditions.

B. SPD shall have a warranty for a period of ten (10) years from date of invoice. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

2.02 MANUFACTURERS

A. Square D/Schneider Electric
B. General Electric Co.
C. Siemens
D. Eaton/Cutler Hammer
E. Or equal
2.03 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.02 STARTUP & COMMISSIONING
   A. Provide in accordance with Division 01 General Requirements.

3.03 STARTUP & COMMISSIONING
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 26 51 00
INTERIOR LIGHTING
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Provide labor, tools, equipment, and materials necessary to furnish and install interior lighting fixtures in accordance with this section and applicable reference standards listed in Article 1.03.

B. Provide a complete lighting system as indicated. Lighting control equipment shall include, if indicated: light fixtures, control modules, power packs, dimming ballasts, occupancy sensors, and light level sensors.

C. Section includes the following.

1. Light Emitting Diode (LED)
2. Luminaires and lamp holders
3. Exit signs
4. Emergency lighting units
5. Lamps
6. Ballasts
7. Photocell controls

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 33 Raceways And Boxes For Electrical Systems
3. Section 26 05 26 Grounding And Bonding For Electrical Systems
4. Section 26 56 00 Exterior Lighting

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.
1.03 REFERENCES

A. Reference Standards

1. American National Standards Institute (ANSI)
   a. C78.1-91: Fluorescent Lamps – Rapid Start Types – Dimensional and Electrical Characteristics
   b. C78.376-01: Chromaticity of Fluorescent Lamps

2. ASTM International (ASTM)
   a. C635-07: Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings

3. Environmental Protection Agency (EPA)

4. Federal Communications Commission (FCC)
   a. CFR Title 47, Part 15: Radio Frequency Devices
   b. CFR Title 47, Part 18: Industrial, Scientific, and Medical Equipment

5. Illuminating Engineering Society (IES):
   a. LM-79-08 Electrical and Photometric Measurements of Solid-State Lighting Products
   b. LM-80-08 Measuring Lumen Maintenance of LED Light Sources
   c. LM-82-12 Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature

6. Illuminating Engineering Society Of North America (IESNA)
   a. IESNA HB-9 Lighting Handbook

7. Institute of Electrical and Electronic Engineers (IEEE)
   a. C62.41-91: Surge Voltages in Low Voltage AC Power Circuits
8. International Code Council (ICC)
   a. IBC-12: International Building Code

9. National Fire Protection Association (NFPA)
   a. 70-11 National Electrical Code (NEC) with Massachusetts amendments.
   b. 101-12 Life Safety Code

10. National Electrical Manufacturer's Association (NEMA)
    a. SSL-1-10: Electronic Drivers for LED Devices, Arrays, or Systems

11. National Fire Protection Association (NFPA)
    a. NFPA 70 National Electrical Code

12. Underwriters Laboratories (UL)
    a. 496-08: Lampholders
    b. 844-12: Luminaires for Use in Hazardous (Classified) Locations
    c. 924-12: Emergency Lighting and Power Equipment
    d. 1598-08: Luminaires
    e. 8750-09: Light Emitting Diode (LED) Light Sources for Use in Lighting Products
    f. 2108-04: Low-Voltage Lighting Systems

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.
B. Submit shop drawings, product data, test data, warranties, and other information as appropriate for the following.

1. Light Emitting Diode (LED), submit US DOE LED Lighting Facts label, and IES L70 rated life.
2. Luminaires and lamp holders
3. Exit signs
4. Emergency lighting units
5. Lamps
6. Ballasts
7. Photocell controls

C. Shop Drawings: Indicate construction details for products which are not manufacturer's standard, when product data does not adequately describe fixture physical characteristics, or upon request by Engineer.

D. Product Data: Provide product data for each luminaire and lighting unit.

E. Submit written warranty for extended warranty items such as batteries and ballasts.

F. Submit luminaire shop drawings in booklet form with a separate sheet for each luminaire type. Indicate clearly on each sheet the proposed luminaire "type" designation, manufacturer, luminaire, lamp, and ballast designation.

G. Submittals shall indicate materials, finishes, metal gauges, overall and detail dimensions, sizes of electrical and mechanical connections, fasteners, welds, joints, end conditions, provisions for the work of others and similar information.

H. The submittals shall state whether or not the fixture, as an assembly, has been UL tested and approved.

I. Upon request, submit sample products for inspection. Provide luminaires identical with approved samples; retain approved samples at site for comparison until all other luminaires have been shipped to site and installed. Transportation charges for samples shall be paid by Contractor. Unapproved samples will be returned at Contractor's expense. Upon notification of disapproval, immediately submit new samples that meet contract requirements.

J. Upon request by Engineer, provide computerized illumination calculation data for specified interior or exterior areas in digital or isofootcandle format and in such detail as requested.
K. Operating and Maintenance Instructions: Provide maintenance and operating instructions for battery powered lighting units. Include technical data sheets and parts ordering information for components used in all luminaires.

L. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Warrant all lighting and components for one year after acceptance of the work and at no additional cost to the Owner. Promptly provide and install replacements for luminaires or components which are defective in materials or workmanship or repair installed equipment at the job site as necessary to restore first class operating condition. For any time during the warranty period that luminaires are not fully functional due to defects in materials or workmanship, provide, install and remove suitable temporary lighting. Warrant replacement luminaires in a similar manner for a period of one year following replacement including replacement of defective replacements.

C. Warrant ballasts, batteries, and occupancy sensors as further specified herein.

D. Provide products of firms regularly engaged in the manufacture of interior luminaires or components of similar types and ratings to those required. Such products shall have been in satisfactory use in similar applications for not less than two years.

1.07 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements

B. Deliver luminaires and their components to job site, factory assembled and wired to the greatest extent practical, in strict accordance with approved shop drawings, samples, certificates and catalog cuts.

C. Protect exposed finishes during manufacture, transport, storage and handling; replace damaged materials.

D. Luminaires shall be stored under cover, above the ground, in clean, dry areas and shall be tagged and/or marked as to type and site destination.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.
PART 2 – PRODUCTS

2.01 GENERAL

A. Provide lighting fixtures as listed on the Lighting, Lamping, and Fixture Schedule on the drawings and as specified herein that meet the physical, performance and quality standard exhibited by that fixture. Substitutes shall be equal in all respects including mechanical, electrical, physical, performance, photometric and quality characteristics except minor variances in construction details, which do not affect overall quality or performance, are permitted.

B. Accessories: Provide required accessories for mounting and operation of each luminaire as indicated.

   1. Thermal Protection: Provide thermal protection devices to meet NFPA 70 requirements.

   2. Disconnecting Means: Provide disconnecting means in fluorescent luminaires that utilize double-ended lamps and contain ballast(s) that can be serviced in place.

   3. Surface Luminaires: Provide spacers and brackets required for mounting; design for a minimum ambient temperature of 92 degree F.

   4. Pendant Luminaires: Provide swivel hangers, pendant rods, tubes, chains and other hardware as required and/or indicated to install luminaire at appropriate height.

2.02 LED LIGHT FIXTURES

A. General

   1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.

   2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated.
   a) Minimum efficiency: 85% at full load.
   b) Minimum Operating Ambient Temperature: -20˚ C. (-4˚ F.)
   c) Input Voltage: 120 - 277V (±10%) at 60 Hz.
   d) Integral short circuit, open circuit, and overload protection.
   e) Power Factor: ≥ 0.95.
   f) Total Harmonic Distortion: ≤ 20%.
   g) Comply with FCC 47 CFR Part 15.

4. LED modules shall include the following features unless otherwise indicated.
   a) Comply with IES LM-79 and LM-80 requirements.
   b) Minimum CRI 80 and color temperature 3000˚ K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
   c) Minimum Rated Life: 50,000 hours per IES L70.
   d) Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights
   1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers
   1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
   2. Housing, LED driver, and LED module shall be products of the same manufacturer.

D. LED Wraparound
   1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
2. Housing, LED driver, and LED module shall be products of the same manufacturer.

2.03 EXIT SIGNS

A. LED Exit Sign with Battery Backup

1. Lamps: Manufacturer's standard, light emitting diode (LED) type designed to NFPA 101 and 70 marking of egress requirements. Warrant lamps for 5 years full replacement.

2. Input Voltage: 120 volts for normal power, equip with self-contained battery, solid state charger with brown out protection, and test switch.

3. Battery: Sealed nickel cadmium, warrant for five years full replacement, plus additional 7 years prorated.

B. Construction

1. Housing: High strength cast aluminum, equipped with low profile canopy mount.

2. Housing and Lens in High Abuse Areas: Injection molded polycarbonate.

3. Face: Aluminum or white painted steel stencil face with red letters, 6" high x 3/4" stroke.

4. Directional Arrows: Universal type for field adjustment.

5. Mounting: Universal, for field selection.

6. Mounting in High Abuse Areas: Ceiling or wall as indicated.

2.04 EMERGENCY LIGHTING UNITS

A. Self-Contained Emergency Lighting Unit:

1. Input Voltage: 120 volts.

2. Lead calcium maintenance free battery, 3 year full, plus 7 year prorated (total 10 year) warranty. Gelled electrolyte batteries are not permitted.

3. Battery Charger: Dual rate type, solid state, with low voltage and brown out protection.

4. Lamps: LED, 3.3 watt.

5. Housing: Steel with manufacturer's standard finish.
B. Indicators and Controls: AC ON, RECHARGING; TEST switch, battery charge voltmeter.

C. Electrical Connection: Hardwired.

2.05 LAMPS

A. Provide type and color indicated on the Lighting, Lamping, and Fixture Schedule.

2.06 PHOTOCCELL SWITCH

A. UL 773 or UL 773A, hermetically sealed cadmium-sulphide cell rated 240 volts ac, 60 hertz with single-throw contacts rated 1000 watts, and 600 volts.

B. Mount switch in a cast weatherproof aluminum housing, with swivel arm mount, in a high impact resistant, non-corroding and non-conductive molded plastic housing, with an EEI-NEMA locking-type receptacle.

C. The switch shall turn on below 3 footcandles and off at 3 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Mount a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Aim switch according to manufacturer's recommendations.

2.07 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

B. Examine adjacent surfaces to determine that surfaces are ready to receive work.

C. Install wiring in accordance with Section 26 05 19.

D. Install luminaires and accessories in accordance with manufacturer's instructions, as indicated, with equipment, materials, parts, attachments, devices, hardware, hangers, cables, supports, channels, frames and brackets necessary to make a safe, complete and fully operative installation.
E. Install luminaires plumb, square and level with ceiling and walls, in alignment with adjacent luminaires, and secure in accordance with manufacturers' directions and approved shop drawings. Conform to the requirements of National Electrical Code with Massachusetts amendments ANSI/NFPA 70.

1. Specified or indicated mounting heights are to be to the bottom of each luminaire for suspended and ceiling mounted luminaires, and to the center of each luminaire for wall mounted luminaires. Obtain approval of exact mounting for luminaires on the job before installation is commenced and, where applicable, after coordinating with type, style, and pattern of ceiling being installed.

2. Provide pendant accessory to mount suspended luminaires and exit signs at height indicated. Use swivel hanger on sloped ceilings.

3. Support surface mounted luminaires from ceiling grid tee structure; provide auxiliary support laid across top of ceiling tees and fasten to prohibit movement.

4. Install recessed luminaires to permit removal from below and install earthquake clips.

5. For lighting fixtures mounted in or on suspended ceilings, provide two support hangers per fixture so that each is independently supported from the building structure.

6. Provide two support hangers for the minimum security fixtures so that each is independently supported from the building structure.

7. Install lamps in luminaires and lamp holders.

8. Ground non-current carrying parts of electrical equipment in accordance with UL and NEC with Massachusetts amendment provisions.

F. Install lighting fixtures where indicated on the plans; plans may be scaled for approximate locations; minor adjustments are permitted to avoid conflicts. Fixture placement that does not conform to the layout indicated shall be corrected; if in doubt about correct placement consult Engineer prior to roughing in. Install all lighting so that it is securely fastened, rows are uniformly spaced and in alignment, and fixture rests flat on mounting surface.

G. Perform insulation resistance and ground continuity test.

H. Emergency Lighting Equipment: Wire emergency lighting units ahead of the switch to the normal lighting circuit located in the same room or area.
I. Exit signs shall only have one control, which shall be from the dedicated circuit breaker. Wire exit signs to a dedicated circuit breaker from nearest available panelboard. Paint control device red, label circuit and provide lockout device.

3.02 ADJUSTING AND CLEANING

A. Align luminaires and clean lenses and diffusers at completion of work.
B. Aim adjustable luminaires and lamp holders as indicated or as directed.
C. Adjust directional arrows on exit signs to meet approval of authority having jurisdiction.
D. Clean paint splatters, dirt and debris from installed luminaires.
E. Touch up luminaire and pole finish at completion of work.
F. Re-lamp luminaires which have failed lamps at completion of work.

3.03 OWNER INSTRUCTION

A. Provide on-site training of Owner’s personnel in operation of controls systems by a factory trained manufacturer's representative. Include instruction in programming time controls to obtain required control functions. Provide one follow-up visit if necessary.

3.04 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 26 56 00

EXTERIOR LIGHTING
(FILED SUB-BID REQUIRED)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide exterior lighting in accordance with this Section and applicable reference standards listed in Article 1.03.

   a. Luminaires and lampholders
   b. Lamps
   c. Ballasts
   d. Photocell controls
   e. Poles and brackets

B. Related Requirements

1. Section 26 05 00 Common Work Results For Electrical
2. Section 26 05 33 Raceways And Boxes For Electrical Systems
3. Section 26 05 26 Grounding And Bonding For Electrical Systems
4. Section 26 51 00 Interior Lighting

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. ANSI/NFPA 70.
3. Underwriters Laboratories, Inc.
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Submit shop drawings, product data, test data, warranties, and other information as appropriate for the following:

1. Luminaires
2. Lamps
3. Ballasts
4. Time switch
5. Photocell controls

C. Shop Drawings: Indicate construction details for products which are not manufacturer's standard, when product data does not adequately describe fixture physical characteristics, or upon request by Engineer.

D. Product Data: Provide product data for each luminaire and lighting unit.

E. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.

F. Submit luminaire shop drawings in booklet form with a separate sheet for each luminaire type. Indicate clearly on each sheet the proposed luminaire "type" designation, manufacturer, luminaire lamp, and ballast designation.

G. Submittals shall indicate materials, finishes, metal gauges, overall and detail dimensions, sizes of electrical and mechanical connections, fasteners, welds, joints, end conditions, provisions for the work of others and similar information.

H. A photometric test report showing photometric candlepower distribution, brightness, coefficients of utilization, and paint reflectance shall be included for all fixtures. Photometric reports shall be prepared for actual fixture, lamp, lens, and ballast combination. Certify data as that taken under National Bureau of Standards calibrated test conditions according to standards of the Illuminating Engineering Society; upon request, submit photometric test of proposed fixture prepared by an independent testing laboratory.
I. Submittals shall state whether or not the fixture, as an assembly, has been UL tested and approved.

J. Upon request, submit sample products for inspection. Provide luminaires identical with approved samples; retain approved samples at site for comparison until after all other luminaires have been shipped to site and installed. Transportation charges for samples shall be paid by Contractor. Unapproved samples will be returned at Contractor's expense. Upon notification of disapproval, immediately submit new samples that meet contract requirements.

K. Upon request by Engineer, provide computerized illumination calculation data for specified interior or exterior areas in digital or isofootcandle format and in such detail as requested.

L. Operating and Maintenance Instructions: Provide maintenance and operating instructions for battery powered lighting units. Include technical data sheets and parts ordering information for components used in all luminaires.

M. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Warranty all lighting and components for one year after acceptance of the work and at no additional cost to the Owner, promptly provide and install replacements for luminaires or components which are defective in materials or workmanship; or repair installed equipment at the job site as necessary to restore first class operating condition. For any time during the warranty period that luminaires are not fully functional due to defects in materials or workmanship, provide, install, and remove suitable temporary lighting. Warrant replacement luminaires in a similar manner for a period of one year following replacement including replacement of defective replacements.

C. Warrant ballasts, batteries, and occupancy sensors as further specified herein.

D. Provide products of firms regularly engaged in the manufacture of interior luminaires or components of similar types and ratings to those required. Such products shall have been in satisfactory use in similar applications for not less than two years.

1.07 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.
B. Deliver luminaires and their components to job site, factory assembled and wired to the greatest extent practical, in strict accordance with approved shop drawings, samples, certificates and catalog cuts.

C. Protect exposed finishes during manufacture, transport, storage and handling; replace damaged materials.

D. Luminaires shall be stored under cover, above the ground, in clean, dry areas, and be tagged and/or marked as to type and site destination.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. Provide lighting fixtures as listed on the Lighting, Lamping, and Fixture Schedule on the drawings and as specified herein that meet the performance and quality standard for that fixture. Substitutes shall be equal in all respects including mechanical, electrical, physical, performance, photometric, and quality characteristics except minor variances in construction details which do not affect overall quality or performance are permitted.

B. Accessories: Provide required accessories for mounting and operation of each luminaire as indicated.

2.02 LUMINAIRES

A. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of lamp and ballast heat, and safe cleaning and relamping.

B. Illumination distribution patterns, BUG ratings and cutoff types as defined by the IESNA shall be as shown on the drawings.

C. Incorporate ballasts in the luminaire housing, except where otherwise shown on the drawings.

D. Lenses shall be frame-mounted, heat-resistant, borosilicate glass, with prismatic refractors, unless otherwise shown on the drawings. Attach the frame to the luminaire housing by hinges or chain. Use heat and aging-resistant, resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. Pre-wire internal components to terminal strips at the factory.
F. Bracket-mounted luminaires shall have leveling provisions and clamp-type adjustable slip-fitters with locking screws.

G. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.

H. Provide manufacturer's standard finish, as scheduled on the drawings. Where indicated on drawings, match finish process and color of pole or support materials.

I. Luminaires shall carry factory labels, showing complete, specific lamp and ballast information.

2.03 LAMPS

A. Install the proper lamps in every luminaire installed and every existing luminaire relocated or reinstalled as shown on the drawings.

B. Lamps shall be general-service, outdoor lighting types.

C. LED sources shall meet the following requirements:

1. Operating temperature rating shall be between -40 degrees F and 120 degrees F.

2. Correlated Color Temperature (CCT): 4000K.


4. Manufacturer shall have performed reliability tests on the LEDs luminaires complying with Illuminating Engineering Society (IES) LM79 for photometric performance and LM80 for lumen maintenance and L70 life.

D. Mercury vapor lamps shall not be used.

2.04 LED DRIVERS

A. LED drivers shall meet the following requirements:

1. Drivers shall have a minimum efficiency of 85%.

2. Starting Temperature: -40 degrees C (-40 degrees F).

3. Input Voltage: 120 to 480 (±10%) volt.

4. Power Supplies: Class I or II output.
5. Surge Protection: system must survive 250 repetitive strikes of C Low (C Low: 6kV/1.2 x 50 μs, 10kA/8 x 20 μs) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. C Low waveforms as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.

6. Power Factor (PF): \( \geq 0.90 \).

7. Total Harmonic Distortion (THD): \( \leq 20\% \).


9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

2.05 PHOTOCCELL SWITCH

A. UL 773 or UL 773A, hermetically sealed cadmium-sulphide cell rated 240 volts ac, 60 hertz with single-throw contacts rated 1000 watts, and 600 volts.

B. Mount switch in a cast weatherproof aluminum housing, with swivel arm mount, in a high impact resistant, noncorroding and nonconductive molded plastic housing, with an EEI-NEMA locking-type receptacle.

C. The switch shall turn on below 3 footcandles and off at 3 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Mount a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Aim switch according to manufacturer's recommendations.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Grounding: Ground noncurrent-carrying parts of equipment, including metal poles. Where the copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

B. Insulation Resistance Test: Perform before and after connection of fixtures and equipment.


D. Field Tests: Upon completion of installation, conduct an operating test to show that the equipment operates in accordance with the requirements of this section.
3.02 ADJUSTING AND CLEANING

A. Clean lenses and diffusers at completion of work.
B. Aim adjustable luminaires and lampholders as indicated or as directed.
C. Clean paint splatters, dirt, and debris from installed luminaires.
D. Touch up luminaire and pole finish at completion of work.
E. Relamp luminaires which have failed lamps at completion of work.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 31 00 00

EARTHWORK

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Excavating, filling, backfilling, stockpiling, bedding, compacting, grading, hauling, disposal of on-Site soils, processing of on-Site soils for reuse, testing of soils, protection and other Work necessary for construction of pipelines, structures, subsurface structures, foundations, pavements, earthen embankments and appurtenant Work in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 01 57 05 – Temporary Dewatering
2. Section 01 57 13 – Temporary Erosion and Sedimentation Controls
3. Section 31 05 19.13 – Geotextiles for Earthwork
4. Section 31 10 00 – Site Clearing
5. Section 31 25 00 – Erosion and Sedimentation Controls
6. Section 31 50 00 – Excavation Support and Protection

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Association of State Highway and Transportation Officials (AASHTO)

   a. AASHTO M85 Standard Specification for Portland Cement
   b. AASHTO M 295 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
d. AASHTO T27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

e. AASHTO T96 Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

2. ASTM International (ASTM)


b. ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

c. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3))

d. ASTM D1556 Density and Unit Weight of Soil in Place by the Sand-Cone Method

e. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort

f. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

g. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

h. ASTM D2922 Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)

i. ASTM D2937 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method

j. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

k. ASTM D3740 Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

l. ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

m. ASTM E329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

n. ASTM C131 / AASHTO T-96 (Los Angeles Abrasion Test)

3. MassDOT Standard Specifications and Supplements and Construction Details
B. Definitions

1. Unsuitable material: soft clay or silt, organic clays or silts, peats, debris, concrete, pavement, stones or boulders over 6 inches in diameter, wet or frozen material, and material deemed unsuitable by Owner or Engineer that will not provide suitable foundation or structural support for pipe and associated drainage structures, buildings, or other structures, and is unsuitable for use in backfill.

2. On-Site material: suitable material from on-Site excavation.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1. Pre-installation conference: conduct at Project Site at least 30 days prior to start of Work.

   a. Required attendees: Owner and Engineer, Owner’s independent testing firm and geotechnical consultant, Contractor’s Superintendent, Support of Excavation (SOE) Installer, Dewatering Installer and Contractor’s independent testing firm

   b. Review methods and procedures related to earthmoving including, but not limited to, the following.

      1) Work hours

      2) Personnel and equipment needed to maintain proposed construction schedule and avoid delays

      3) Work procedures

      4) Establishing and maintaining Site access

      5) Coordination of Work with utility locator service

      6) Stockpiling area and temporary access points

      7) Site logistics for hauling and stockpiling

      8) Coordination of Work and equipment movement with support of excavation systems installation

      9) Construction phasing, anticipated daily and weekly progress and conformance to construction schedule

     10) Methodology for field quality control
2. Make provisions for observations and testing of Work by Owner’s independent testing and inspection agency and geotechnical consultant.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

1. Provide for each on-Site and borrow soil material or aggregate
   a. Name of each material Supplier, specific type and source of each material
   b. Bills of Lading documenting materials source, including Supplier name and relationship to source, location where materials were obtained; including street, town, lot and block, country and state. Include present and past usage of source Site.
   c. Supplier’s statement that material is not contaminated and is free of extraneous debris or solid waste, and description of steps taken to confirm
   d. Product weight shipping tickets certified by Supplier

C. Samples and Mockups: as specified in Article 1.06.

D. Certificates

1. Certification stating materials are virgin materials from a commercial or non-commercial source.

E. Design Data/Submittals

1. Materials gradation

F. Source and Field Quality Control Submittals

1. Field compaction testing
2. Material testing reports for each on-Site and borrow soil material proposed for fill and backfill in accordance with ASTM D2487
3. Laboratory compaction curve in accordance with ASTM D1557
4. Backfill moisture-density relationships
5. Submit daily field reports documenting earthwork activity and field-testing for each day. At minimum, reports shall include
   a. Description of day’s activities
b. Results of in-place density testing including in-place dry density, moisture content, percent compaction, elevation of test and description of soil

c. Sketch indicating extent of each day’s Work and location of testing

6. Daily records of over-excavated volumes including

   a. Beginning and end station of over-excavation
   b. Proposed elevation of subgrade
   c. Actual elevation of subgrade
   d. Calculated volume of additional excavation in bank cubic yards (BCY)

G. Qualification Statements

   1. Contractor’s independent testing agency, qualified for testing specified in ASTM E329 and ASTM D3740.

H. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

   A. Provide in accordance with Division 01 General Requirements.

   B. Qualifications: per Division 01 General Requirements and as follows for geotechnical testing.

      1. Geotechnical testing agency to monitor earthwork: qualified per ASTM 329 and ASTM D3740.

   C. Independent Testing

      1. Minimum of 50 pounds of material in an airtight container to testing laboratory.

   D. Samples

      1. Each type of soil or aggregate proposed for use on Project, a minimum of 14 days prior to Work.

      2. Submit additional material Samples at least every 500 cubic yards throughout course of Work, if requested by Engineer to evaluate consistency of source or process.
1.07 DELIVERY, STORAGE, AND HANDLING
A. Provide in accordance with Division 01 General Requirements.
B. Waste Management and Disposal
   1. Legally dispose of excess or unsuitable material.

1.08 SITE CONDITIONS
A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS
A. General
   1. Obtain approval of Owner and Engineer for changes in material sources.
   2. Identify off-Site sources of materials and testing of materials to verify compliance with Specifications. Material may be inspected by Owner.
B. Crushed stone: 3/4-inch sized, durable, clean angular rock fragments obtained by breaking and crushing rock material meeting MassDOT M2.01.4 criteria, free of ice, snow, sand, silt, clay, loam, shale, or other deleterious matter.

Sieve analysis by weight

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<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
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<td>100</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>90-100</td>
</tr>
<tr>
<td>1/2-inch</td>
<td>10-50</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>0-20</td>
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<tr>
<td>#4</td>
<td>0-5</td>
</tr>
</tbody>
</table>
C. Sand: clean inert, hard, durable grains of quartz or other hard durable rock, free from loam or clay, surface coatings and deleterious materials.

### Sieve analysis by weight

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
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</table>

D. Suitable backfill: well-graded granular material. Retain at least 25 percent by weight on #4 sieve and contain less than 35 percent finer than a #200 sieve by weight, predominantly free from organic matter, man-made materials, ice, snow or other deleterious material.

E. Gravel borrow for trench backfill: hard, durable stone and course sand inert material, free from loam and clay, surface coatings and deleterious material, MassDOT Division III, subsection M1.03.0, Type b. Gradation requirements: AASHTO T11 and T27.

### Sieve analysis by weight

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch</td>
<td>50-85</td>
</tr>
<tr>
<td>#4</td>
<td>40-75</td>
</tr>
<tr>
<td>#50</td>
<td>8-28</td>
</tr>
<tr>
<td>#200</td>
<td>0-10</td>
</tr>
</tbody>
</table>

Type b: maximum stone size = 3-inches in largest dimension

F. Gravel borrow for roadway subbase: processed gravel for backfill per MassDOT Section M1.03.1, consisting of hard, durable stone and course sand inert material, free from loam and clay, surface coatings and deleterious materials. Coarse aggregate percentage of wear: maximum 50 by ASTM C131 and AASHTO T 96.
Sieve analysis by weight

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inch</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2 inch</td>
<td>70-100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>50-85</td>
</tr>
<tr>
<td>#4</td>
<td>30-60</td>
</tr>
<tr>
<td>#200</td>
<td>0-10</td>
</tr>
</tbody>
</table>

G. Dense graded crushed stone: crusher-run coarse aggregates of crushed stone and fine aggregates of natural sand or stone screenings, uniformly pre-mixed with a predetermined quantity of water per MassDOT M2.01.7.

H. Refill material: 3/4-inch crushed stone for below grade or rock excavation unless otherwise directed.

I. Common fill: friable material with no objects greater than 6 inches in diameter, no more than 30 percent by weight finer than No. 200 sieve, free from ice, snow, roots, sod, rubbish, other deleterious or organic matter, and observable contamination. Excavated material from on-Site sources meeting these Specifications may be used for common fill.

J. Select backfill: as specified for gravel borrow with stones maximum 3 inches in diameter.

K. Compacted structural fill: suitable bank run sand and gravel, free of clay, organic material, snow, ice, or other unsuitable materials, well-graded.

<table>
<thead>
<tr>
<th>Sieve Designation</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inch</td>
<td>100</td>
</tr>
<tr>
<td>#4</td>
<td>30-90</td>
</tr>
<tr>
<td>#40</td>
<td>10-50</td>
</tr>
<tr>
<td>#200</td>
<td>0-8</td>
</tr>
</tbody>
</table>
L. Drainage stone: 1-1/2-inch crushed stone per MassDOT Section M2.01.1 of durable, clean angular rock fragments obtained by breaking and crushing rock material.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inch</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2 inch</td>
<td>95 - 100</td>
</tr>
<tr>
<td>1 inch</td>
<td>35 - 70</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>0 - 25</td>
</tr>
</tbody>
</table>

M. Controlled density fill (CDF): excavatable and used to limit settlement, lateral movement, undermining, washout and other hazards created by earthwork operations as shown on Drawings and when excavating around structures, utilities, sidewalks, pavements, and other facilities. Batch CDF at concrete plant.

2. Fly ash: AASHTO M295. Class F
5. Air entraining admixture: MassDOT M4.02.05.
6. Compressive strength: 28 day = 30-80 psi, 90 day = 100 psi.
7. Slump: 10 - 12 inches.

N. Riprap stone: sound, durable rock that will not disintegrate due to exposure to water or weather, angular in shape such as rough, unhewn quarry stone or fragments obtained by blasting, breaking or crushing natural rock. Do not use rounded boulders or cobbles; flat, platy stones; shale or slate rock with its largest length dimension 3 times greater than its shortest dimension.

O. Riprap gradation: stone size corresponding to inch dimension indicated on Drawings. $D_{50}$ stone size represents 50 percent of stone passing $D_{50}$ dimension sieve screen. $D_{20}$ stone size, 20 percent passing: 1/2 $D_{50}$ dimension. Maximum size limit: $D_{100}$: twice the $D_{50}$ stone size dimension.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 EXAMINATION

A. Verification of Conditions

1. Check and verify governing dimensions and elevations before starting Work. Survey condition of adjoining properties with Engineer. Take digital video recording of any prior settlement or cracking of structures, pavements and other improvements. Provide list of damages, verified and signed by Contractor and Engineer.

2. Coordinate survey. Establish exact elevations at fixed points to act as benchmarks. Identify benchmarks and record existing elevations. Locate datum level used to establish benchmark elevations so it will not be affected by excavation operations.

3. Review geotechnical report and information for the Project. Review available logs of borings and test pits, records of explorations and other pertinent data for the Site.

4. Verify subsurface utilities have been marked prior to performing excavation or earthwork and provide sufficient notification to the local Dig Safe agency.

3.02 PROTECTION

A. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost. Remove temporary protection before continuing Work.

D. Prevent surface water and groundwater from entering excavations, ponding on prepared subgrades, and flooding Project Site and surrounding area.

E. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Excavation will occur below water level. Complete Work in-the-dry to maintain undisturbed condition of bearing soil.
2. Reroute surface water runoff away from excavated area. Do not allow water to accumulate in excavations to ensure bottoms and sides of excavations remain firm and stable throughout construction operations. Do not use excavated trenches as temporary drainage ditches.

3. Install a dewatering system in accordance with Section 01 57 05 to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.

4. Recharge water from excavations on-Site avoiding injury to public health, public and private property, existing Work, Work to be completed or in progress, roads, walks and streets, or causing any interference with the public.

5. Do not place concrete or fill in excavations containing free water.

3.03 GENERAL EXCAVATION

A. Ensure sequence of excavation operations provides efficient use of excavated materials into embankments and minimum use of borrow.

B. Dispose of excavated materials including unsatisfactory soil materials, cobbles, boulders, and obstructions and replace with suitable backfill materials. Urban fill may be screened to remove unsatisfactory material, and used requirements of suitable backfill are met.

C. Remove and legally dispose of pavements, curbing and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, and other materials encountered that are not classified as rock excavation or unauthorized excavation. Legally dispose of surplus materials resulting from excavation not needed for use on Project as determined by Engineer. Obtain necessary permits for legal disposal of surplus material.

D. Unclassified excavation: excavating to subgrade elevations regardless of surface and subsurface conditions.

E. Classified excavation: excavating to subgrade elevations. Material excavated: classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions.
a. 24 inches outside of concrete forms other than at footings
b. 12 inches outside of concrete forms at footings
c. 6 inches outside of minimum required dimensions of concrete cast against grade
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments
   1) 6 inches beneath bottom of concrete slabs-on-grade
   2) 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide

F. Remove materials encountered to limits shown on Drawings, as specified or required.

G. Do not perform excavation below normal grade to remove and replace unsuitable materials until approved by Engineer.

H. Unauthorized excavation: removal of materials beyond indicated subgrade elevations or dimensions without specific direction.
   1. Refilling Unauthorized Excavation
      a. Trenches: use 3/4-inch crushed stone or compacted structural fill and stabilization fabric as separator material as directed.
      b. Backfill and compact unauthorized excavations as specified for authorized excavations, of same classification, unless otherwise directed.
      c. Excavation below normal grade
         1) Notify Engineer to observe conditions when excavation has reached required subgrade elevations. Carry excavations deeper and replace excavated material with compacted structural fill or crushed stone if unsuitable materials are encountered at required subgrade elevations as directed.
   2. Excavation Above Normal Grade
      a. Remove from Site and dispose of legally if unsuitable materials are encountered above normal grade. Do not use unsuitable materials as backfill on any portion of Project unless approved.
b. Use approved suitable stockpiled material to replace unsuitable material to backfill trenches to dimensions for pipe and structure bedding and backfill as shown on Drawings. Use gravel borrow to complete trench backfills to elevation shown for pipe and structure backfill if suitable stockpile material is not sufficient to backfill trenches to required dimensions.

I. Site Clearing
   1. Clear site in accordance with Section 31 10 00.

J. Material Storage
   1. Stockpile and maintain suitable surplus excavated materials for re-use as specified in Section 31 14 13.16.

3.04 EXCAVATION IN ASPHALT PAVEMENT AREAS

A. Saw cut or mill to full depth through existing pavement for pipe or structure placement prior to excavation. Minimize disturbance of remaining pavement.

B. Use shoring and bracing where sides of excavation will not stand without undermining pavement.

C. Remove and legally dispose of existing pavements during course of Work. Avoid mixing existing pavement material with excavation material intended for backfill.

3.05 EXCAVATION FOR TRENCHES

A. Excavate to widths shown on Drawings.

B. Produce an evenly graded flat trench bottom at subgrade elevation required for installation of pipe and bedding material.

C. Load excavated material directly into trucks unless otherwise approved.

D. Place backfill material directly into trench or excavation. Do not stockpile material to be used as backfill in traffic areas.

3.06 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within tolerance of plus or minus 1 inch. Extend excavations sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and inspections.
1. Excavate footings, foundations, and structures to final grade by hand just before concrete reinforcement placement. Do not disturb bottom of excavation. Trim bottoms to required lines and grades to leave solid base to receive other Work.

2. Do not excavate to final subgrade level until geotextile and compacted structural fill or crushed stone layer can be placed immediately to avoid softening or deterioration of formation. Leave a minimum depth of 3 feet overlying the final subgrade level in place where geotextile and compacted structural fill or crushed stone layer are not immediately placed.

3. Do not allow trafficking on final subgrade or upper surface of crushed stone layer without prior placement of approved sacrificial haulage layer.

B. Approval of Subgrade

1. Notify Engineer when excavations have reached required subgrade. Remove last 6 inches just prior to inspection.

2. Clear subgrade of soft, spongy or other material unsuitable for founding. Continue excavation and replace with compacted structural fill as directed if independent inspection and testing agency or geotechnical consultant determines presence of unsatisfactory soil.

3. Finished subgrade tolerance: plus or minus 1 inch.

4. Seal subgrade and protect from degradation.

5. Re-compact exposed surfaces prior to placing compacted structural fill or constructing foundations in accordance with Article 3.11, with a minimum 4 passes with double-drum vibratory roller compactor following excavation to foundation bearing levels in natural soils, using Bomag BW 60S or equivalent. Engineer may waive re-compaction if integrity of subgrade soils is compromised. Do not proof-roll wet or saturated subgrades.

6. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water or construction activities affecting final subgrade.

7. Seal formations within 4 hours of inspection with specified geotextile and compacted structural or crushed stone fill.

8. Install geotextiles in accordance with Section 31 05 19.13.

9. Protect formations from loosening by traffic or resulting from high groundwater table.
C. Provide monitoring of geotechnical instrumentation against predefined target performance values.

3.07 PROCESSING OF ON-SITE URBAN FILL USED FOR BACKFILL

A. Excavate urban fill where encountered in Work to designated depths and stockpile until processed.

B. Pass on-Site cohesionless soils excavated from trench through mechanical screen to remove particles larger than 3 inches.

C. Reuse only processed urban fill containing maximum of 5 percent by dry weight of roots, plants, sod, clay lumps or other organic or cohesive soils.

3.08 ROCK EXCAVATION

A. Notify Engineer immediately of change in classification. Expose bedrock surface to allow Engineer to perform an elevation survey and take cross-sectional measurements if bedrock is encountered above trench bottom grade or above subgrade elevation.

B. Perform rock excavation by mechanical methods only. Do not blast.

C. Remove or partially remove boulders exposed on sides or bottom of excavations as directed. Remove boulders to:

1. minimum 2 feet outside structure walls;
2. minimum 12 inches outside footings;
3. minimum 6 inches below under-slab subgrade;
4. minimum lateral trench width line limits indicated; and
5. minimum 12 inches below underside of pipes.

D. Refill depressions resulting from removal of boulders and rock with approved compacted bedding.

E. Refill unauthorized rock excavations, or excavations made beyond or below indicated or directed excavation limits, with compacted bedding.

F. Remove and legally dispose of unused rock and boulders off-Site.

G. Remove and legally dispose of residual solids to limits shown on Drawings, as specified, or needed to complete Project in accordance with Laws and Regulations.
3.09 SHORING AND BRACING

A. Provide in accordance with Section 31 50 00.

3.10 BACKFILL AND FILL

A. General

1. Suspend operations when weather conditions are unsatisfactory for placing backfill and avoid disturbing placed material and approved excavations.

2. Remove and replace excavation or material previously placed that have softened or eroded, soft and yielding material, or other unsuitable or damaged areas with compacted backfill as specified.

3. Do not backfill excavations and trenches until new utilities and structures have been inspected and tested satisfactorily for conformance with Drawings and Specifications unless directed. Place soil material in layers to required elevations as shown on Drawings or specified. Fill, backfill, and compact in accordance with this Section to produce minimum subsequent settlement of material. Provide support for surface treatment or structure to be placed on material. Place material in approximately horizontal layers beginning at lowest area, maintaining drainage. Replace frozen or saturated fill in stockpiles with suitable off-Site fill.

B. Provide compacted structural fill or backfill for structure, placed beneath the structures’ foundations and slabs-on-grade where unsuitable soil has been over excavated below design subgrades, and against below grade walls.

C. Do not reuse excess excavated on-Site soils as compacted structural fill below foundations.

D. Ground Surface Preparation

1. Remove asphalt and concrete pavements, granular base course, existing sandy and gravelly fills, existing organic silty clay soils, organic peat, vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface to excavation subgrade prior to placement of fills.

2. When existing ground surface has a density less than specified for a particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.
E. Placement

1. Place backfill and fill materials in layers of maximum 6 inches in loose depth for material compacted by heavy compaction equipment or hand-operated tampers. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

2. Place backfill and fill materials evenly, adjacent to structures, to required elevations. Prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.

3. Do not allow heavy machinery within 5 feet of structure during backfilling and compacting.

F. Backfilling Excavations

1. Backfill excavations promptly as Work permits and after completion of the following.
   a. Inspection and recording locations of underground utilities and structures
   b. Removal of concrete formwork
   c. Removal of shoring and bracing, and backfilling of voids with satisfactory materials
   d. Removal of trash and debris

2. Backfill under existing utility pipes crossed by new utility pipes with CDF. Extend CDF continuously from bedding of new pipe to utility pipe crossed, including a 6-inch thick envelope around existing utility pipes.

3. Backfill with CDF when clearance between proposed structure and existing structure is 18 inches or less and sufficient clearance is not provided to obtain suitable compaction.

4. Backfill with CDF for trenches within impervious surfaces with pipes containing less than 3 feet of cover.

5. Provide that 3/4 inch crushed stone backfill stands at its own angle of repose. Do not haunch or form with common fill.

G. Backfilling Trenches

1. Place pipe and structure bedding, and gravel bedding to extent and dimensions shown on Drawings so pipes and structures have complete and uniform bearing.
2. Grade, compact, and shape pipe and structure bedding so full length of pipe barrel has complete and uniform bearing. Dig bell holes and depressions for joints after bedding has been graded and compacted, at proper clearance for jointing pipes.

3. Carefully hand place and compact additional approved bedding to limits shown on Drawings following inspection and approval of pipe installation by Engineer. Perform hand or mechanical tamping on sides of pipe.

4. Place 6 inches of suitable backfill (having stones maximum 3 inches in diameter) in trenches above pipe crown; 6 inches above crown of highest pipe around structures and up to underside of pavement. Spread in layers of maximum 6 inches in loose thickness and compact in accordance with Article 3.11, and compact each layer by minimum 4 passes using approved vibratory compactor. Avoid disturbance of Work and existing structures. Adjust moisture content of backfill for proper compaction.

5. Bed pipe in 3/4-inch crushed stone pipe and structure bedding as shown on Drawings. Remaining trench backfill: as shown on Drawings.

6. Restore surface of trenches in cross-country runs to pre-existing conditions as shown on Drawings, mounding trench 6 inches above existing grade or as directed.

H. Earthen Embankment Fill

1. Strip organic topsoil, trees, shrubs and roots of other vegetation along length and breadth of areas having fill material placed on top. Fill depressions left by grubbing and stripping with same type material and compact to a density at least equal to surrounding foundation material.

2. Replace unsuitable soil with compacted fill material identified by independent inspection and testing agency or Engineer.

3. Proof roll subgrades as directed prior to placement of fill. Excavate soft areas and replace with appropriate compacted fill.

4. Do not place embankment over porous, wet, frozen, or spongy subgrade or previous embankment surfaces. Excavate and remove unsuitable material prior to placing additional fill.

5. Dewater to maintain groundwater levels a minimum of 1 foot below bottom of excavations or subgrades. Place fill in-the-dry.

6. Bench existing slopes prior to placing horizontal fill layers on existing slopes greater than 6H:1V.
7. Place materials in continuous horizontal layers in loose lift thickness of maximum 8 inches.

8. Compact soil materials in accordance with ASTM D1557, with water content of plus or minus 2 percent moisture content. Remove and replace with drier fill if wet fill cannot be compacted as specified.

9. Uniformly water fill that is too dry for proper compaction with sufficient water to allow compaction to required density.

10. Compact impervious and semi pervious materials with more than 15 percent passing the #200 sieve, with a tamping sheep-foot roller or rubber-tired roller. Scarify surface before placement of next lift if compaction results in smooth surface on top of lift.

11. Remove and replace fill that is disturbed after compaction and re-compact to specified degree of compaction.

12. Place and compact soil material on embankment in a direction parallel to embankment top.

3.11 COMPACTION

A. Use approved methods that produce required degree of compaction throughout entire depth of material placed without damage to new or existing facilities. Adjust moisture content of soil as required. Remove and replace material that is too wet to compact to required density. Compact each layer as Work progresses.

B. Place compacted structural fill for support of footings and foundations and against below grade walls in loose lift thicknesses not exceeding 10 inches. Compact to minimum 95 percent maximum dry density in accordance with ASTM D1557.

C. Place backfill in open areas with self-propelled vibratory rollers, and hand-guided equipment in confined areas. Loose lift thickness: maximum 6 inches.

D. Perform a minimum 4 systematic passes to compact each lift with specified compaction equipment.

E. Place backfill and fill soil materials evenly on sides of structures to required elevations, and uniformly along full length of each structure.
<table>
<thead>
<tr>
<th>Compaction Method</th>
<th>Maximum Stone Size</th>
<th>Maximum Loose Lift Thickness</th>
<th>Minimum Number of Passes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Below Pavement</td>
<td>Less Critical Areas</td>
</tr>
<tr>
<td>Hand-operated vibratory plate or light roller in confined areas</td>
<td>4 inches</td>
<td>6 inches</td>
<td>8</td>
</tr>
<tr>
<td>Hand-operated vibratory drum rollers weighing at least 1,000 pounds in confined areas</td>
<td>6 inches</td>
<td>10 inches</td>
<td>12 inches</td>
</tr>
<tr>
<td>Light vibratory drum roller minimum weight at drum 5,000 pounds, minimum compaction force 10,000 pounds</td>
<td>8 inches</td>
<td>6 inches</td>
<td>18 inches</td>
</tr>
<tr>
<td>Medium vibratory drum roller min. weight at drum 10,000 pounds, minimum compaction force 20,000 pounds</td>
<td>8 inches</td>
<td>6 inches</td>
<td>24 inches</td>
</tr>
</tbody>
</table>

F. Degree of Compaction

<table>
<thead>
<tr>
<th>Fill and Backfill Location</th>
<th>Minimum Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top 3 feet under pavement grade</td>
<td>95 percent of maximum</td>
</tr>
<tr>
<td>Below slabs and foundations</td>
<td>95 percent of maximum</td>
</tr>
<tr>
<td>Below top 3 feet under pavement grade</td>
<td>92 percent of maximum</td>
</tr>
<tr>
<td>Pipe Bedding</td>
<td>92 percent of maximum</td>
</tr>
<tr>
<td>Beside structure foundation walls</td>
<td>95 percent of maximum</td>
</tr>
<tr>
<td>Maximum density</td>
<td>ASTM D698, modified</td>
</tr>
<tr>
<td>Field density tests</td>
<td>ASTM D1556 (sand cone) or ASTM D6938 (nuclear methods)</td>
</tr>
</tbody>
</table>

G. Disc harrow or dry fill material that is too wet for compaction to specified moisture content and to required density. Remove and replace with drier fill that cannot be dried within 48 hours of placement.
3.12 GRADING

A. Uniformly grade areas, including adjacent transition areas. Smooth finished surface within specified tolerances. Compact with uniform levels or slopes between points where elevations are shown, or between points where elevations are shown and existing grades.

B. Grade areas adjacent to structure lines to drain away from structures and prevent ponding.

C. Finish surfaces: free from irregular surface changes and as follows.
   1. Finish lawn or other unpaved areas to receive topsoil to within a maximum 0.10 feet above or below required subgrade elevations.
   2. Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than plus or minus 1 inch above or below required subgrade elevation.

3.13 RIPRAP

A. Place riprap to full depth of 1.5D_{50} in one operation without special handwork, measured perpendicular to face of slope to obtain uniform appearance true to line and grade. Place larger stones at bottom of slope. Place stones in close contact with interlocking of face stones and backing stones. Fill openings between stones with smaller stones. Embed, re-orient or discard loose stones or excessively large stones projecting above surface.

3.14 EROSION CONTROL

A. Provide erosion control measures in accordance with Section 01 57 13 and Section 31 25 00.

3.15 PROTECTION

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Scarify surface, re-shape, and compact to required density prior to further construction where completed compacted areas are disturbed by subsequent construction operations or adverse weather. Immediately repair any subsequent settling and provide maintenance for remainder of Work.
C. Remove soft or unsuitable material and replace with suitable backfill material prior to paving on sub-grade. Bring low sections, holes, or depressions to required grade with approved material. Shape sub-grade to line, grade, and cross section, and thoroughly compact.

D. Keep roads free of debris. Use watertight vehicles for hauling wet materials over roads and streets. Promptly clean materials dropped or spread by vehicles or when directed by Engineer.

3.16 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements. Owner may engage a qualified special inspector to perform the following special inspections in addition to the Contractor’s independent testing.

1. Confirm specified fill and backfill are used.

2. Confirm preparation of Site.

3. Observe removal of existing unsuitable foundation materials from footing and slab areas and confirm character of material encountered at bearing levels.

4. Confirm compliance of fill material and maximum lift thickness.

5. Confirm compliance of in-place density of compacted fill with required frequency.

6. Observe preparation of footing bearing surfaces.

7. Confirm suitability of excavated soils for reuse as fill, including reuse of on-Site soils as common fill.

B. Perform at least 1 test of each soil stratum at foundation subgrades to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on visual comparison of subgrade with tested subgrade when approved.

C. Engage an independent testing agency to test compaction of soils in place in accordance with ASTM D1556, ASTM D2167, ASTM D2922, and ASTM D2937.

1. Tests

   a. Paved and structure areas: at subgrade and each compacted fill and backfill layer, at least 1 test for every 2,000 square feet or less of paved area or concrete slab, with minimum 3 tests.
b. Foundation walls backfill: at each compacted backfill layer, at least 1 test for every 100 feet or less of wall length, with minimum 2 tests.

c. Trench backfill: at each compacted initial and final backfill layer, at least 1 test for every 150 feet less of trench length, with minimum 2 tests.

2. Scarify and moisten or aerate, or remove and replace soil materials to depth required when testing agency reports subgrades, fills, or backfills have not achieved degree of compaction specified. Re-compact and re-test until specified compaction is obtained.

3. Determine actual in-place densities using field tests as directed.

4. Perform additional Work to obtain proper compaction if in-place densities do not meet specified densities. Retest if directed by Engineer.

5. Tests for Pipe Backfill

   a. Suitable backfill: compact backfill in maximum loose lifts per table above. Conduct 1 field density test every 50 linear feet for each lift for utility lines.

   b. Pavement sub-base: minimum 1 field density test of sub base for every 50 linear feet of paved area.

3.17 CLOSEOUT ACTIVITIES

   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 31 10 00
SITE CLEARING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide Site clearing and grubbing in accordance with this Section.

B. Related Requirements

1. Section 32 90 00 – Planting

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Definitions

1. Clearing: cutting and disposing of trees, downed timber, stubs, brush, bushes, snags, rubbish, debris, and other objectionable matter and materials, and removal and storage of fences, signs, walks, guard rails, curbs and items to be restored.

2. Grubbing: removal and disposal of stumps, roots, duff, foundations and other objectionable matter, and materials to a minimum of 6 inches below original ground surface.

3. Topsoil: friable loam surface soil found in a depth of not less than 4 inches from original ground surface. Satisfactory topsoil: reasonably free of subsoil, clay lumps, stones, and objects over 2 inches in diameter, and free of weeds, roots, and other objectionable material.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Store trees, plants and shrubs in protected areas and provide water to keep them in thriving condition for replanting.
   C. Store slate and flagstone walk sections, granite and stone curbs, fences, signs, guard rails and other items removed for reinstallation at approved locations.
   D. Do not obstruct roads, driveways, sidewalks, gutters and drainage ditches, swales and channels with stored materials.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 EXAMINATION
   A. Verification of Conditions
      1. Verify Site conditions. Trees, plantings, vegetation, sidewalks, curbs and other living and nonliving item locations shown on Drawings were determined by actual surveys and conditions may have changed.
      2. Verify limiting boundaries, such as permanent and temporary easements, property lines, rights-of-way and grading limits, have been located and marked.
      3. Verify pipeline routings and other items of Work have been located and marked.

3.02 PREPARATION
   A. Mark trees, plantings and other items to be removed, trimmed, cut, or removed and preserved. Inspect items with Engineer prior to start of Work. Do not remove or trim unmarked items unless approved by Engineer.
   B. Protect existing trees and vegetation indicated to remain in place against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering by stockpiling construction or excavated materials within drip line, excess foot or
vehicular traffic, or vehicle parking within drip line. Provide temporary guards to protect trees and vegetation to be left standing.

C. Protect existing objects. Avoid interference with use of, and passage to and from adjacent buildings, facilities, driveways, walks, drainage systems and road.

D. Remove highway signs, guard rails and other control, safety, and warning devices just prior to installation of Work.

E. Notify affected property owners at least 4 days in advance of fence removal. Do not remove fencing more than 48 hours in advance unless written permission is received from property owner.

F. Leave items affecting traffic, safety, containment of humans and animals, and essential to protection of property or operation of a business, in place until Work is ready to be installed. Restore items immediately after installation.

3.03 IMPLEMENTATION

A. General

1. Use of explosives for clearing and grubbing operations is not allowed.

2. Limit clearing and grubbing to preserve plantings and natural vegetation. Perform Work so present growth will blend with limits of construction and attain natural appearance.

3. Confine clearing and grubbing operations within grading limits as shown on Drawings, and within Owner easements and property lines.

4. Provide measures to avoid erosion.

5. Do not disturb property markers unless absolutely necessary. If necessary to disturb or remove a property marker, employ a professional land surveyor licensed in the state where the Project is located to establish property marker location; mark area, and replace property marker immediately, in compliance with Division 01 General Requirements.

B. Stripping Topsoil

1. Strip topsoil within limits indicated on Drawings, or as required to prevent mixing with underlying subsoil or objectionable material.

2. Prevent damage to main root system of trees indicated to be left standing.

3. Stockpile topsoil in areas shown on Drawings, or where directed, and provide for drainage of surface water. Protect stockpiles to prevent windblown dust and erosion.
4. Stockpile surplus material on-Site. Surplus loam and topsoil not required for completion of Work will remain on Owner’s property. Maintain and protect until Work is complete.

C. Trees and Plantings
   1. Remove only items marked for removal in grassed, planted and open areas.
   2. Trees
      a. Notify property owners 1 month in advance of tree trimming or removal to allow property owner to cut and remove trees and retain debris, unless otherwise directed.
      b. Remove or trim trees in wooded areas only as required. Minimize damage to trees left standing. Immediately remove and legally dispose of debris.
      c. Take possession of timber and wood removed.
      d. Trim trees evenly to achieve neat appearance with least possible damage to trees.
      e. Apply wet burlap to prevent drying where roots are cut or damaged.

D. Pavements, Walks, Curbs and Guard Rails
   1. Remove existing pavements, walks, and curbs to limits shown on Drawings, or if not shown, to minimum extent possible to complete the work.
   2. Saw-cut pavements to be removed, including highways, driveways and walks. Remove when Work is ready to be installed.
   3. Remove slate and flag stone walks, granite and stone curbs, and guard rails to minimum extent possible. Terminate removals at joint or guard rail post. Store and protect for reuse.

E. Walls, Fences, and Other Obstructions
   1. Remove walls, fences, signs, sheds and other obstructions and store for replacement after verification with Owner and Engineer.
   2. Protect existing structures during Work.

F. Remove and legally dispose of materials not specified to be stored or reused. Do not burn debris unless approved and required permits obtained.

G. Comply with Section 32 90 00 for replanting and restoring surfaces.

H. Replace and restore items and materials removed to original conditions.
I. Replace items damaged during removal, storage or re-installation.

3.04 FIELD QUALITY CONTROL
A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES
A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 31 14 13.16
SOIL STOCKPILING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes
   1. Provide labor, equipment and materials associated with soil stockpiling in accordance with this Section.

B. Related Requirements
   1. Section 01 57 13 – Temporary Erosion and Sediment Control
   2. Section 31 00 00 – Earthwork
   3. Section 31 10 00 – Site Clearing
   4. Section 31 50 00 – Excavation Support and Protection

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.05 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.07 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.
PART 2 – PRODUCTS

2.01 MATERIALS
   A. Provide minimum 6 mil fire retardant polyethylene sheeting.

2.02 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 SOIL STOCKPILING
   A. Locate soil stockpiles in area approved by Engineer. Transport soils from generation area to stockpile areas along designated transport roadways approved by Engineer, preventing soil spillage, mud and soil tracking, and release of other materials to transport roadway throughout construction.

   B. Arrange location, clearing, removal and salvage of overburden soils, and other Site preparation for temporary stockpiles. Location: approved by Engineer.

   C. Cover soil stockpiles with minimum 6 mil polyethylene sheeting at all times, except during active loading or removal, if directed by Engineer. Keep stockpiles in neat and well drained condition.

   D. Identify stockpiles, including classification of soil or other excavated spoils. Maintain an updated inventory of all stockpiled material.

3.02 SOIL REUSE
   A. Utilize on-Site soils for backfill before use of imported soil, as directed by Engineer.

   B. Transportation and legal disposal of surplus native soils is allowed.

3.03 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

3.05 PROTECTION
   A. Protect structures, utilities, facilities and pavements from damage caused by settlement, lateral movement, washout, and other hazards created by stockpiling of soil.
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SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROLS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide and install permanent devices to control erosion, siltation, and sedimentation in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. MassDEP – Massachusetts Erosion & Sedimentation Control Guidelines for Urban and Suburban Areas

2. MassDOT Standard Specifications and Supplements and Construction Details
   a. Section 767 – Mulching, Seed for Erosion Control
   b. M6.04.2 Straw Mulch

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data: for permanent erosion control matting.

C. Manufacturer’s Instructions

D. Closeout and maintenance material submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements

PART 2 – PRODUCTS

2.01 MATERIALS
   A. Permanent Erosion Control Blanket
      1. Provide as shown on Drawings or as directed by Engineer in compliance 
         with the Order of Conditions to prevent slope erosion. If sequence of 
         operations is such that only portions of slopes have been completed, 
         preserve those portions by seeding and installation of erosion control 
         blanket when directed, prior to completion of remaining portions of slope.
      2. Provide soft pine wood wedges and stakes of biodegradable materials as 
         recommended by manufacturer.
      3. Coir log: coconut fiber mats woven into a matrix in compliance with the 
         following.

<table>
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<tr>
<th>PROPERTY</th>
<th>Test Method</th>
<th>Parameter</th>
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<tr>
<td>Weight</td>
<td>ASTM D 3776</td>
<td>17.8 oz/SY (600 g/m2)</td>
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<td>Wide width tensile strength Wet</td>
<td>ASTM D 4595</td>
<td>910 lbs/ft (13.3 kN/m)</td>
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<tr>
<td>Machine direction</td>
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<td>870 lbs/foot (12.7 kN/m)</td>
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<tr>
<td>Cross direction</td>
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<tr>
<td>Wide width tensile strength Dry</td>
<td>ASTM D 4595</td>
<td>1130 lbs/foot (16.5 kN/m)</td>
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<tr>
<td>Machine direction</td>
<td></td>
<td>1040 lbs/foot (15.2 kN/m)</td>
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<tr>
<td>Cross direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elongation at failure Wet</td>
<td>ASTM D 4595</td>
<td>32 percent</td>
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<td>Machine direction</td>
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<tr>
<td>Thickness</td>
<td>ASTM D 177</td>
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<td>Recommended shear stress</td>
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<tr>
<td>Recommended flow</td>
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<td>10 fps (3 m/s)</td>
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<td>Recommend slope</td>
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</table>

B. Straw mulch: MassDOT M6.04.2, long fibered straw, 100 percent certified weed 
   free, free from foreign matter detrimental to plant life, and in dry condition.
C. Tackifier: biodegradable and non-toxic bonding adhesive agent during hydraulic seeding or straw mulching to minimize wind and water effects.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GENERAL

A. Prevent erosion of soil and to prevent silting of drainage ditches, storm sewers, rivers, streams, and lakes.

B. Limit duration of exposure of soils on embankments, excavations, and graded areas.

C. Install erosion control measures in any ditch, swale or channel before runoff flows to waterways.

3.02 PREPARATION

A. Protection

1. Provide pollution prevention measures, erosion and sedimentation control, before, during and after soils are exposed. Implement and maintain erosion and sedimentation control measures as necessary until Site is permanently stabilized.

2. Stabilize areas shown on Drawings with permanent erosion control practices immediately, and within 14 days after construction activity on a particular portion of Site has permanently ceased, except where construction activities will resume on the particular portion of Site within 21 days, and where snow cover precludes initiation of stabilization measures.

B. Conform to grades and cross sections for slopes and ditches shown on Drawings.

C. Finish to a smooth and even condition. Rake out and remove debris, roots, stones, and lumps.

D. Loosen soil surface to permit bedding of matting.

E. Apply seed prior to placement.

F. Dewater trenches and swales to install materials in the dry.
3.03  INSTALLATION

A. Install erosion control blanket and straw mulch in accordance with manufacturer’s instructions, the following, and as shown on Drawings or directed by Engineer. Submit manufacturer's instructions to Engineer prior to installation. Place immediately following seeding.

B. Install erosion control blanket onto slopes that have been graded, seeded, completed to required line and where grades are steeper than or equal to 3:1 as shown on Drawings and directed by Engineer.

C. Place strips lengthwise in direction of flow of water.

D. Overlap ends at least 6 inches in a shingle fashion.

E. Turn down up-slope end of each strip of matting and bury to a depth of not less than 6 inches with soil firmly tamped against it.

F. Engineer may require that any edge exposed to more than normal flow of water be buried in a similar manner.

G. Build check slots at right angles to direction of flow of water. Space so one check slot or one end occurs within each 50 feet of slope length. Construct by placing a tight fold of matting at least 6 inches vertically into ground, and tamp same as up-slope ends.

H. When directed by Engineer, spread additional seed over matting, particularly at locations disturbed by building the slots. Press matting onto ground with a light lawn roller or similar means.

I. Use pine wedges to fasten coir to ground. Metal staples are not allowed. Pound vertically flush to surrounding surface, not protruding above finished grade. Place pine wedges in same locations as recommended by manufacturer for staples.

J. On grades 4:1 or steeper, place pine wedges in same 3 rows, but spaced 2 feet apart.

K. On overlapping or butting edges, double pine wedges, with spacing halved. Secure ends of matting and required check slots spaced every foot.

L. Apply weed free straw mulch in combination with erosion control blanket on side slopes steeper than 3:1.

M. Place mulch according to MassDOT Section 767. Do not use short fibered material or material so wet or decayed that it cannot be properly spread. Apply tackifier as needed.

N. Maintain areas mulched or matted, until Project acceptance.
O. Maintain swales by removing silt that reaches a depth of over one foot, until Project acceptance.

3.04 REPAIR/RESTORATION

A. Repair matting immediately if any pine anchors become loosened or raised, or if any matting becomes loose, torn, or undermined.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field Tests and Inspections

1. Inspections of disturbed soil areas, material storage areas exposed to precipitation and erosion control measures will be conducted by both Contractor and Engineer a minimum of once every 14 days and also within 24 hours after any storm event greater than 0.5 inches of rainfall. Immediately correct deficiencies identified.

2. Inspect erosion control blanket immediately after each rainfall and at least daily during prolonged rainfall or snowmelt for damage. Make appropriate repairs or replacement until acceptance by Engineer.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide excavation support and protection in accordance with this Section and applicable reference standards listed in Article 1.03, including shoring and bracing necessary to protect existing buildings, sidewalks and streets, utilities, all existing improvements, and excavation against movement due to caving, to meet OSHA safety requirements of shoring and bracing, and to cofferdams.

a. Installation of shoring and bracing
b. Maintenance of shoring and bracing
c. Removal of shoring and bracing, as required

2. Shoring and bracing systems include permanent and temporary measures.

B. Related Requirements

1. Section 31 00 00 - Earthwork

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Institute of Steel Construction (AISC)

a. Steel Construction Manual

2. ASTM International (ASTM)

a. ASTM A36 Standard Specification for Carbon Structural Steel
b. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
c. ASTM A328 Standard Specification for Steel Sheet Piling
d. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

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

f. ASTM A690 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

g. ASTM A992 Standard Specification for Structural Steel Shapes

3. American Welding Society (AWS)
a. D1.1 - Structural Welding Code, Steel

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

B. Pre-installation Conference

1. Review geotechnical report, existing utilities and subsurface conditions.

2. Review coordination for interruption, shutoff, capping, and continuation of utility services.

3. Review instrumentation and monitoring program, and dewatering program. Confirm coordination with instrumentation and monitoring, and dewatering activities.

4. Review proposed excavations and equipment, monitoring of excavation support and protection system and abandonment or removal of excavation support and protection system.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

1. Do not begin excavation requiring support until submittals are approved.

B. Product Data

1. Construction details, material descriptions, performance properties, dimensions of individual components and profiles, and calculations for excavation support and protection system for each type of product
C. Shop Drawings
   1. Plans, elevations, sections, and details for excavation support and protection system, by professional engineer licensed in the state where Project is located
   2. Arrangement, locations, and details of soldier piles, sheet piling, lagging, tiebacks, bracing, and other components of excavation support and protection system by professional engineer licensed in the state where Project is located
   3. Written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation
D. Calculations and analysis data for excavation support and protection system by professional engineer licensed in the state where Project is located
E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.
   1. Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions on record documents.

1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.
   B. Qualifications: per Division 01 General Requirements for Installer and professional engineer.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.
   B. Review geotechnical report and determine need to perform additional test borings and conduct other exploratory operations necessary for excavation support and protection.
   C. Verify dimensions and elevations before starting Work. Survey condition of adjoining properties with Engineer. Take photographs, recording any prior settlement or cracking of structures, pavements, and other improvements. Prepare list of existing damages, verified by dated photographs, signed by Contractor, Engineer and others conducting the investigation.
D. Survey adjacent structures and improvements, establishing exact elevations at fixed points to act as benchmarks. Identify benchmarks and record existing elevations. Locate datum level where it will not be affected by excavation operations.

E. Interruption of Existing Utilities

1. Do not interrupt any utility serving facilities without Owner's written permission. Provide temporary utility if required.

2. Provide minimum 5 days’ advance notice of proposed interruption of utility.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Provide shoring and bracing materials, in serviceable condition and adequate for intended purpose.

B. Steel sheet piling and shapes: continuous interlocking type; section modulus, type of section specified, in accordance with ASTM A328, ASTM A572, and ASTM A690, with continuous interlocks.

C. Provide movable box where shoring system is required, and where sheet piling is not specified.

D. Bracing members: wood timbers or steel members in accordance with ASTM A36.

E. Provide bolts in accordance with ASTM A307.

F. Provide structural steel in accordance with ASTM A36, ASTM A690, and ASTM A992.

G. Wood lagging: lumber, mixed hardwood, pressure-treated.

H. Provide reinforcing bars in accordance with ASTM A 615, Grade 60, deformed.

2.02 DESIGN CRITERIA

A. Provide services by professional engineer licensed in the state where Project is located, including preparation of Shop Drawings.

B. Design excavation support system in accordance with earth pressures and other criteria indicated, for construction of permanent structures without excessive movement or settlement of adjacent buildings, roadways, structures, or utilities, as shown on Drawings and as specified. Include analysis by professional engineer licensed in the state where Project is located.
C. Earth support design: coordinated dewatering design incorporating lowest anticipated excavation depths and full differential water head during dewatering.

D. Consult official records of both surface and subsurface existing utilities and connections to verify existing conditions and limitations as they apply to this Work and its relation to other construction work. Proceed with caution in areas of utility facilities. Excavate by hand, or other methods acceptable to utility owner. Protect existing utilities to remain within and adjacent to Work area in accordance with requirements of authorities having jurisdiction.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GENERAL

A. Anchor and brace system to resist earth and hydrostatic pressures, including surcharges from surface loads. Support excavation to prevent undermining or disturbance to foundations of existing structures and utilities, or of ongoing or previously completed Work. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or adjacent occupied or used facilities without approval. Provide alternate routes around closed or obstructed traffic ways if required.

C. Maintain shoring and bracing while excavation is open.

D. Check base stability.

E. Prevent surface water from entering excavations.

3.02 STEEL SHEET PILING

A. Install 1-piece sheet piling lengths and interlock vertical edges to form a continuous barrier before starting excavation.

B. Place piling using templates and guide frame unless otherwise specified by sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line, and not more than 1:120 out of vertical alignment.

C. Cut off sheet piling to be left in place at least 5 feet below finish grade. Indicate location of sheet piling cut off and left in place on record documents.
D. Remove steel sheet piling following completion of Work where shown on Drawings or directed by Engineer. Obtain approval for steel sheet piling to be left in place.

3.03 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent Work. Install new bracing before removing original brace if moved. Do not place bracing where it will be cast into permanent concrete Work unless approved by Engineer.

B. Install internal bracing if required to prevent spreading or distortion of braced frames.

C. Maintain bracing until structural elements are supported by other bracing, or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.04 REPAIR/RESTORATION

A. Remove excavation support and protection systems in stages to avoid disturbing underlying soils and rock, or damaging structures, pavements, facilities, and utilities.

B. Fill voids immediately with approved backfill compacted to density specified in accordance with Section 31 00 00.

C. Repair or replace adjacent Work damaged or displaced by removing excavation support and protection systems.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 31 66 15

HELICAL FOUNDATION PILES

PART 1 – GENERAL

1.01 SUMMARY

A. Description

1. Provide helical pile foundation for the pump station as indicated in the Drawings including all materials, tools, equipment and labor required for the design, preparation, shop fabrication, shipping, supervision, installation and load testing in accordance with this Specification, the Drawings and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. 03 30 00 Cast-In-Place Concrete

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Concrete Association (ACI)

   a. ACI 318 Building Code Requirements for Structural Concrete

2. American Institute of Steel Construction (AISC)

   a. AISC 360 Specification for Structural Steel Buildings

3. American Society for Testing and Materials (ASTM)

   a. ASTM A29 Steel Bars, Carbon and Alloy, Hot-Wrought and Cold Finished

   b. ASTM A36 Structural Steel

   c. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

   d. ASTM A153 Zinc Coating (Hot Dip) on Iron and Steel Hardware

   e. ASTM A193 Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service

   f. ASTM A252 Welded and Seamless Steel Pipe Piles
g. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

h. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

i. ASTM A513 Standard Specification for Electric Resistance Welded Carbon and Alloy Steel Mechanical Tubing

j. ASTM A572 HSLA Columbium-Vanadium Steels of Structural Quality

k. ASTM A618 Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing

l. ASTM A656 Hot-Rolled Structural Steel, High-Strength Low-Alloy Plate with Improved Formability

m. ASTM A775 Electrostatic Epoxy Coating

n. ASTM A1018 Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability.

o. ASTM D1143 Method of Testing Piles Under Static Axial Compressive Load

p. ASTM D3689 Method of Testing Individual Piles Under Static Axial Tensile Load

4. American Welding Society (AWS)

   a. AWS D1.1 Structural Welding Code - Steel

5. Society of Automotive Engineers (SAE)

   a. SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

B. A preconstruction meeting shall be held at least 5 working days prior to Contractor beginning helical pile construction at the site to review construction procedures, schedule and required testing. At a minimum the Contractor, Engineer and Geotechnical Engineer shall attend preconstruction meeting.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.
B. At least four weeks prior to the start of helical pile construction, the Contractor shall submit a project reference list to the Engineer (Woodard & Curran) for approval. The reference list shall be used to verify the successful completion by the Contractor of at least three separate foundation projects within the last five years with helical piles and similar subsurface conditions. A brief description of each project and the owner’s contact person’s name and current phone number shall be included for each project listed.

C. At least 14 calendar days prior to the start of foundation construction, the Contractor shall prepare and submit to the Engineer (Woodard & Curran) and Geotechnical Engineer, working drawings and design calculations for the helical piles intended for use based on the subsurface conditions encountered at the site, the applicable Building Code, the structural loads provided in the Drawings, the requirements of this Specification, and the recommendations included in the Geotechnical Engineering Report. Design criteria include the following:

1. Compression: Allowable working load shall not exceed \(0.6 \times F_y \times A\) where \(F_y\) is yield strength of central shaft and \(A\) is area of central shaft.

2. Tension: Allowable working load shall not exceed \(S_{ut}/2\). \(S_{ut}\) is minimum ultimate tensile strength of central shaft (at coupling joint).

3. Except where noted otherwise on the project plans, all helical piles shall be designed and installed to provide a minimum safety factor for ultimate applied load of \(FS = 2.0\) and a maximum axial displacement at working load of 1 inch.

4. The overall length and installed torque of a helical pile shall be specified such that the required in-soil capacity is developed by end-bearing on the helix plate(s) in an appropriate strata(s). Required soil parameters are available in the geotechnical report.

5. Lateral load and bending: Helical piles are subjected to lateral loads as indicated on the plans, the bending moment from said loads shall be determined using lateral load analysis program such as LPILE or equal commercially available software. The required soil parameters for use with LPILE or equal are available in the geotechnical report. Allowable deflection due to lateral working load is 1 inch. The combined bending and axial load factor of safety of the helical pile shall be \(FS = 2.0\).

6. Down-Drag/Negative Skin Friction: For helical shafts > 4 inches in diameter used in compressible soils or where expansive or frozen soils can cause pile jacking, helical pile shafts should be provided with a no-bond zone along a specified length to prevent load transfer that may adversely affect pile capacity. Alternately, helical piles can be provided with sufficient axial load capacity to resist down-drag/negative skin friction forces.
7. The helical pile structure attachment (pile cap) shall distribute the design load to the concrete foundation such that the concrete bearing stress does not exceed those in ACI 318 (specified in 03 30 00) and the stresses in the steel plates/welds does not exceed AISC allowable stresses.


D. The working drawings shall include the following:

1. Helical pile number, location and pattern by assigned identification number
2. Helical pile design load and required safety factor
3. Type and minimum size of central steel shaft
4. Minimum number of helix plates
5. Minimum overall depth
6. Inclination angle of helical pile
7. Cut-off elevation
8. Helical pile attachment to pile caps, grade beams, etc
9. Detailed description of construction procedures and major equipment

E. At least 14 days prior to the start of drilled pier construction, the Contractor shall submit a list identifying the on-site supervisor(s) and operator(s) assigned to the project for review by the Engineer. A detailed summary of each individual’s experience in helical pile construction should be included.

F. At least 14 days prior to the start of drilled pier construction, the Contractor shall submit shop drawings for all helical pile components, including corrosion protection and pile top attachment to the Engineer for review and approval. This includes helical pile lead/starter and extension section identification (manufacturer’s catalog numbers). Shop drawings shall include certified mill test reports, ultimate strength, yield strength, % elongation and chemistry composition.

G. The Contractor shall submit plans for production testing of the helical piles to the Engineer for review and acceptance prior to beginning load tests. The purpose of the test is to determine the load versus displacement response of the helical pile and provide an estimation of ultimate capacity.

H. The Contractor shall submit to the Engineer copies of calibration reports for each torque indicator or torque motor and all load test equipment to be used on the project. The calibration tests shall have been performed within 6 months of the date submitted. Helical pile installation and testing shall not proceed until the
Engineer has received the calibration reports. These calibration reports shall include but are not limited to, the following information:

1. Name of project and Contractor
2. Name of testing agency
3. Identification (serial number) of device calibrated
4. Description of calibrated testing equipment
5. Date of calibration
6. Calibration data

I. All submittals shall be signed and sealed by a Registered Professional Engineer licensed in the State of Massachusetts and have a minimum of four years of experience as an engineer knowledgeable in helical pile foundation analysis and design.

J. The Contractor shall provide the Engineer copies of helical pile installation records. These records shall include, but are not limited to, the following information:

1. Name of project and Contractor
2. Name of Contractor’s supervisor during installation
3. Date and time of installation
4. Name and model of installation equipment
5. Type of torque indicator used
6. Location of helical pile by assigned identification number
7. Actual helical pile type and configuration – including lead section (number and size of helix plates), number and type of extension sections (manufacturer’s SKU numbers)
8. Helical pile installation duration and observations
9. Total length of installed helical pile
10. Cut-off elevation
11. Inclination of helical pile
12. Installation torque at one-foot intervals for the final 10 ft
13. Comments pertaining to interruptions, obstructions or other relevant information

14. Rated load capacities

K. The Contractor shall submit to the Owner copies of field test reports within 24 hours after completion of the load tests. These test reports shall include, but are not limited to, the following information:

1. Name of project and Contractor
2. Name of Contractor’s supervisor during installation
3. Name of third party test agency
4. Date, time and duration of test
5. Location of helical pile by assigned identification number
6. Type of test (i.e., tension or compression)
7. Description of calibrated testing equipment and test set-up
8. Actual helical pile type and configuration – including lead section, number and type of extension sections (manufacturer’s SKU numbers)
9. Steps and duration of each load increment
10. Cumulative pile-head movement at each load step
11. Comments pertaining to test procedure, equipment adjustments, or other relevant information
12. Signed by third party test agency rep., registered professional engineer, or as required by local jurisdiction

L. Approvals: Work shall not begin until all the required submittals have been accepted in writing by the Engineer. All procedural acceptances given by the Engineer shall not relieve the Contractor of the responsibility to satisfactorily complete the work.

M. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and not a limitation of, other rights the Owner may have under Contract Documents.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.
B. Installer Qualifications: Installation shall be performed by an installation contractor authorized by helical pile manufacturer.

C. All helical piles shall be installed in the presence of a designated representative of the Owner unless said representative informs the Contractor otherwise. The designated representative shall have the right of access to any and all field installation records and test reports.

D. Welding: Meet requirements of AWS D1.1, latest edition. All welders shall be AWS certified.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 WARRANTY

A. Manufacturer’s 30-year warranty on materials and workmanship.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. AB Chance

B. Pier Tech

C. Heli Pile

D. Or equal

2.02 CENTRAL STEEL SHAFT

A. The central steel shaft, consisting of lead sections, helical extensions, and plain extensions, shall be square shaft, round shaft or a combination of the two.

1. Approved materials

a. ASTM A29 hot-rolled round-corner solid steel bar, modified medium carbon steel (similar to AISI 1044), Minimum yield strength = 70 ksi (AB Chance SS5)

b. ASTM A29 hot-rolled round-corner solid steel bar, High Strength Low Alloy (HSLA), low to medium carbon steel, Minimum yield strength = 90 ksi (AB Chance SS125, SS150, SS175, SS200, SS225)
c. ASTM A500 or A513 structural steel tube or pipe, welded or seamless, minimum wall thickness = 0.203”, Minimum yield strength = 50 ksi (AB Chance RS2875)

d. ASTM A53, A252, A500 or A618 structural steel tube or pipe, seamless or straight-seam welded, minimum wall thickness = 0.300” (schedule 80), Minimum yield strength = 50 ksi (AB Chance RS3500)

e. ASTM A500 or A513 structural steel tube or pipe, seamless or straight-seam welded, minimum wall thickness = 0.337” (schedule 80), Minimum yield strength = 50 ksi (AB Chance RS4500)

f. For combination square/round shafts, approved materials above may be used with a welded adapter for the transition.

2.03 HELIX BEARING PLATE

A. Shall be hot-rolled carbon steel sheet, strip or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate material shall conform to the following ASTM specifications.

1. Approved materials

a. ASTM A572, A1018 or A656, Minimum yield strength = 50 ksi, Minimum thickness = 3/8” (AB Chance SS5)

b. ASTM A572, Minimum yield strength = 50 ksi, Minimum thickness = 3/8” (AB Chance SS125, SS1375)

c. ASTM A656 or A1018, Minimum yield strength = 80 ksi, Minimum thickness = 3/8” (AB Chance SS150, SS175)

d. ASTM A656 or A1018, Minimum yield strength = 80 ksi, Minimum thickness = 1/2” (AB Chance SS200, SS225)

e. ASTM A36 or A572, Minimum yield strength = 36 ksi, Minimum thickness = 3/8” (AB Chance RS2875)

f. ASTM A36, A572, A1018 or A656, Minimum yield strength = per requirements cited above, Minimum thickness = 3/8” (AB Chance RS2875)

g. ASTM A572, Minimum yield strength = 50 ksi, Minimum thickness = 1/2” (AB Chance RS4500)

2.04 BOLTS

A. The size and type of bolts used to connect the central steel shaft sections together shall conform to the following ASTM specifications.

1. Approved bolts
a. For square shaft: 5/8” minimum diameter, ASTM A325 or A193 Grade B7
b. For round shaft: 3/4” minimum diameter, SAE J429 Grades 5 or 8

2.05 COUPLINGS

A. For square shaft material, the coupling shall be formed as an integral part of the plain and helical extension material as hot upset forged sockets.

B. For round shaft material, the couplings shall either be formed as an integral part of the plain and helical extension material as hot forge expanded sockets, or as internal sleeve wrought steel connectors. The steel connectors can be either tubing or solid steel bar with holes for connecting shaft sections together.

2.06 PILE CAP

A. Depending on the application, the pile cap shall be a welded assembly consisting of structural steel plates and shapes designed to fit the pile and transfer the applied load. Structural steel plates and shapes for helical pile top attachments shall conform to ASTM A36 or A572 Grade 50.

2.07 CORROSION PROTECTION

A. Epoxy coating (if required): the thickness of coating applied electrostatically to the central steel shaft shall be 7-12 mils. Epoxy coating shall be in accordance with ASTM A775. Bend test requirements are not required. Coupling bolts and nuts are not required to be epoxy coated.

B. Galvanization (if required):

1. Square shafts: Hot-dipped or electrodeposited in accordance with ASTM A153 or B633 after fabrication

2. Round shafts: Hot-dipped or electrodeposited in accordance with ASTM A153 or A123 or B633 after fabrication

2.08 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Prior to commending helical pile installation, the Contractor shall inspect the work of all other trades and verify that all said work is completed to the point where helical piles may commence without restriction.
B. The Contractor shall verify that all helical piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.

C. In the event of a discrepancy, the Contractor shall notify the Owner. The Contractor shall not proceed with helical pile installation in areas of discrepancies until said discrepancies have been resolved. All costs associated with unresolved discrepancies shall be the responsibility of the Owner.

3.02 INSTALLATION EQUIPMENT

A. Shall be rotary type, hydraulic power-driven torque motor with clockwise and counter-clockwise rotation capabilities. The torque motor shall be capable of continuous adjustment to revolutions per minute (RPM’s) during installation. Percussion drilling equipment shall not be permitted. The torque motor shall have torque capacity 15% greater than the torsional strength rating of the central steel shaft to be installed.

B. Equipment shall be capable of applying adequate down pressure (crowd) and torque simultaneously to suit project soil conditions and load requirements. The equipment shall be capable of continuous position adjustment to maintain proper helical pile alignment.

3.03 INSTALLATION TOOLING

A. Shall consist of a Kelly Bar Adapter and drive tools for square or round shaft used in accordance with manufacturer’s written installation instructions.

B. A torque indicator shall be used during helical pile installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling.

1. Shall be capable of providing continuous measurement of applied torque throughout installation.

2. Shall be capable of torque measurements in increments of at least 500 ft-lb.

3. Shall be calibrated prior to pre-production testing or start of work. Torque indicators which are an integral part of the installation equipment, shall be calibrated on-site. Torque indicators which are mounted in-line with the installation tooling, shall be calibrated either on-site or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be calibrated at normal operating temperatures.

4. Shall be re-calibrated, if in the opinion of the Owner and/or Contractor reasonable doubt exists as to the accuracy of the torque measurements.

3.04 INSTALLATION PROCEDURES
A. The helical pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental and load carrying conditions of the project.

B. The lead section shall be positioned at the location as shown on the working drawings. The helical pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of 5 to 20 RPM’s. Extension sections shall be provided to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt(s) and nut torqued to 40 ft-lb.

C. Sufficient down pressure shall be applied to uniformly advance the helical pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

### 3.05 TERMINATION CRITERIA

A. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.

B. The minimum installation torque and minimum overall depth criteria as shown on the working drawings shall be satisfied prior to terminating the helical pile installation.

C. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required, the Contractor shall have the following options:

1. Terminate the installation at the depth obtained subject to the review and acceptance of the Owner, or,

2. Remove the existing helical pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new helical pile shall be terminated at least (3) three feet beyond the terminating depth of the original helical pile.

3. If the minimum installation torque as shown on the working drawings is not achieved at the minimum overall length, and there is no maximum length constraint, the Contractor shall have the following options:

   a. Install the helical pile deeper using additional extension sections, or,

   b. Remove the existing helical pile and install a new on with additional and/or larger diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new helical pile shall be terminated at least (3) three feet beyond the terminating depth of the original helical pile.
c. De-rate the load capacity of the helical pile and install additional helical pile(s). The de-rated capacity and additional helical pile location shall be subject to the review and acceptance of the Owner.

4. If the helical pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the pile removed. The obstruction shall be removed, if feasible, and the helical pile re-installed. If the obstruction can’t be removed, the helical pile shall be installed at an adjacent location, subject to review and acceptance of the Owner.

5. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to proper positioning of the last plain extension section relative to the final elevation, the Contractor may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension, the Contractor may cut said extension shaft to the correct elevation. The Contractor shall not reverse (back-out) the helical pile to facilitate extension removal.

6. The average torque for the last two feet of penetration shall be used as the basis of comparison with the minimum installation torque as shown on the working drawings. The average torque shall be defined as the average of the last three readings recorded at one-foot intervals.

3.06 TOLERANCES

A. Allowable Tolerances:

1. Centerline of helical piles shall not be more than 2 inches from indicated plan location

2. Plumbness shall be with 2 degrees of design alignment

3. Top elevation of helical pile shall be within ±1 inch of the design vertical elevation.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Pre-production load tests: Not required.

C. Production load tests – Axial: Required.

1. The Contractor shall perform proof tests on a minimum of 10% of the total production helical piles. The helical piles to be tested will be selected by the Owner. At the Contractor’s suggestion, but with the Owner’s permission, tension tests may be performed in lieu of compression tests up to 100% of the design load for helical piles with sufficient structural tension capacity.
2. The Contractor shall determine a test sequence and acceptance criteria including load steps, hold times and the maximum test load. Maximum test load shall be selected so as to ensure that the production pile is not permanently damaged. The production test plan shall be submitted to the Owner for review and acceptance.

3. If a production pile that is tested fails to meet the acceptance criteria, the Contractor shall be directed to proof test another helical pile in the vicinity. For failed helical piles and further construction of other foundations, the Contractor shall modify the design, construction procedure or both. These modifications include but are not limited to, installing replacement helical piles, modifying the installation methods and equipment, increasing the minimum effective installation torque, changing the helix configuration, or changing the helical pile material (ie central steel shaft). Modifications that require changes to the structure shall have prior review and acceptance of the Owner and Engineer. Any modifications of design or construction procedures shall be at the Contractor’s expense.

D. Production load tests - Lateral: Not required

3.08 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 32 12 16

ASPHALT PAVING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Furnish and install tack prime coat, hot mix asphalt pavement base and surface courses, temporary trench paving, permanent trench paving, pavement reclamation, structure protection and adjustments, sidewalks, driveways, hot mix asphalt berm and curb, and miscellaneous patching in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Association of State Highway and Transportation Officials (AASHTO)

   a. AASHTO M320 Standard Specifications for Performance-Graded Asphalt Binder

   b. AASHTO T166 Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens

   c. AASHTO T209 Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA)

   d. AASHTO TP 68 Standard Method of Test for Density of In-Place Hot-Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices

2. MassDOT

   a. Standard Specifications and Supplements, and Construction Standard Details
1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS
   A. Submit in accordance with Division 01 General Requirements.
   B. Certificates: manufacturer's certificate verifying conformance.
   C. Mix design: for each grade of pavement used, at least 20 days prior to start of paving.
   D. Source and field quality control submittals
      1. Certified weigh slips for each truck load of bituminous material.
   E. Closeout and maintenance material submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.
   B. Comply with road opening permits.
   C. Establish and control pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections to match existing and prevent ponding.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 BITUMEN FOR TACK PRIME COAT
   A. Provide in accordance with MassDOT Section 460, M3.11.06.

2.02 HOT POUR ED RUBBERIZED ASPHALT SEALANT
   A. Provide in accordance with MassDOT Section 460.
2.03 HOT MIX ASPHALT SURFACE COURSE STANDARD TOP
   A. Provide in accordance with MassDOT Section 460, M3.11.03.

2.04 HOT MIX ASPHALT BASE COURSE
   A. Provide in accordance with MassDOT Section 420, M3.11.03.

2.05 HOT MIX ASPHALT BERM
   A. Provide in accordance with MassDOT Section 470, M3.11.03.

2.06 HOT MIX ASPHALT FOR MISCELLANEOUS WORK
   A. Provide in accordance with MassDOT Section 472.

2.07 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GENERAL
   A. Minimize area of pavement removed to suitable width for installation of Work. Legally dispose of existing pavements.

   B. Place hot mix asphalt between April 1 and November 15, unless otherwise specified by Owner.

   C. Do not place hot mix asphalt mixture unless breakdown and intermediate rolling can be completed by time material has cooled to 175 degrees F, and provided density of completed pavement attains at least 92.5 percent of maximum theoretical density as determined by AASHTO T209.

   D. Do not place mix on wet or damp surfaces, or when ambient temperature is 40 degrees F and falling, unless otherwise specified by Owner.

   E. When air temperature falls below 50 degrees F, take extra precaution drying aggregates, controlling temperatures of materials, placing, and compacting mixtures.

   F. Use straightedge to check compacted surfaces and obtain Engineer’s approval.
G. Utilize approved dial type thermometer and infrared pistol thermometer for each paving machine. Retain thermometer upon completion of Project.

1. Fahrenheit or Celsius selectable
2. Portable and battery operated
3. Repeatability: plus or minus 5 degrees F.
4. LCD display: to nearest 1 degree.
5. Accuracy: plus or minus 2 percent.
6. Emissivity: present at 0.95.
7. Temperature operation range: 0 degrees F to 750 degrees F.

3.02 INSTALLATION

A. Place hot mix asphalt base and top courses on roadways, sidewalks and other areas to maintain traffic access and egress to properties abutting Work, and for safe passage of pedestrian and vehicular traffic in accordance with MassDOT Section 460 and Construction Standard Details.

1. Provide minimum compacted thickness depth of hot mix asphalt base course indicated on Drawings or as directed by Engineer to achieve necessary base course grade in support of finish grade pavement elevations.

2. Apply bitumen for prime and tack coat at a rate of 0.07 gallons per square yard over milled areas immediately prior to installation of top course, as shown on Drawings or directed by Engineer. Clean surface of sand and foreign matter, and dry before applying prime coat.

3. Apply bitumen for prime and tack coat at a rate of 0.05 gallons per square yard over hot mix asphalt base course immediately prior to installation of top course, as shown on Drawings or directed by Engineer. Clean surface of sand and foreign matter, and dry before applying prime coat.

4. Provide minimum compacted thickness depth of hot mix asphalt surface course indicated on Drawings or as directed by Engineer to achieve finish grades.

5. Apply hot poured rubberized asphalt sealant to longitudinal and transverse joints.

6. Remove and replace defective mix not conforming to specified mix formula within stipulated tolerances on basis of testing. Samples of mixture in use will be taken as many times daily as necessary, and mixtures maintained
uniform as specified. Owner may suspend further approval of plant mixtures in related Work if mixtures are not uniformly furnished as specified, until necessary changes have been made so mixtures conform to specified requirements.

7. Irregularities which may develop before completion of rolling, and while material is still workable, may be remedied by loosening surface mixture and removing or adding material as necessary. If irregularities or surface defects remain after final compaction, defective Work will be corrected by minor surface projections, joints, and minor honeycombed surfaces ironed out smoothly to grade, and as directed.

8. If any soft, imperfect places or spots develop on surface before final acceptance of Work, remove and replace with new materials and compact until edges of new Work seamlessly connect with old Work.

B. Install hot poured rubberized asphalt sealer on roadway cracks less than or equal to 1-inch width. Clean and dry crack to minimum depth of twice the crack width with a high-pressure air blast prior to placing sealer. Apply sealer according to manufacturer’s recommendations.

C. Install hot mix asphalt by handwork on roadway surfaces in locations where irregularities, inaccessibility or other unavoidable obstacles prevent mechanical spreading and finishing.

D. Maintain safe passage of vehicular and pedestrian traffic and access and egress.

E. Set manhole covers and valve boxes flush with finish grade of top course.

F. Do not permit vehicular traffic or loads on newly completed pavement until adequate stability has been attained and material has cooled sufficiently to prevent distortion or loss of fines. If climate or other conditions warrant, the time-period for opening to traffic may be extended, at discretion of Owner.

3.03 RECLAMATION OF ROADWAY WITH PAVING

A. Locate and protect existing drainage and utility structures, underground pipes, culverts, conduits and other appurtenances prior to scarifying and pulverizing existing pavement. If upper sections of utilities are removed, immediately cover remaining part of structure with steel plate capable of withstanding 36.5-ton truckload with impact. Protect, remove or replace existing utility structures and boxes as part of Work.

B. Reclamation of paving includes scarifying and pulverizing in-place pavement and underlying material, mixing or blending material in depths specified on Drawings, followed by placing Type I-1 binder course in depths specified on Drawings and Type I-1 top course in depths specified on Drawings.
C. Remove unsuitable material in sub-grade to lines and depths established by Owner and dispose of legally. Replace with gravel borrow in accordance with MassDOT M1.03.0, Type B.

3.04 TEMPORARY TRENCH PAVEMENT

A. Comply with the construction method requirements of MassDOT Section 420, MassDOT Section 460 and the Drawings.

B. Grade gravel base to the depths required for installation of temporary trench pavement and compact gravel base prior to installing pavement.

C. Install temporary trench pavement over gravel base to the limits and thickness shown on the Drawings. Compact temporary trench pavement in accordance with MassDOT Section 460.

D. Unless otherwise directed by Owner, temporary trench pavement shall remain in place for one winter season. Maintain temporary pavement and repair settlement or failures until permanent pavement is installed at no additional cost to the Owner.

E. No more than 1,000 linear feet of unpaved trenches shall be permitted at any time. The Owner reserves the right to further limit the length of unpaved trenches. No additional compensation shall be made to the Contractor if Owner restricts the unpaved trench limits.

F. No unpaved trenches shall remain at the end of each week. Unpaved trenches during holidays or over the weekend shall not be permitted

3.01 PERMANENT TRENCH PAVEMENT

A. Comply with the construction method requirements of MassDOT Section 420 and MassDOT Section 460.

B. Remove temporary trench pavement to the depths and limits shown on the Drawings. Provide neat, straight cuts and square, vertical edges. Seal seams and joints with rubberized asphalt joint sealant.

C. Clean sand, dirt, debris and other foreign materials from surfaces before applying tack coat. Apply bituminous tack coat to clean, dry vertical edges and existing paved surfaces to bond existing and new pavement.

D. Provide necessary protection for roadway castings to prevent damage to castings and vehicles and ensure pedestrian safety.

E. Install hot mix asphalt base and top courses to the limits and lift depths required on the Drawings. Compact each lift in accordance with MassDOT Section 460. Match existing grades and install permanent trench pavement to maintain or improve existing drainage patterns.
F. Maintain and repair all trenches to Owner’s satisfaction during warranty period.

3.02 HOT MIX ASPHALT BERM

A. Replace existing hot-mix asphalt berms damaged by the Work in kind. Provide foundation for hot-mix asphalt berms in accordance with the Drawings or as directed by Engineer, conforming to requirements for type of berm.

B. Place mixture and compact with machine approved by Owner for type of berm required.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide wetland area landscaping and restoration in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Construction Areas

   a. Wetland restoration area of plus or minus 830 square feet consists of temporary impacts to the bordering vegetated wetlands that will be restored in place by re-grading upper 6 to 12 inches of soil as necessary to match existing wetland conditions, re-establishing a wetland plant community by spreading a native wetland seed mix and installing native wetland plantings as indicated on Drawings. Import additional topsoil to Site if necessary.

   b. Wetland replication area of plus or minus 1,573 square feet will be created through excavation to a sub-grade 12 inches below existing adjacent wetland elevation. Import 12 inches of topsoil to match elevations with adjacent wetland. Replant area with native wetland vegetation.

B. Related Requirements

1. Section 31 00 00 Earthwork

2. Section 31 25 00 Erosion and Sedimentation Controls

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. AOAC International (AOAC)

2. Association of Official Seed Analysts (AOSA)

3. Order of Conditions (OOC)
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: in accordance with Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Samples and Mockups: as specified in Article 1.06.

C. Source and Field Quality Control Submittals
   1. Suppliers’ certified analysis by a recognized laboratory in accordance with methods established by AOAC for non-standard products
   2. Suppliers’ certified analysis for soil amendments and fertilizer materials
   3. Seed Suppliers’ certified statement for each grass seed mixture required, stating botanical and common name; percentage by weight; percentages of purity germination; and weed seed for each grass seed species
   4. Proposed planting schedule indicating dates for each type of landscape Work during typical seasons as specified, for Work in area of Site correlated with specified maintenance periods, to provide maintenance until Final Completion or a minimum of 180 days, whichever is longer.
   5. Provide submittals at least 30 days prior to ordering materials. Do not order material until submittals are approved.

D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Samples
   1. Topsoil material from on-Site stockpile
   2. Topsoil material from off-Site sources

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading
1. Deliver grass seed in original containers identifying analysis of seed mixture, percentage of pure seed, year of production, net weight, and date and location of packaging. Do not deliver damaged packages.

2. Deliver fertilizer in waterproof bags identifying weight, chemical analysis, and name of manufacturer.

3. Package certified analyses with products.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 TOPSOIL

A. Furnish new, imported topsoil, free of invasive species, consisting of mixture of organic clean leaf compost soil and clean loam mineral soil which is fertile, friable, natural loam surface soil found at a depth of not less than 4 inches from original ground surface, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, debris, and stones larger than 2 inches in any dimension.

B. Obtain topsoil from local sources or from areas having similar soil characteristics as Site. Obtain topsoil only from naturally, well-drained Sites where topsoil occurs in a depth of not less than 4 inches. Do not obtain from bogs or marshes.

1. Recommended mineral soil textures: sandy loam, fine sandy loam, silt loam or loam.

2. Have wetland specialist confirm proper ratio of mineral soil and compost mixture. Organic matter content of soil mixture: approximately 20 percent.

C. Obtain approval of soil Supplier from wetland specialist prior to ordering soil mixture.

D. Test soil sample to confirm it meets requirements specified. Obtain inspection and approval of soil mixture by wetland specialist before topsoil is placed in replication area and restoration area.

E. Furnish additional topsoil to complete landscape Work if quantity of topsoil stockpiled for reuse is insufficient, as specified, and in Section 31 10 00. This Section takes precedence over Section 31 00 00 for wetlands areas.

2.02 PLANTINGS

A. Furnish native species plantings. Do not use landscape cultivars. Furnish plants of type and quantities as shown on Drawings.
B. Contact wetland specialist prior to ordering plantings and seed mix to confirm nursery sources.

2.03 EROSION AND SEDIMENTATION CONTROL

A. Furnish 6-inch diameter biodegradable coir fiber logs or compost filled logs for stabilization of banks.

B. Anti-erosion mulch: clean, seed-free threshed straw of wheat, rye, oats, or barley. Do not use hay.

C. Erosion control mesh: uniform, open-weave jute matting or flexible vinyl mat. Acceptable level of quality: equivalent to Mira Mat erosion control. Acceptable level of quality for re-vegetation mat: equivalent to TenCate Mirafi.

2.04 SOIL AMENDMENTS

A. Furnish natural limestone containing not less than 90 percent total carbonates, ground so not less than 98 percent passes a 20-mesh sieve and not less than 40 percent passes a 100-mesh sieve.

2.05 GRASS SEED

A. Furnish fresh, clean, new crop seed, complying with tolerance for purity and germination established by AOSA. Do not use wet, moldy, or damaged seed. Seed mixtures listed below are proportions by weight.

1. Germination: minimum 80 percent.

2. Purity: minimum 85 percent.

3. Weed content: maximum 1 percent.

B. Roadside Mixture

1. 50 percent Creeping Red Fescue

2. 15 percent Kentucky Bluegrass

3. 2 percent Red Top Clover

4. 25 percent Annual Ryegrass

5. 3 percent Bird's Foot Trefoil, Variety Empire

6. 5 percent White Clover
C. Ecology Mixture
   1. 50 percent Creeping Red Fescue
   2. 5 percent White Clover
   3. 15 percent Kentucky Bluegrass
   4. 2 percent Red Top Clover
   5. 25 percent Annual Ryegrass
   6. 3 percent Bird's Foot Trefoil, Variety Empire

D. Lawn Repair Mixture
   1. 60 percent Kentucky Bluegrass
   2. 20 percent Perennial Ryegrass
   3. 20 percent Chewings Fescue

E. Wetlands Edge Mixture
   1. 55 percent Tall Fescue
   2. 10 percent Poa trivialis
   3. 15 percent Kentucky Bluegrass
   4. 5 percent Redtop
   5. 10 percent Perennial Ryegrass
   6. 5 percent Reed Canary Grass

F. New England Conservation Seed Mixture
   1. Acceptable level of quality: equivalent to that manufactured by New England Wetland Plants.
   2. Big Bluestem (Andropogon gerardii)
   3. Switchgrass (Panicum virgatum)
   4. Little Bluestem (Schizachyrium scoparium)
   5. Canada Wild Rye (Elymus canadensis)
   6. Fox Sedge (Carex vulpinoidea)
7. Partridge Pea (Chamaecrista fasciculata)
8. Fringed Bromegrass (Bromus ciliatus)
9. Pennsylvanian Smartweed (Polygonum pensylvanicum)
10. Common Milkweed (Asclepias syriaca)
11. Showy Tick-Trefoil (Desmodium canadense)
13. Flat-top Aster (Aster umbellatus)
14. Nodding Bur-Marigold (Bidens cernua)

2.06 SOURCE QUALITY CONTROL
A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GENERAL
A. Install DEP sign indicating DEP File Number at entrance to Site so it can be seen from the public way prior to commencing Work. Do not place on a living tree.
B. Remove foreign materials, plants, roots, stones, and debris from Site and dispose of legally. Do not bury foreign material.
C. Do not obstruct roads, driveways, sidewalks, gutters and drainage ditches, swales and channels with excavated material.
D. Avoid damage to utilities, buildings and private property.
E. Do not disturb property markers.
F. Immediately report damage to Engineer.
G. Complete landscape Work immediately as portions of Site become available, working within seasonal limitations for each kind of landscape Work. Notify Engineer before planting if conditions detrimental to plant growth are encountered.
H. Plant or install materials during normal planting seasons for each type of landscape Work required.
I. Remove contaminated subsoil.
3.02 PREPARATION

A. Import soil to complete wetland replication area and as needed to complete wetland restoration area if existing impacted soils are not salvageable. Import approximately 12 inches of organic rich topsoil to wetlands replication area. Depth of topsoil in wetland restoration area and wetland replication area may be modified as necessary by wetland specialist. Legally dispose of excess soil.

B. Loosen subgrade of grass areas to minimum of 3 inches. Remove stones over 1-1/2 inches in any dimension and sticks, roots, rubbish and other extraneous matter. Limit preparation to areas to be planted promptly after preparation.

C. Spread top soil to minimum depth of 4 inches after light rolling and natural settlement. Add specified soil amendments and mix thoroughly into upper 4 inches of topsoil.

D. Prepare soil for grass planting in areas that have not been altered or disturbed by excavating, grading, or stripping operations.
   1. Till to a depth of not less than 6 inches.
   2. Apply soil amendments and initial fertilizer.
   3. Remove high areas and fill in depressions.
   4. Till soil to homogenous mixture of fine texture free of lumps, clods, stones, roots and other extraneous matter.

E. Fine grade areas to smooth even surface with loose, uniformly fine texture. Roll, rake and remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas to be planted immediately after grading. Provide positive drainage away from buildings and structures.

F. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting grass. Do not create muddy soil conditions.

G. Restore grassed areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

3.03 WETLANDS SPECIALIST

A. Furnish wetland specialist on-Site to monitor construction of wetland replication area and wetland restoration area for compliance with approved Drawings and Plans.

B. Wetland Specialist Responsibilities
1. Monitor wetland replication area and wetland restoration area in accordance with OOC and prepare monitoring reports to be submitted to Conservation Commission, and Engineer.

2. Verify proper subgrades are achieved to intercept wetland hydrology in wetland replication area.

3. Observe establishment of final grading of wetland replication area and wetland restoration area to verify final grades are similar to adjacent bordering vegetated wetlands.

4. Confirm proposed plantings have been installed properly.

C. Include photographic documentation, description of health of plantings, and recommendations for replacement plantings or modifications, if necessary in monitoring reports. Address compliance with 310 CMR 10.55 (4)(b), which requires 75 percent or more coverage by native wetland indicator species within 2 growing seasons.

3.04 SEEDING NEW AREAS

A. Sow seed using a spreader or seeding machine. Do not seed when wind velocity exceeds 5 miles per hour. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other.

B. Do not sow immediately following rain or when ground is too dry.

C. Seed Application Rate

1. New England Conservation Seed Mix: 1 pound per 1,750 square feet.

2. All others: 1 pound per 1,000 square feet.

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with a fine spray.

3.05 HYDROSEEDING NEW AREAS

A. Mix specified seed and pulverized mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.

B. Apply slurry using an approved machine. Seed and suitable corn fiber mulch may be applied in 1 operation. Mix materials with water in machine and agitate to keep mixture uniformly suspended. Use spraying equipment that will distribute slurry uniformly at required rates.

C. Mulch areas with anti-erosion mulch by means of mulch blower at rate of 1,200 pounds per acre on level grades, 2,000 pounds on slopes if mulch is not part of slurry immediately following hydroseeding.
D. Seed only areas that can be mulched on same day.

3.06 PROTECTION OF SEEDED SLOPES

A. Protect seeded slopes against erosion with erosion netting or other acceptable methods.

B. Spread specified mulch after completion of seeding operations to form a continuous blanket not less than 1-1/2 inches’ loose measurement over seeded areas.

C. Anchor mulch by spraying with asphalt emulsion at rate of 10 to 13 gallons per 1,000 square feet. Prevent damage or staining of construction or other plantings adjacent to mulched areas.

D. Cover seeded slopes with jute matting where grade is 3:1 or greater. Roll matting down over slopes without stretching or pulling.

E. Lay matting smoothly on soil surface, burying top end of each section in narrow 6-inch trench. Leave 12-inch overlap from top roll over bottom roll. Leave 4-inch overlap over adjacent section.

F. Staple outside edges and overlaps at 36-inch intervals.

G. Lightly dress slopes with topsoil to ensure close contact between matting and soil.

H. Unroll matting in direction of flow in ditches. Overlap ends of strips 6 inches with upstream section on top.

3.07 PLANTING OF SHRUBS AND TREES

A. Plant areas during 1 of the planting seasons outlined in Section 01 15 30, weather permitting. Coordinate planting periods to provide required maintenance. Deviations from dates listed must be approved in writing.

B. Prune injured roots or branches to make clean-cut ends prior to planting, utilizing clean, sharp tools, removing only injured or diseased branching.

C. Remove planting containers, baskets, and non-biodegradable materials from root balls during planting. Cut natural fiber burlap from around the trunk of trees and folded down against root ball prior to backfilling.

D. Position trees and shrubs at intended locations shown on Drawings and obtain Engineer’s approval prior to excavating pits, making necessary adjustments as directed.

E. Dig planting pits with level bottoms with width twice the diameter of root ball. Rest root ball on undisturbed grade. Backfill each plant pit in layers with thoroughly mixed, prepared soil; 1-part peat moss; 1-part composted cow manure by volume; 3 parts topsoil by volume.
1. Provide 21-gram planting tablets, acceptable level of quality: equivalent to Agriform.
   a. 2 tablets per 1-gallon plant
   b. 3 tablets per 5-gallon plant
   c. 4 tablets per 15-gallon plant
   d. Larger plants: 2 tablets per 1/2-inch caliper of trunk

F. Fill prepared soil around ball of plant halfway, and insert plant tablets. Complete backfill, and water thoroughly.

3.08 EROSION AND SEDIMENTATION CONTROL

A. Furnish and install as indicated, and in accordance with Section 31 25 00.

B. Install coir fiber logs or compost filled logs for stabilization of banks. Install logs directly on banks and anchor with earth anchors or wooden stakes.

C. Maintain erosion and sedimentation controls during construction to protect wetland resource areas. Do not remove erosion controls until up-gradient areas are fully stabilized with vegetation, or directed by Engineer.

3.09 REPAIR/RESTORATION

A. Restore pavement, sidewalks and walkways, grassed and planted areas, damaged during execution of Work, as directed by Engineer. Provide seed to re-establish grass where existing topsoil remains. Provide additional topsoil where necessary.

B. Recondition existing lawn areas damaged during execution of Work and existing lawn areas where minor re-grading is required.

C. Provide fertilizer, seed or sod, and soil amendments as specified and required for new lawns, to provide a satisfactorily reconditioned lawn. Provide new topsoil as required to fill low spots and meet new finish grades.

D. Cultivate bare and compacted areas thoroughly to provide satisfactory planting bed.

E. Remove diseased and unsatisfactory lawn areas. Do not bury into soil. Remove topsoil containing foreign materials resulting from execution of Work, and dispose of legally.

F. Water newly planted areas and keep moist until new grass is established.

3.10 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
B. Site/Field Tests and Inspections

1. Provide inspection by wetlands specialist to address compliance with 310 CMR 10.55 (4)(b), which requires 75 percent or more coverage by native wetland indicator species within 2 growing seasons.

3.11 CLEANING

A. Keep pavement, sidewalks, and walkways clean. Maintain protection during installation and maintenance periods.

3.12 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.13 MAINTENANCE

A. Provide maintenance of grass seeded areas immediately after planting.

B. Maintain grass by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, re-grading, and replanting as required to establish smooth, acceptable lawn areas free of eroded or bare areas.

C. Maintain grassed areas to establish acceptable lawn until Final Completion, or for a minimum of 180 days after Substantial Completion, whichever is longer.

D. If seeded in the fall season, and full 180 days of maintenance is not provided, or if not considered acceptable at that time, continue maintenance during the following spring season until acceptable lawn areas are established.

E. Replace dead plants within 1 year of initiation of Warranty Period, or as recommended by wetland specialist and Engineer.

F. Maintain trees and shrubs until Final Completion, or for a minimum of 180 days after Substantial Completion, whichever is longer.

END OF SECTION
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SECTION 32 90 00

PLANTING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide loam borrow, topsoil, seeding, and supporting materials in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 31 00 00 – Earthwork
2. Section 31 25 00 – Erosion and Sediment Control
3. Section 32 72 00 – Wetlands Restoration

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American National Standards Institute (ANSI)
   a. ANSI Z60.1 American Standard for Nursery Stock
2. AOAC International (AOAC)
3. ASTM International (ASTM)
   a. ASTM D75 Standard Practice for Sampling Aggregates
   b. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
4. MassDOT
   a. Standard Specifications and Supplements, and Construction Details
5. United States Department of Agriculture (USDA)
1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data
   1. Seeding and planting fertilizer showing composition and analysis
      a. Fertilization rates for fertilizer product based upon soil testing, analysis, and recommendations
      b. Receipt showing total quantity purchased for Project prior to installation

C. Samples and Mockups: as specified in Article 1.06.

D. Certificates: seeding and planting fertilizer composition and analysis.

E. Manufacturer Instructions

F. Source and Field Quality Control Submittals
   1. Suppliers’ certified analysis in accordance with AOAC for non-standard products.
   2. Suppliers’ certified analysis for soil amendments and fertilizer materials.
   3. Seed Supplier’s certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity germination and weed seed for each grass seed species.
   4. Certificates of agronomic rates from Supplier for organic matter used in loam borrow manufacturing process.
   5. Supplier's certifications for peat moss, limestone, acidulants, gypsum, additives needed to amend a specific soil.

G. Provide submittals at least 30 days prior to ordering materials.

H. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Survey data of on-Site topsoil stockpiles plotted on a 20-scale plan of the Site, prepared by a registered surveyor or civil engineer.

C. Samples
   1. Loam borrow: 1 cubic foot representative sample per each 1,000 cubic yards of proposed stockpile of loam borrow for testing. Stockpile sampling: in accordance with ASTM D75.
   2. On-Site stockpiles of loam borrow: two 1 cubic foot representative samples selected for testing or from loam after it has been spread and amended. Take Samples from on-Site stockpiles and from spread and amended loam borrow from locations as directed by Engineer and packaged in presence of Engineer.
   3. Deliver samples to testing laboratories via overnight courier and have testing reports sent directly to Engineer.
      a. Obtain testing for gradation, organic content, soil chemistry and pH by a certified laboratory.
      b. Include the following tests.
         1) Sieve analysis: performed and compared to USDA Soil Taxonomy, by combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D698 after destruction of organic matter by H2O2. Provide a computer generated gradation curve from UMASS Laboratory to facilitate review and approval of sieve analysis.
         2) Determine percent of organics by loss on ignition of oven dried samples. Oven dry test samples minus #10 material to a constant weight at a temperature of 450 degrees F.
         3) Provide chemical analysis for nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, magnesium, extractable aluminum, lead, zinc, cadmium, copper, soluble salts, and pH and buffer pH. Use a conductivity meter to measure soluble salts in 1:2 soil/water (v/v %). Nutrient tests: for available nutrients.
4) Provide recommendations for soil additives to correct soil deficiencies, and additives necessary to complete planting work specified with soil analysis tests.

c. Provide biosolid compost testing to determine compost is mature, stable and suitable for use in a growing medium by Woods End Research Laboratory, Mt. Vernon, ME.

d. Provide analysis by recognized laboratory for other materials in accordance with AOAC, where applicable.


5. Gypsum: 2-pound sample.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading

1. Do not order or deliver material until submittals are approved.

2. Package products with manufacturers certified analysis.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 LOAM BORROW

A. Provide in accordance with MassDOT Section 751 and MassDOT Construction Details.

B. Type: MassDOT Section M1.05.0.

C. Furnish sufficient loam borrow to complete loaming operations required for Project and as directed by Engineer. Obtain loam borrow from the following sources and meet requirements specified after testing and addition of necessary soil additives.

1. Naturally well-drained areas that have never been stripped before and have a history of satisfactory vegetative growth. Comply with bylaws and Regulations regarding removal of topsoil.

2. Commercial processing facility specializing in manufacturing of loam.
2.02 TOPSOIL

A. Provide additional topsoil required to complete landscape work if quantity of stockpiled topsoil is insufficient.

B. Furnish new topsoil, which is fertile, friable, natural loam surface soil found at a depth of not less than 4 inches from original ground surface, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, debris, and stones larger than 2 inches in any dimension.

C. Obtain topsoil from local sources or from areas having similar soil characteristics as Site. Obtain topsoil only from naturally, well-drained Sites where topsoil occurs in a depth of not less than 4 inches. Do not obtain from bogs or marshes.

2.03 SEED AND SUPPORTING MATERIAL

A. Provide seed, limestone, fertilizers, plant materials, water for irrigation and soil conditioners in accordance with MassDOT Section 765.40 and MassDOT Construction Details, and ANSI Z60.1.

B. If biosolid compost (Massachusetts Department of Environmental Protection-permitted material) is used as an organic component of proposed planting soil mixture, amount of organic material used shall not exceed agronomic rates for nitrogen and phosphorus for trees and shrubs, turf or ornamental perennials.

2.04 PLANTING TREES, SHRUBS AND GROUNDCOVER

A. Furnish in accordance with MassDOT Section 771s.

B. Type: per MassDOT Section M6.06.1

2.05 GRASS SEED

A. Furnish fresh, clean, new crop seed, complying with tolerance for purity and germination established by AOSA. Do not use wet, moldy, or damaged seed. Seed mixtures listed below are proportions by weight.

1. Germination: minimum 80 percent.

2. Purity: minimum 85 percent.

3. Weed content: maximum 1 percent.

B. Roadside Mixture

1. 50 percent Creeping Red Fescue

2. 15 percent Kentucky Bluegrass
3. 2 percent Red Top Clover
4. 25 percent Annual Ryegrass
5. 3 percent Bird's Foot Trefoil, Variety Empire
6. 5 percent White Clover

C. Ecology Mixture
1. 50 percent Creeping Red Fescue
2. 5 percent White Clover
3. 15 percent Kentucky Bluegrass
4. 2 percent Red Top Clover
5. 25 percent Annual Ryegrass
6. 3 percent Bird's Foot Trefoil, Variety Empire

D. Wetlands Edge Mixture
1. 55 percent Tall Fescue
2. 10 percent Poa Trivialis
3. 15 percent Kentucky Bluegrass
4. 5 percent Redtop
5. 10 percent Perennial Ryegrass

E. Lawn Repair Mixture
1. 60 percent Kentucky Bluegrass
2. 20 percent Perennial Ryegrass
3. 20 percent Chewings Fescue

F. New England Conservation Seed Mixture
1. Acceptable level of quality: equivalent to that manufactured by New England Wetland Plants.
2. Big Bluestem (Andropogon gerardii)
3. Switchgrass (Panicum virgatum)
4. Little Bluestem (Schizachyrium scoparium)
5. Canada Wild Rye (Elymus canadensis)
6. Fox Sedge (Carex vulpinoidea)
7. Partridge Pea (Chamaecrista fasciculata)
8. Fringed Bromegrass (Bromus ciliatus)
10. Common Milkweed (Asclepias syriaca)
11. Showy Tick-Trefoil (Desmodium canadense)
13. Flat-top Aster (Aster umbellatus)
14. Nodding Bur Marigold (Bidens cernua)

2.06 FERTILIZER

A. Bone meal: commercial, raw or steamed, finely ground; minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: commercial, phosphate mixture, soluble; minimum of 20 percent available phosphoric acid.

C. Fertilizer: commercial grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition.

1. Nitrogen, phosphorous and potassium in amounts recommended in topsoil analysis reports from a qualified soil testing agency.

2. Minimum 1 pound per 1,000 square feet of actual nitrogen, 4 percent phosphorous and 2 percent potassium by weight.

2.07 EROSION AND SEDIMENTATION CONTROL

A. Anti-erosion mulch: clean, seed-free threshed straw of wheat, rye, oats, or barley. Do not use hay.

B. Erosion control mesh: uniform, open-weave jute matting or flexible vinyl mat. Acceptable level of quality: equivalent to Mira Mat erosion control.

C. Acceptable level of quality for re-vegetation mat: equivalent to TenCate Mirafi.
2.08 Source Quality Control

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 General

A. Avoid damage to utilities, buildings and private property.
B. Do not disturb property markers.
C. Immediately report damage to Engineer.
D. Complete landscape work immediately as portions of Site become available, working within seasonal limitations for each kind work. Notify Engineer before planting if conditions detrimental to plant growth are encountered.
E. Plant or install materials during normal planting seasons for each type of landscape work required, and as specified in Section 32 72 00.
F. Use topsoil stockpiled for re-use as specified in Section 31 00 00.

3.02 Loam Borrow

A. Place loam borrow at designated locations where plant material is to be installed or re-installed in accordance with MassDOT Section 751 and MassDOT Construction Details and Drawings, or as directed by Engineer.
B. Protect loam borrow delivered to Site from erosion and spread immediately. Cover material that sits on-Site for more than 24 hours with tarpaulin or other soil erosion system acceptable to Engineer, and surround with silt fence as shown on Drawings.
C. Do not handle, plant or use loam borrow if wet or frozen. Use moist loam borrow.

3.03 Planting Trees, Shrubs and Groundcover

A. Provide in accordance with MassDOT Section 771 and MassDOT Construction Details.
B. Type: per MassDOT Section M6.06.1
C. Prune injured roots or branches to make clean-cut ends prior to planting, utilizing clean, sharp tools, removing only injured or diseased branching.
D. Remove planting containers, baskets, and non-biodegradable materials from root balls during planting. Cut natural fiber burlap from around trunk of trees and folded down against root ball prior to backfilling.
E. Position trees and shrubs at intended locations shown on Drawings and obtain Engineer’s approval prior to excavating pits, making necessary adjustments as directed.

F. Dig planting pits with level bottoms with width twice the diameter of root ball. Rest root ball on undisturbed grade. Backfill each plant pit in layers with thoroughly mixed, prepared soil; 1-part peat moss; 1-part composted cow manure by volume; 3 parts topsoil by volume.

1. Provide 21-gram planting tablets, acceptable level of quality: equivalent to Agriform.
   a. 2 tablets per 1-gallon plant
   b. 3 tablets per 5-gallon plant
   c. 4 tablets per 15-gallon plant
   d. Larger plants: 2 tablets per 1/2-inch caliper of trunk

G. Fill prepared soil around ball of plant halfway, and insert plant tablets. Complete backfill, and water thoroughly.

3.04 FINE GRADING

A. Clean subgrade of stones greater than 2 inches and all debris immediately prior to dumping and spreading loam borrow, and remove from Site. Do not rake to edges and bury. Obtain Engineer’s approval of subgrade conditions prior to spreading loam borrow.

B. Spread and thoroughly incorporate soil additives into layer of loam borrow by harrowing or other approved methods. Incorporate the following soil additives.

1. Ground limestone or acidulants: as required by soil analysis to achieve required pH specified. Spread limestone at rate required by soil analysis up to maximum limit of 200 pounds per 1,000 square feet. Make a surface application of limestone not in excess of 50 pounds per 1,000 square feet to established planting area during the season after Final Acceptance if recommendations of soil analysis require rates of application greater than 200 pounds per 1,000 square feet.

2. Fertilize at rate and analysis recommended by soil analysis.

3. Use biosolid compost, peat moss, sand or other soil amendments as required by soil analysis.

C. Prepare loam borrow by scarifying, harrowing, or tilling loam to integrate soil additives into top 6 inches of loam after loam borrow and required additives have
been spread. Remove large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter. Remove all stones over 1-inch in diameter from top 6 inches of loam bed from unscreened soils. Remove smaller stones in excessive quantities as directed.

D. Set sufficient grade stakes for checking finished grades. Set stakes in bottom of swales and at top of slopes. Do not deviate more than one-tenth of foot from indicated elevations. Connect contours and spot elevations with an even slope. Finish grades: smooth and continuous with no abrupt changes at top or bottom of slopes.

E. Fill depressions caused by settlement or rolling during compaction process with additional loam borrow and regrade surface and roll until finish is smooth and even corresponding to required grades.

F. Install loam borrow in successive horizontal lifts no thicker than 6 inches in turf areas and 12 inches in plant bed areas to desired compaction as indicated. Install soil at a higher level to anticipate any reduction of loam borrow volume due to compaction, settling, erosion, and decomposition during Warranty Period. Obtain full depths of loam borrow for plant beds by digging holes in loam borrow at same frequency as for compaction testing.

1. Compact loam to specified density.

2. Maximum dry density for topsoil and loam: determined in accordance with ASTM D698. Achieve the following percentages of minimum to maximum dry densities for fill materials or prepared subgrades.

   a. Fills within plant beds, tree pits and treeways: minimum 80 percent; maximum 85 percent for areas in top 18 inches of finished grade.

3. Scarify surface area of each lift by raking prior to placing next lift.

G. Compact each lift to reduce settling, but not enough to prevent movement of water and feeder roots through the soil in addition to range cited above. Loam borrow in each lift: firm underfoot and make only slight heel prints. Loam borrow at completion of installation: firm, even resistance when a soil sampling tube is inserted from lift to lift. Perform percolation tests after placement of each lift to determine if soil has been over compacted using the following percolation test procedure.

1. Dig a hole in installed soil minimum of 4 inches in diameter. Holes in 6-inch lift in turf areas: 4 inches deep. Holes in 12-inch lifts in plant beds: 8 inches deep. Do not penetrate through lift being tested.

2. Fill hole with water and let it drain completely. Immediately refill hole with water and measure rate of fall in water level.
3. Till soil to a depth required to break over compaction if water drains at a rate less than 1-inch per hour.

4. Perform a minimum of 1 soil percolation test per 10,000 square feet of turf area, and 2,500 square feet of tree and shrub planting area as directed.

H. Select equipment and phase installation of loam borrow so wheeled equipment does not travel over subsoil, placed fills or ordinary borrow, or already installed soil. Movement of tracked equipment over these soils will be reviewed and considered by Engineer for approval. If Engineer determines that wheeled equipment must travel over already installed soil, provide a written description of sequencing of Work that ensures compacted soil is loosened and uncompacted as Work progresses, or place 1-inch thick steel plate ballast or approved equivalent over length and width of any travelway to cover loam borrow to protect it from compaction.

I. Grade disturbed areas outside limit of Work, smooth and spread with minimum 6 inches of loam borrow to finished grade.

J. Maintain stockpiles of existing on-Site topsoil until final placement of existing on-Site topsoil and loam borrow is approved. Provide survey data plotted on a 20-scale plan of the Site prepared by a registered surveyor or civil engineer, showing volume of stockpiles of existing on-Site topsoil. Remove excess, unused existing on-Site topsoil from Site and legally dispose of upon approval.

3.01 SEED AND SUPPORTING MATERIAL

A. Install and apply seed and supporting materials at rates of application in accordance with MassDOT Section 765.40 and MassDOT Construction Details and the Drawings.

3.02 HYDROSEEDING NEW AREAS

A. Mix specified seed and pulverized mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.

B. Apply slurry using an approved machine. Seed and suitable corn fiber mulch may be applied in 1 operation. Mix materials with water in machine and agitate to keep mixture uniformly suspended. Use spraying equipment that will distribute slurry uniformly at required rates.

C. Mulch areas with anti-erosion mulch with mulch blower at rate of 1,200 pounds per acre on level grades, 2,000 pounds on slopes if mulch is not part of slurry, immediately following hydroseeding.

D. Seed only areas that can be mulched on same day.
3.03 SEEDING NEW AREAS

A. Sow seed using a spreader or seeding machine. Do not seed when wind velocity exceeds 5 miles per hour. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other.

B. Do not sow immediately following rain or when ground is too dry.

C. Seed application rate

1. New England Conservation Seed Mix: 1 pound per 1,750 square feet.
2. All others: 1 pound per 1,000 square feet.

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

3.01 PROTECTION OF SEEDED SLOPES

A. Protect seeded slopes against erosion with erosion netting or other acceptable methods.

B. Spread specified mulch after completion of seeding operations to form a continuous blanket not less than 1-1/2 inches’ loose measurement over seeded areas.

C. Anchor mulch by spraying with asphalt emulsion at rate of 10 to 13 gallons per 1,000 square feet. Prevent damage or staining of construction or other plantings adjacent to mulched areas.

D. Cover seeded slopes with jute matting where grade is 3:1 or greater. Roll matting down over slopes without stretching or pulling.

E. Lay matting smoothly on soil surface, burying top end of each section in narrow 6-inch trench. Leave 12-inch overlap from top roll over bottom roll. Leave 4-inch overlap over adjacent section.

F. Staple outside edges and overlaps at 36-inch intervals.

G. Lightly dress slopes with topsoil to ensure close contact between matting and soil.

H. Unroll matting in direction of flow in ditches. Overlap ends of strips 6 inches with upstream section on top.

3.02 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Replace rejected Work, and continue specified maintenance until re-inspected by Engineer and accepted. Remove rejected plants and materials promptly from Site.
3.01 CLEANING

A. Keep pavement, sidewalks, and walkways clean. Maintain protection during installation and maintenance periods.

3.02 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.03 MAINTENANCE

A. Provide maintenance of grass seeded areas immediately after planting.

B. Maintain grass by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, re-grading, and replanting as required to establish smooth, acceptable lawn areas free of eroded or bare areas.

C. Maintain grassed areas to establish acceptable lawn until Final Completion or for a minimum of 180 days, whichever is longer, by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, re-grading, and replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas.

D. Maintain trees and shrubs until Final Completion, or for a minimum of 180 days, whichever is longer.

END OF SECTION
SECTION 32 92 19

SEEDING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide seeding and landscape development accordance with this Section and applicable reference standards listed in Article 1.03, including the following.

a. Preparation of subgrade to receive topsoil
b. Spreading topsoil
c. Seeding
d. Hydroseeding
e. Maintaining seeded areas until acceptance

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. Official Seed Analysts of North America
2. Association of Official Agriculture Chemists

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.
B. Certificates

1. Submit manufacturers or vendors certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

2. Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity germination, and weed seed for each grass seed species.

C. Samples

1. Submit Sample of topsoil material from the on-site stockpile and all off-site sources to be used for approval by Engineer.

2. Submit proposed planting schedule indicating dates for each type of landscape work during normal seasons for such Work in area of Site. Correlate with specified maintenance periods to provide maintenance from date of substantial completion. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

D. Closeout and maintenance material submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Certifications

1. Package standard products with manufacturers’ certified analysis.

2. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1. Deliver grass seed in original containers showing analysis of seed mixture, percentage of pure seed, year of production, net weight, date of packaging, and location of packaging. Damaged packages are not acceptable.

2. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
1.08 SITE CONDITIONS

A. Existing conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 TOPSOIL

A. Use topsoil stockpiled for re-use in landscape work. If quantity of stockpiled topsoil is insufficient, provide additional topsoil as required to complete landscape work.

B. Provide new topsoil which is fertile, friable, natural loam surface soil found at a depth of not less than 4-inches from the original ground surface, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2-inches in any dimension, and debris.

C. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at Project Site. Obtain topsoil only from naturally, well-drained sites where topsoil occurs in a depth of not less than 4-inches; do not obtain from bogs or marshes.

2.02 SOIL AMENDMENTS

A. Lime: Natural limestone containing not less than 90 percent total carbonates, ground, so that not less than 98 percent passes a 20-mesh sieve and not less than 40 percent passes a 100-mesh sieve.

2.03 GRASS MATERIALS

A. Grass Seed: Fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analyst of North America. Do not use seed that has become wet, moldy, or damaged. All seed mixtures listed are proportions by weight.

1. Germination: not less than 80 percent
2. Purity: not less than 85 percent
3. Weed content: not more than 1 percent


1. Big Bluestem (Andropogon gerardii)
2. Switchgrass (Panicum virgatum)
3. Little Bluestem (Schizachyrium scoparium)
4. Canada Wild Rye (Elymus canadensis)
5. Fox Sedge (Carex vulpinoidea)
6. Partridge Pea (Chamaecrista fasciculata)
7. Fringed Bromegrass (Bromus ciliatus)
8. Pennsylvanian Smartweed (Polygonum pensylvanicum)
9. Common Milkweed (Asclepias syriaca)
10. Showy Tick-Trefoil (Desmodium canadense)
11. New England Aster (Aster novae-angliae)
12. Flat-top Aster (Aster umbellatus)
13. Nodding Bur Marigold (Bidens cernua)

2.04 MISCELLANEOUS LANDSCAPE MATERIALS

A. Erosion control mesh: uniform, open weave jute matting or flexible vinyl mat. Acceptable level of quality: equivalent to Mira Mat.

B. Acceptable level of quality of erosion control and revegetation mat: equivalent to TenCate Mirafi.

2.05 FERTILIZER

A. Bone meal: commercial, raw or steamed, finely ground; minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: commercial, phosphate mixture, soluble; minimum of 20 percent available phosphoric acid.

C. Fertilizer: commercial grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition.

1. Nitrogen, phosphorous and potassium in amounts recommended in topsoil analysis reports from a qualified soil testing agency.

2. Minimum 1 pound per 1,000 square feet of actual nitrogen, 4 percent phosphorous and 2 percent potassium by weight.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 GENERAL

A. Proceed with, and complete landscape Work as rapidly as portions of Site become available, working within seasonal limitations for each kind of landscape work required. When conditions detrimental to plant growth are encountered, notify Engineer before planting.

B. Locate underground utilities. Perform Work in a manner that will avoid damage.

C. Plant or install materials during normal planting seasons for each type of landscape Work required.

D. Beginning Work means acceptance of existing conditions.

E. Repair grassed areas disturbed during performance of the Work. Where existing topsoil remains, provide seed to re-establish grass.

3.02 PREPARATION

A. Protect existing underground improvements from damage.

B. Remove foreign materials, plants, roots, stones, and debris from Site. Do not bury foreign material.

C. Remove contaminated subsoil.

D. Preparation for Planting Grass

1. Loosen subgrade of grass areas to a minimum of 3-inches. Remove stones over 1-1/2 inches in any dimension, sticks, roots, rubbish and other extraneous matter. Limit preparation to areas that will be planted promptly after preparation.

2. Spread top soil to minimum depth of 4-inches after light rolling and natural settlement. Add specified soil amendments and mix thoroughly into upper 4-inches of topsoil.

E. Where grass is to be planted in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil for planting as follows: Till to a depth of not less than 6-inches; apply soil amendments and initial fertilizers as specified; remove high areas and fill in depressions; till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.
F. Fine grade areas to smooth, even surface with loose, uniformly fine texture. Roll, rake and remove ridges, and fill depressions as required to meet finish grades. Limit fine grading to areas that can be planted immediately after grading. Assure positive drainage away from buildings.

G. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

H. Restore grassed areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

3.03 SEEDING NEW AREAS

A. Sow seed using a spreader or seeding machine. Do not seed when wind velocity exceeds 5 miles per hour. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other. Do not sow immediately following rain or when ground is too dry.

B. Seed application rate

1. New England Conservation Seed Mix: 1 pound per 1,750 square feet.
2. All others: 1 pound per 1,000 square feet.

C. Rake seed lightly into top 1/8-inch of soil, roll lightly, and water with a fine spray.

3.04 HYDROSEEDING NEW AREAS

A. Mix specified seed and pulverized mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.

B. Apply slurry using an approved machine. Seed and suitable corn fiber mulch may be applied in one operation. Mix materials with water in machine and agitate to keep mixture uniformly suspended. Use spraying equipment that will distribute slurry uniformly at required rates.

C. Immediately following hydroseeding, mulch areas by means of mulch blower at rate of 1,200 pounds per acre on level grades, 2,000 pounds on slopes if mulch is not part of slurry. Do not seed area in excess of that which can be mulched on same day.
3.05 PROTECTION OF SEEDED SLOPES

A. Protect seeded slopes against erosion with erosion netting or other methods acceptable to the Engineer.

B. Spread specified lawn mulch after completion of seeding operations to form a continuous blanket not less than 1-1/2-inches loose measurement over seeded areas.

C. Anchor mulch by spraying with asphalt emulsion at the rate of 10 to 13 gallons per 1000 square feet. Take precautions to prevent damage or staining of construction or other plantings adjacent to mulched areas.

D. Cover seeded slopes where grade is 3:1 or greater, unless otherwise noted, with jute matting. Roll matting down over slopes without stretching or pulling.

E. Lay matting smoothly on soil surface, burying top end of each section in narrow 6-inch trench. Leave 12-inch overlap from top roll over bottom roll. Leave 4-inch overlap over adjacent section.

F. Staple outside edges and overlaps at 36-inch intervals.

G. Lightly dress slopes with topsoil to ensure close contact between matting and soil.

H. In ditches, unroll matting in direction of flow. Overlap ends of strips 6 inches with upstream section on top.

3.06 RECONDITIONING EXISTING GRASSED AREAS

A. Recondition existing lawn areas damaged by Contractor’s operations and existing lawn areas where minor re-grading is required.

B. Provide fertilizer, seed, or sod, and soil amendments as specified for new lawns and as required to provide a satisfactorily reconditioned lawn. Provide new topsoil as required to fill low spots and meet new finish grades.

C. Cultivate bare and compacted areas thoroughly to provide a satisfactory planting bed.

D. Remove diseased and unsatisfactory lawn areas. Do not bury into soil. Remove topsoil containing foreign materials resulting from Contractor’s operations.

E. Water newly planted areas and keep moist until new grass is established.
3.07 MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain grassed areas for not less than 60 days after substantial completion, and longer as required to establish an acceptable lawn.

C. If seeded in fall, and not given full 60 days of maintenance, or if not considered acceptable at that time, continue maintenance during the following spring until acceptable lawn is established.

D. Maintain grass by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, re-grading, and replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas.

3.08 CLEANUP AND PROTECTION

A. Keep pavements clean. Maintain protection during installation and maintenance periods.

B. Restore pavement, grassed areas and planted areas damaged during execution of Work of this section.

3.09 INSPECTION AND ACCEPTANCE

A. Landscape work may be inspected for acceptance in parts agreeable to Engineer, provided Work offered for inspection is complete, including maintenance.

B. Replace rejected Work and continue specified maintenance until re-inspected by Engineer and found to be acceptable.

3.10 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.11 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 33 01 30.10

TELEVISION INSPECTION AND CLEANING OF STORM SEWERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide cleaning and closed-circuit television (CCTV) inspection of a stormwater force main noted in Drawings in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. National Association of Sewer Service Companies (NASSCO)
   a. Jetter Code of Practice
   b. Pipeline Assessment Certification Program (PACP) Standards

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product data

1. Description of system and equipment proposed for pipe cleaning

2. Description of system and equipment proposed for CCTV inspection after cleaning

3. Documentation of PACP certification for CCTV software

4. Sample test reports and evaluations

   a. Sample inspection data and CCTV video of minimum 3 pipe segments to verify compatibility with Owner’s PACP database.
C. Qualification statements

1. Names and qualifications of personnel or firm performing Work, including a minimum of 5 similar reference projects with equipment specified, and experience with cured-in-place pipe (CIPP) technology specified.

2. Current PACP certifications for CCTV operators

D. Source and field quality control submittals

1. Description of proposed procedures for removal of existing blockages in pipeline if encountered during cleaning process.

2. Description of proposed procedures and equipment for internally grinding laterals and anticipated equipment.

E. Closeout and maintenance material submittals: per Division 01 General Requirements.

1. CCTV inspection data and video recordings in digital format on portable USB hard drive, and electronic copies for post-cleaning and post-installation inspections.

2. CCTV inspection reports for inspected pipes with the following fields, in addition to mandatory PACP header fields.
   a. Pipe segment reference number
   b. Upstream and downstream manhole rim-to-invert depths
   c. Pipe joint length
   d. Total pipe length
   e. Length surveyed
   f. Still-capture photographs of significant defects

3. Single PACP certified access database containing report information and defect coding for inspected pipes.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements and as follows.

1. Firm with minimum 10 years’ experience in cleaning and CCTV inspection.
2. PACP certification required for on-Site operators and individuals performing PACP coding if inspection videos are coded separately from actual recording.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing conditions: per Division 01 General Requirements.

B. Notify Engineer immediately if Site conditions prevent access to manholes or pipes identified as part of Work.

PART 2 – PRODUCTS

2.01 EQUIPMENT

A. Manufacturer recommended equipment to protect manholes and pipes.

B. Cleaning

1. High velocity jet and mechanically powered equipment based on NASSCO’s Jetter Code of Practice and field conditions.

2. Vactor truck or other mechanical means for removal of solid or semisolid material resulting from cleaning operation.

C. CCTV Inspection

1. CCTV equipment designed for pipe inspection, with high resolution color video and lighting to allow a clear picture with minimal reflective glare for entire periphery of pipe.

2. Equipment that displays and records the following minimum data.

   a. Project identification
   b. Date recorded
   c. Company and personnel conducting inspection
   d. Pipe identification
   e. Size of pipe and material
   f. Footage counter
g. Station and clock position of laterals

h. Location, severity and rate of observed infiltration or defects

3. Camera: remote controlled, color pan and tilt type lens with lighting system, capable of turning perpendicular to direction of flow and rotating 360 degrees while inside pipe, and capable of viewing minimum service connection length of 4 feet to determine whether connection is active or inactive.

D. Cutting Protruding Services

1. Protruding lateral removal equipment: remote controlled hydraulically driven cutters and reamers, and remotely operated robotic routers or grinders capable of cutting back concrete, vitrified clay, PVC and other pipe materials protruding into main line without damage to host pipe.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Remove standing water to allow adequate cleaning and inspection. Provide pipe flow is no more than 1/4 full during cleaning, and bottom of pipe is visible during inspection.

B. Maintain sufficient flow to pass flash of storm flow in drainage ditches and prevent backwater flooding due to obstruction caused by cleaning and inspection equipment.

3.02 PIPE CLEANING

A. Perform pipe cleaning prior to CCTV inspection.

B. Qualified supervisory personnel must be on-Site during performance of services specified.

C. Review previous inspection logs if available, to identify areas that may require additional cleaning.

D. Consult with Engineer if damage is anticipated based on existing conditions and structural soundness of host pipe to determine if Work will be discontinued.

E. Maintain detailed documentation of cleaning efforts that will reduce hydraulic capacity of the pipe. Record type of debris removed from each segment of pipe.
F. Clean pipes to minimum 95 percent of carrying capacity of pipe diameter at point of debris, based on results of CCTV inspection. If results are unsatisfactory, repeat cleaning until acceptable to Engineer.

G. Remove debris from pipe, except for known pre-existing conditions, including debris washed up into service connections, drop connections, or bench wall of manholes that will reduce hydraulic capacity of pipe and limit future maintenance access of remote equipment.

H. Light cleaning: up to 4 passes.

I. Heavy cleaning: exceeds number of passes established for light cleaning.

J. Perform removal of protruding laterals Work without excavation from existing ground surface.

K. Cut or grind flush protruding break-in service connection to main pipe without scouring or damaging main pipe or service connection. Screen, collect, remove, and legally dispose of pipe cuttings.

L. Grinding of break-in service connections will be determined by Engineer based on initial survey CCTV inspection.

M. Repair or replace damages to service laterals or host pipe during removal with new materials to existing condition.

3.03 TELEVISION INSPECTION

A. Perform CCTV inspection in accordance with PACP standards.

B. Begin each inspection, where possible, at footage 0.0 by panning upwards to view pipe connection with manhole, with both manhole and pipe visible in the same frame.

C. Visually inspect pipe using remote CCTV and record inspection in digital format. Pause, pan, and visually inspect service connections, pipe ends, and maintenance or structural defects. Center camera in pipe to provide accurate distance measurements to locations of features in pipe. Record observations via audio commentary and on PACP log in NASSCO PACP format.

D. Move camera through pipe in either direction at a uniform rate, pausing when necessary to ensure proper identification of pipe condition. Use manual winches, power winches, TV cable and powered rewinds or other devices to move camera through pipe. Use appropriate speed to inspect each pipe joint, tee connection, structural deterioration, infiltration and inflow sources, and deposits, not to exceed 30 feet per minute.
E. If blockage hampers inspection of pipe in one direction, attempt to complete section by televising from another manhole to complete the section and report obstruction to Engineer.

F. Repeat survey if image quality is not adequate for post-inspection coding.

G. Deliver CCTV inspections, recording entire survey in electronic format with electronic links between data and video. Provide CCTV inspection reports within 2-feet of measured linear footage between manholes along existing pipe centerline from start to end of pipe. Enter Owner and PACP required header information on CCTV reports.

3.04 WATER AND WASTE MANAGEMENT

A. Discharge, bypass, or flooding of stormwater, cleaning water, or debris to public or private property, including ground, surrounding residences, and downstream pipes is prohibited. Immediately clean and repair damage resulting from cleaning and inspection to satisfaction of Engineer.

3.05 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 33 01 30.72
CURED IN PLACE PIPE LINING
ALTERNATE A (IF AWARDED BY OWNER)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide cured-in-place pipe (CIPP) and CIPP short liners within existing, deteriorated stormwater pipe in accordance with this Section and applicable reference standards listed in Article 1.03.

2. The Work in this section is only to be completed if the stormwater force main is determined by the Engineer to be in unacceptable condition per inspection in Section 33 01 30.10 and is authorized by Owner.

B. Design Requirements

1. CIPP system design life and corrosion resistance to typical chemicals found in domestic sewage: minimum of 50 years.

2. Design as structurally sound, fully stand-alone pipe-within-a-pipe. Meet or exceed physical properties specified, fit tightly within existing pipe and within tolerances specified. Provide that installed CIPP withstands applicable surcharge loads, such as soil overburden and live loads, and external hydrostatic pressure, if present, for each specific installation location.

C. Related Requirements

1. Section 01 51 40 – Temporary Bypass Pumping

2. Section 33 01 30.10 – Television Inspection and Cleaning of Storm Sewers

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.
1.03 REFERENCES

A. Reference Standards

1. ASTM International (ASTM)
   
   
   b. ASTM D5813 – Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems
   
   c. ASTM F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
   
   d. ASTM F1743 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)
   
   e. ASTM F2019 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled-in-Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)

2. National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) Standards

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling per Division 01 General Requirements and as follows:

1. Attach written notice of anticipated service interruption to door of each building that has sewer service through pipe being lined 1 week prior to lining installation and again 24 hours before lining installation.

2. Distribute written notice following service connection reinstatement notifying occupants that service connection has been restored, or include start and end time of service disruption on notice distributed 24 hours prior to lining installation.
1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

1. Proposed manufacturers technology data for CIPP lining and products
2. Description of CIPP materials
3. Manufacturer of and description of fabric tube components, and certified information on void volume in fabric to be filled with resin
4. Flexible membrane coating material data
5. Raw resin data including manufacturer and description of product components
6. Manufacturer’s data on hydrophilic rubber gasket to be placed between host pipe and CIPP
7. Material Safety Data Sheets (MSDS) for materials used during preparation and installation of CIPP system

C. Design Data/Submittals

1. Engineering design calculations, according to ASTM F1216, for each length of liner installed including thickness of each proposed CIPP. Design for most severe line condition may be submitted and applied to line sections. Calculations: performed and certified by professional engineer licensed in the state where the Project is located. Submit design calculations for maximum allowable pulling force on liner tube for pulled in CIPP liners.

D. Manufacturer Instructions

1. Recommended patching procedure for flexible membrane material
2. Manufacturer’s shipping, storage and handling recommendations for products and components of CIPP system
3. Manufacturer’s recommended cure method for each diameter and thickness of CIPP to be installed, including curing medium and method of application
4. Blockage removal procedures
5. Description of methods and equipment proposed for repairs of uncured areas, defects, test sample section repairs or other deformities in completed liner pipe.
E. Source and Field Quality Control Submittals
   1. Independent laboratory testing results of CIPP samples

F. Manufacturer Reports
   1. Description of proposed wet-out procedure for proposed CIPP lining technology and example wet out report

G. Detailed plan for identifying active service connections and maintaining service during mainline installation to each building connected to section of pipe being lined, including temporary service if required

H. Proposed locations of inversion manholes

I. Flow handling and bypass pumping plan according to Section 01 51 40

J. Public notification plan including example notification to building occupants affected by CIPP installation

K. Description of odors anticipated as result of curing process and detailed odor control plan ensuring Project specific odors are minimized at Site and surrounding area.

L. Procedures and details on methods to obtain water if required for installation.

M. Qualification Statements
   1. For firm and lead personnel in accordance with Article 1.06

N. Closeout and Maintenance Material Submittals per Division 01 General Requirements

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements and as follows for firm:
   1. Minimum 5 years’ continuous experience in cured in place pipe lining.

C. Qualifications: per Division 01 General Requirements and as follows for lead personnel:
   1. Minimum 5 years’ total experience with proposed CIPP technology, and have demonstrated competency and experience to perform resin wet-out, CIPP liner installation, liner curing and robotic service reconnections.
D. Certifications
   1. Confined Space Entry certifications for Contractor’s personnel entering pipeline or access structures.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Packaging, Shipping, Handling and Unloading
      1. Ship materials with test reports certifying material conforms to applicable ASTM standards specified.

1.08 SITE CONDITIONS
   A. Existing conditions: per Division 01 General Requirements.
   B. Notify Engineer immediately if Site conditions prevent access to manholes or pipes identified as part of Work.

PART 2 – PRODUCTS

2.01 PRELINER TUBE
   A. Reinforced plastic sheet formed to fit host pipe being lined, continuous from manhole to manhole.

2.02 FABRIC TUBE
   A. One or more layers of absorbent non-woven felt fabric, felt/fiberglass or fiberglass
   B. Capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures, have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections.
   C. Provide wet-out fabric tube with uniform thickness and excess resin distribution to meet or exceed design thickness after cure when compressed at installation pressures.
   D. Manufacture to size and length for tight fit to internal circumference of original pipe when installed, meeting or exceeding ASTM D5813, F1216, F1743 and F2019. Make allowance for circumferential stretching during installation and provide ability to stretch to fit irregular pipe sections and negotiate bends.
   E. Determine minimum tube length necessary to effectively span designated runs between manholes. Verify lengths in field prior to ordering and prior to impregnation of tubes with resin to ensure tube will have sufficient length to extend entire length of run.
F. Coat outside and inside layer of fabric tube before inversion/pull-in, with impermeable, flexible membrane to contain resin and facilitate vacuum impregnation and monitoring of resin saturation during wet-out procedure.

G. Do not include material in fabric tube that causes de-lamination in cured CIPP. Dry and unsaturated layers visually evident by color contrast between tube fabric and activated resin containing colorant are not acceptable.

H. Provide light reflective wall color on interior pipe surface of CIPP, after installation, to ensure clear detailed examination with closed circuit television inspection equipment. Hue: dark enough to distinguish contrast between fully resin-saturated felt fabric and dry or resin lean areas.

I. Seams in fabric tube: according to ASTM D5813.

J. Mark outside of fabric tube every 5-feet with name of manufacturer or CIPP system, manufacturing lot, and production footage.

K. Installer shall determine minimum length of fabric tube to span distance from starting to terminating manhole or access point, plus mount required to run-in and run-out for installation process.

L. Construct nominal fabric tube wall thickness to minimum nearest 0.5-mm increment, rounded up from design thickness for that section of installed CIPP. Fabricate wall thickness transitions into fabric tube between installation entrance and exit access points in 0.5-mm increments or greater.

M. Impregnate sufficient quantity of resin to fill voids for nominal fabric thickness.

2.03 RESIN

A. Provide corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system to:

1. produce CIPP that will comply with or exceed structural and chemical resistance requirements specified;

2. meet ASTM F1216, ASTM F1743 or F2019 when properly cured within tube composite;

3. meet physical properties specified; and

4. meet properties utilized in design of CIPP.

B. Resin to tube ratio, by volume: as recommended by manufacturer.
2.04 CIPP SHORT LINERS

A. Impregnated with epoxy resin prior to insertion, forming hard, impervious, corrosion-resistant lining upon curing.

B. Materials: according to ASTM F1216.

2.05 HYDROPHILIC COMPRESSION GASKET

A. Acceptable level of quality: equivalent to Hydotite from Greanestreak Group Inc., or Insignia from LMK Technologies.

2.06 STRUCTURAL REQUIREMENTS

A. Cured-in-place liner shall have sufficient structural strength to support loads imposed with assumption that existing pipe is fully deteriorated and cannot support any loading or contribute to structural integrity of liner.

B. Physical properties and characteristics of finished liner: varied and dependent on types and mixing proportions of materials used, and degree of cure executed. Control variables to provide that CIPP system meets or exceeds minimum properties specified.

1. Design according to ASTM F1216 and assume no bonding to original pipe wall.

2.07 MINIMUM PHYSICAL PROPERTIES

A. Meet following minimum physical properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Cured Composite per ASTM F1216</th>
<th>Cured Composite Per Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Modulus of Elasticity (Short Term)</td>
<td>ASTM D790</td>
<td>250,000 psi</td>
<td>Contractor Value</td>
</tr>
<tr>
<td>(Felt Tubes) Felt/Fiberglass, Fiberglass as recommended by manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexural Strength (Short Term)</td>
<td>ASTM D790</td>
<td>4,500 psi</td>
<td>Contractor Value</td>
</tr>
<tr>
<td>(Felt Tubes) Felt/Fiberglass, Fiberglass as recommended by manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. Provide required structural CIPP wall thickness based, at minimum, on physical properties of cured composite, according to design by Engineer, design equations contained in appendices of applicable ASTM standards, and design parameters below.

<table>
<thead>
<tr>
<th>Design Safety Factor</th>
<th>2.0 (1.5 for pipes 36-inches or larger)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creep Retention Factor</td>
<td>50 percent</td>
</tr>
<tr>
<td>Ovality Correction Factor</td>
<td>2 percent or as measured by field inspection</td>
</tr>
<tr>
<td>Modulus of Soil Reaction E</td>
<td>1,000 psi</td>
</tr>
<tr>
<td>Depth of Groundwater Above Pipe</td>
<td>At Ground Surface</td>
</tr>
<tr>
<td>Depth of Cover</td>
<td>Varies. As indicated on record drawings</td>
</tr>
<tr>
<td>Wheel Load</td>
<td>16,000-pounds</td>
</tr>
<tr>
<td>Specific Weight of Soil</td>
<td>120 pounds per cubic foot</td>
</tr>
<tr>
<td>Minimum Service Life</td>
<td>50 years</td>
</tr>
<tr>
<td>Design Temperature</td>
<td>80 degrees F</td>
</tr>
<tr>
<td>Shape Factor</td>
<td>6</td>
</tr>
<tr>
<td>Bedding Deflection Coefficient</td>
<td>0.103</td>
</tr>
</tbody>
</table>

2.08 MANUFACTURERS

A. Insituform Technologies
B. National Liner
C. Perma-Liner
D. Or equal

2.09 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 PREPARATION

A. Clean interior of existing host pipe prior to installation of CIPP liner according to Section 33 01 30.10. Remove debris and obstructions that will affect installation and long-term performance of CIPP.

B. Perform post-cleaning video inspection according to Section 33 01 30.10 and submit post-cleaning video and data in digital format within 1 week after post-cleaning and prior to installation of CIPP.

C. Review existing conditions data prior to commencement of construction, including CCTV logs provided.

D. Verify lengths and pipe sizes in field prior to liner installation.

E. Verify all active sewer service locations to be reinstated as part of pre-CCTV inspection prior to the CIPP mainline and lateral installation.

F. Confirm locations of branch service connections prior to installation of CIPP.

G. Complete internal grinding of protruding sewer services prior to cured-in-place pipe lining work according to Section 33 01 30.10.

H. Provide bypass pumping according to Section 01 51 40.

3.02 INSTALLATION OF CIPP

A. Perform CIPP with minimal excavation or demolition of existing structures.

B. Commence CIPP operations at beginning of anticipated 3-day minimum period of dry weather.

C. Install and cure continuous and jointless CIPP liner from manhole to manhole or access point to access point, forming to internal circumference of host pipe when cured, according to manufacturers’ specifications, applicable ASTM standards, and as specified.

D. Install pre-liner tube in presence of Engineer.

E. Provide for bypass pumping of existing mainline and service connection effluent around sections of pipe designated for CIPP installation. After notifying occupants, plug pipelines and connections and monitor regularly to prevent backup of sewage into adjacent buildings. Do not allow plugs to remain overnight. Begin installation after required plugs or sewage bypass system have been installed, and pumping facilities have been installed and tested under full operating conditions including bypass of mainline and side sewer flows according to Section 01 51 40.
F. Insert CIPP tube through existing manhole. Equip winch with dynometer to record pulling forces during installation. Pull forces shall not exceed manufacturer’s recommendations. Inversion heads for tubes that are inverted in place shall not exceed manufacturer’s recommendations.

G. After inversion/installation of tube, circulate hot water, steam, ultraviolet light or other methods approved by Engineer to cure resin into hard, impermeable pipe.

H. Temperature Monitoring During Cure Cycle

1. Place remote temperature gauges or sensors inside host pipe prior to installation as recommended by manufacturer to monitor temperatures. Monitor, and log, liner and host pipe interface temperature during curing of liner.

2. Place temperature sensors between host pipe and liner in bottom of host pipe invert throughout its length to monitor temperature on outside of liner to verify correct curing.

3. Place temperature sensors at intervals recommended by CIPP liner and resin manufacturers. Place additional sensors where significant heat sinks are likely. Continuous temperature sensors and monitoring may be required, according to manufacturer’s recommendations.

4. Monitor sensors by computer using database capable of recording temperatures at interface of liner and host pipe. Provide output report identifying each installed sensor station in length of pipe, maximum temperature achieved, sustained temperature time, minimum cool down temperature, and light train sensor readings for UV cured liners, documenting cure along entire length of installed liner.

I. Position wet-out tube in pipeline using method specified by manufacturer. Pull-in or invert through existing manhole or approved access point and fully extend to next designated manhole or termination point.

J. Use appropriate medium according to manufacturer’s recommended cure schedule and method, taking into account liner wall thickness and existing ground conditions, with regards to temperature, moisture level, and thermal conductivity of soil, and applicable ASTM standards.

K. Adjust, according to manufacturer’s recommendations for heat-cured liners, if temperature sensor or multiple sensors do not reach temperature specified by manufacturer to achieve proper curing or cooling. Use manufacturer’s cure procedure for UV cured liners.
L. Cool CIPP according to manufacturers’ recommendations. Cold water used to cure CIPP liner shall not be discharged into existing system without authorization from Engineer. Contractor is responsible for handling and properly disposing of cure-water.

M. Reinstate existing service connections after liner is cured-in-place. Reopen branch connections to buildings without excavation according to ASTM F1216.

N. Mitigate odors onto public or private property due to renewal operations, immediately after notification from Engineer including, but not limited to, forced-air ventilation and chemical cleaning of buildings.

### 3.03 REPAIR/RESTORATION

A. Installed CIPP: continuous over entire length of sewer line section and free from visual defects such as foreign inclusions, discoloration, dry/soft spots, pinholes, major wrinkles, bulges and de-lamination, and impervious and free of leakage from pipe to surrounding ground or from ground to inside lined pipe.

B. Repair defects that could affect structural integrity or impact continuous flow through pipeline according to manufacturers’ recommendations.

C. Grout infiltration leaks identified between host pipe, service connections and CIPP liner to remove observed infiltration as specified in Section 33 01 30.10.

### 3.04 INSTALLATION OF CIPP SHORT LINERS

A. Install and cure CIPP short liner in host pipe according to manufacturer’s specifications and this section.

B. Taper edges of short liners at both ends.

C. Do not allow significant pipe volume change due to installation of short liners.

D. Install short liners to force excess resin into cracks, joints or other surface defects of existing interior pipe wall surface.

E. Minimum length: 3 linear feet. Extend short liner minimum of 1-foot beyond each end of defect. Do not allow end of short liner to correspond with location of joint or service connection. Location and length of short liners: as shown on Drawings and as directed by Engineer.

F. Reinstate existing service connections after short liner has been cured-in-place. Reopen branch connections to buildings without excavation according to ASTM F1216.
3.05 MANHOLE CONNECTIONS AND RECONNECTIONS OF EXISTING SERVICES

A. Apply hydrophilic compression gasket seal at manhole/wall interface according to CIPP system manufacturer’s recommendations. When hydrophilic compression gaskets are not feasible due to physical pipe or lateral properties, grout service connections or mainline CIPP ends according to Section 33 01 30.61 after existing service connections are reinstated. Ensure annular space between sewer main and CIPP is fully sealed with grout.

B. Reinstate lateral service connections internally using CCTV camera and remote cutting device. Machined opening: between 95 and 100 percent of service connection opening. Bottom of both openings must match. Do not allow pipe fragments or liner fragments at edges of opening to avoid obstructing flow or snagging debris. Cut invert of sewer connection flush with invert entering mainline.

1. Determine exact locations of service laterals during internal inspection and re-verify with pre-construction inspection reports for accuracy. Repair holes or trial cuts in CIPP liner not in alignment with service lateral.

2. If service reinstatements result in openings greater than 100 percent of service connection opening, install CIPP type repair, sized to completely cover over-cut service connection.

C. Make reconnections of existing services after CIPP is installed, fully cured, and cooled down.

D. Collect coupons of pipe material resulting from service tap cutting at next manhole downstream of pipe rehabilitation operation prior to leaving site. Coupons may not be allowed to pass through system.

3.06 REPAIR/RESTORATION

A. Repairs: according to manufacturer’s recommended written procedures and techniques for uncured areas, defects, test sample section repairs or other deformities in completed liner pipe.

3.07 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
B. Site/Field Tests and Inspections

1. Verify physical properties of installed CIPP through field sampling provided by Contractor and testing by independent third party laboratory selected by Engineer. Furnish materials for testing to the Owner for testing by independent third party laboratory selected by Owner and recommended by the CIPP manufacture. Sampling and testing: per applicable ASTM test methods to confirm compliance with requirements specified.

2. Provide samples to Engineer for testing from installed CIPP liner, minimum 1 location per 1,000 linear feet of CIPP installed or as required by Engineer. Cut sample from section of cured CIPP that has been inverted or pulled through like diameter pipe and has been held in place by suitable heat sink, such as sandbags. Engineer will witness curing, cutting and identification of samples and transmit samples to testing laboratory.
   a. Engineer may require plate samples cured with CIPP or designate location in newly installed CIPP for Contractor to take sample from. Pipelines: minimum 18-inches in diameter. Repair opening produced from sample according to manufacturer’s recommended procedures.

3. Laboratory results shall identify test sample location referenced to nearest manhole and station. Repair or replace CIPP if properties tested do not meet minimum physical and thickness requirements.

4. Chemical resistance requirements without plastic coating: according to ASTM D5813. Provide CIPP samples of fabric tube and resin used for construction or submit certification from manufacturer verifying chemical resistance of CIPP meets requirements.

5. Installed CIPP shall, at minimum, be equal to full flow capacity of original pipe before rehabilitation. When full capacity cannot be achieved after liner installation, Contractor shall submit request to waive this requirement, together with reasons for waiver request. Calculated capacities may be derived using commonly accepted roughness coefficient for existing pipe material taking into consideration its age and condition.

6. Post-Installation Inspection
   a. Immediately prior to conducting post-installation CCTV inspection, Contractor shall clean newly installed liner, removing debris and build-up that may have accumulated.
   b. Perform CCTV inspection to NASSCO standards in presence of Engineer after installation of CIPP liner and reinstatement of laterals.
c. Submit unedited digital documentation of CCTV inspection within 10 working days of liner installation according to Section 33 01 30.10. Engineer may suspend Work if documentation is not submitted as specified above.

d. Utilize bypass pumping or plugging from upstream manhole to minimize sewage from entering line during CCTV inspection. Clear pipe of standing water to provide continuous visibility during CCTV inspection.

e. Leak free pipe is required for final approval of liner installation. Repair or remove liner where leakage is observed through wall of pipe as recommended by CIPP manufacturer.

f. Final acceptance of rehabilitation work shall not be granted until defective areas are repaired to pipe lining manufacturers and Engineer’s satisfaction.

7. Warranty Inspection

a. Warranty inspection must commence within 45 calendar days prior to expiration of Warranty Period or within 10 days of receipt of notice from Engineer to commence warranty inspection. Perform CCTV inspection of 10 percent of rehabilitated pipes, according to Section 33 01 30.10 and in presence of Engineer, within 14 calendar days prior to expiration of Warranty Period, 351 days from Substantial Completion. Specific locations will be selected for warranty sections by Engineer and will include all sizes of CIPP in Project.

b. Perform CCTV inspection of entire CIPP system during Warranty Period if abnormalities or defects are discovered by Engineer after primary warranty inspection.

c. Repair and replace abnormalities and defects discovered during warranty inspection as recommended by manufacturer or requested by Engineer, and as specified.

3.08 CLEANING

A. Do not discharge, bypass, or flooding of sewage to public or private property, including ground, surrounding residences, and downstream sewer lines. Immediately clean and repair damage resulting from cleaning and inspection activities to satisfaction of Engineer.

B. Collect cleaning water, solids and debris generated from sewer pipe cleaning and discharge off-Site to appropriate waste facilities. Do not discharge cleaning water and solids to public or private property.
C. Promptly remove and legally dispose of damaged materials, including but not limited to, items with gouging, abrasion, flattening, cutting, puncturing, or ultra-violet degradation.

3.09 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

3.10 ATTACHMENTS

A. Cured-In-Place Pipe Lining Installation Form

END OF SECTION
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## CURED-IN-PLACE PIPE LINING INSTALLATION FORM

<table>
<thead>
<tr>
<th>Project Name: The Strand Pump Station Rehabilitation</th>
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</thead>
<tbody>
<tr>
<td>Project No.: 0229766.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Woodard &amp; Curran Representative:</th>
<th>Signature:</th>
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</table>

<table>
<thead>
<tr>
<th>Lining Contractor:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Lining Contractor Foreman:</th>
<th>Signature:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Upstream Manhole:</th>
<th>Downstream Manhole:</th>
<th>Length:</th>
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</table>

<table>
<thead>
<tr>
<th>Date of Install:</th>
<th>Weather:</th>
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</table>

<table>
<thead>
<tr>
<th>Time Onsite:</th>
<th>Uncured Liner Installed:</th>
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</thead>
</table>

<table>
<thead>
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<th>Required Cure Time:</th>
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</table>

<table>
<thead>
<tr>
<th>Cure Started:</th>
<th>Cure Finished:</th>
</tr>
</thead>
</table>

<table>
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<tr>
<th>Comments:</th>
</tr>
</thead>
</table>

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**ATTACHMENT TO CURED IN PLACE PIPE LINING INSTALLATION & SERVICE LATERAL REINSTATEMENT FORM**

WOODARD & CURRAN

33 01 30.72A-1
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SECTION 33 14 19

VALVES AND HYDRANTS FOR WATER UTILITY SERVICE

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes

1. Provide valves, hydrants, and appurtenances in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 31 00 00 – Earthwork
2. Section 32 12 16 – Asphalt Paving
3. Section 32 90 00 – Planting

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Society of Mechanical Engineers (ASME)
   a. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
2. ASTM International (ASTM)
   b. ASTM A536 Standard Specification for Ductile Iron Castings
   c. ASTM B98 Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
3. American Water Works Association (AWWA)
   a. AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
   b. AWWA C502 Dry-Barrel Fire Hydrants
c. AWWA C509 Resilient-Seated Gate Valves for Water Supply Service

d. AWWA C515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service

e. AWWA C550 Protective Interior Coatings for Valves and Hydrants

f. AWWA C600 Installation of Ductile-Iron Mains and Their Appurtenances

g. AWWA C651 Disinfecting Water Mains

1) Section 4.8 Preventive and Corrective Measures During New Construction

4. Manufacturers Standardization Society (MSS)

a. MSS SP-60 Connecting Flange Joints Between Tapping Sleeves and Tapping Valves

5. NSF International (NSF)

a. NSF/ANSI 61 Drinking Water System Components - Health Effects

b. NSF/ANSI 372 Drinking Water System Components – Lead Content

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product data: manufacturer’s product data and installation instructions for each product specified.

C. Shop Drawings

D. Certificates: manufacturer’s notarized certificate, certifying conformance to accompany shipments.

E. Closeout and maintenance material submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Comply with requirements of AWWA C600, and Section 4.8 of AWWA C651 for cleanliness.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, shipping, handling and unloading

1. Each shipment to include manufacturer’s certificate of conformance.

2. Inspect upon delivery and reject pipe not in conformance with specified requirements, or damaged beyond repair. Immediately remove damaged pipe from Site and dispose of legally.

1.08 SITE CONDITIONS

A. Existing conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. Products in contact with raw or drinking water must meet NSF/ANSI 61 and NSF/ANSI 372.

2.02 GATE VALVES

A. Resilient wedge of non-rising stem (NSR) type meeting AWWA C515, with a 2-inch square AWWA operating nut opening right.

B. Ductile iron valve body, bonnet, disc, stuffing box and operating nut.

C. Stem and stem nut: silicon bronze.

D. Stem seals: triple O-rings, 2 above thrust collar, 1 below.

E. Stuffing box and bonnet sealing: nitrile O-rings.

F. Exterior nuts and bolts: Type 304 stainless steel.

G. Minimum working pressure: 250 psi.

H. Standard mechanical joint ends in accordance with AWWA C111.
I. Interior and exterior surfaces coated with fusion bonded epoxy coating in accordance with AWWA C550, and certified per NSF/ANSI 61.

J. Manufacturers
   1. Mueller Corporation
   2. U.S. Pipe Valve & Hydrant, LLC
   3. Kennedy Valve Company
   4. Or equal

2.03 VALVE BOXES

A. Heavy duty cast iron, two-piece slide type in accordance with ASTM A48. Telescoping, adjustable heavy-pattern type, inside diameter minimum 5-1/4 inches, designed to prevent transmission of traffic loads, adjustable through minimum 6 inches vertically without reduction of lap between sections to less than 4 inches, and length necessary to suit ground elevation. Covers: close fitting, dirt-tight, with WATER cast-in. Top of cover: flush with top of box rim.

2.04 YARD HYDRANTS

A. Inlet: 1 ½” brass valve body, FPT
B. Outlet: 1 ½” FPT galvanized tee
C. Handle: manual closing, almag casting lever handle
D. Automatic draining through 1/8” NPT drain hole, must be installed below frost line
E. Casting: 1 ½” galvanized pipe
F. Maximum pressure: 125 psi

G. Manufacturers
   1. Woodford
   2. Simmons Manufacturing
   3. Everbilt
   4. Or equal
2.05 TAPPING SLEEVES AND VALVES

A. Tapping Sleeve

1. ASTM A536 Grade 65-45-12 ductile iron rated for 250 psig maximum working pressure with end joint accessories and split glands to assemble sleeve to pipe.

2. Asphaltic varnish coating in accordance with NSF/ANSI 61.

3. Side flange seals: O-ring type, round, oval or rectangular in cross-sectional shape.

4. 12-inch and smaller: capable of working on Class ABCD pipe diameters without changing either half of sleeve.

5. 12-inch and greater: field measured to determine class required.

6. Outlet flange dimensions and drilling in compliance with ASME B16.1, class 125 and MSS SP-60.

7. Provide 3/4-inch national pipe thread (NPT) test plug.

B. Tapping Valve

1. Conform to Gate Valves requirements specified.

2. Provide with inlet flange conforming to ASME B16.1 Class 125 and MSS SP-60, and mechanical joint outlet end with dimensions complying with AWWA C111.

3. Designed to connect directly to flanged end of tapping sleeve.

2.06 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GENERAL

A. Perform excavation and backfill in accordance with Section 31 00 00.

B. Install in accordance with manufacturer’s installation instructions, AWWA C600, as shown on Drawings, and as specified.
3.02 INSTALLATION

A. Valve and Valve Box

1. Provide that valves bear no stresses due to loads from adjacent pipe.
2. Inspect valves before installation, clean and lubricate prior to installation.
3. Install valve with stem in vertical position.
4. Secure valves to water main with retainer glands.
5. Set valve box over valve stem in vertical position. Brace valve box to ensure it remains in vertical position and centered on valve stem during and after backfilling.
6. Maintain proper alignment and height of valve box until final completion.

B. Hydrant

1. Provide hydrants have drains.
2. Restrain joints in hydrant lateral from main to hydrant.
3. Install hydrant gate on hydrant tee.
4. Set hydrant in true vertical alignment with solid concrete block support.
5. Embed hydrant within crushed stone material from bottom of excavation to 12 inches above hydrant drains. Cover crushed stone with plastic polyethylene sheet barrier.
6. Engineer to inspect hydrant installation prior to backfilling.
7. Paint hydrant with rust inhibiting paint in color scheme selected by Owner.

C. Tapping Sleeve and Valve

1. After installation, pressure test joints before tapping.
2. Verify actual pipe size and material to be tapped.
3. Remove dirt and scale on exterior of water main to be tapped.
4. Clean and disinfect pipe exterior tapping saddle and valve, drilling and cutting tools.
3.03  **REPAIR/RESTORATION**

A. Repair defective work and retest until installation is accepted.

B. Repair leaks.

C. Restore disturbed surface areas as follows.

1. Paved areas, including bituminous curbing and bituminous sidewalks: in accordance with Section 32 12 16.

2. Lawn areas: in accordance with Section 32 90 00.

D. Replace other materials and items removed, restore disturbed areas to original conditions.

3.04  **FIELD QUALITY CONTROL**

A. Provide in accordance with Division 01 General Requirements.

3.05  **CLOSEOUT ACTIVITIES**

A. Provide in accordance with Division 01 General Requirements.

**END OF SECTION**
SECTION 33 14 20

WATER SERVICE CONNECTIONS - POLYETHYLENE

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes

1. Provide polyethylene (PE) utility service connections including service saddles, repair clamps, corporation stops, PE service tubing and stainless steel tubing inserts, tracer wire and wire connectors, curb stops, service boxes, and service fittings in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 31 00 00 – Earthwork
2. Section 31 10 00 – Site Clearing
3. Section 32 90 00 – Planting
4. Section 33 05 33 – Polyethylene Water Utility Pipe and Fittings

1.02 PRICE AND PAYMENT

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Water Works Association (AWWA)


   b. ANSI/AWWA C600 Standard for Installation of Ductile Iron Water Mains and their Appurtenances

   c. ANSI/AWWA C605 Standard for Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings

   d. ANSI/AWWA C800 Underground Service Line Valves and Fittings
2. ASTM International (ASTM)
   b. ASTM B62 – Standard Specification for Composition Bronze or Ounce Metal Castings
   d. ASTM A536 – Standard Specification for Ductile Iron Castings
   e. ASTM B584 – Standard Specification for Copper Alloy Sand Casting for General Application

3. NSF International (NSF)
   a. NSF/ANSI 61 Drinking Water System Components - Health Effects
   b. NSF/ANSI 372, Drinking Water System Components – Lead Content

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

B. Provide utility service connections after disinfection, flushing and bacteriological testing of the water utility piping systems are completed and accepted by the ENGINEER.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data: Submit manufacturer's product data and installation instructions for each product specified for utility service connections.

C. Shop Drawings

D. Certificates

   1. Manufacturer's notarized certificate certifying conformance with the Specifications to accompany shipments
E. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1. Record depth and take ties as directed by the Engineer for Conformed to Construction Records.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1. Comply with Owner requirements.

2. Code Compliance: Comply with State Plumbing Code and local plumbing codes. Where there is a conflict in the codes, the more stringent code shall apply.

3. AWWA Standards: Comply with requirements of latest revision of AWWA C651 including Section 4.3, "Preventive and Corrective Measures During Construction" for cleanliness.

4. General: All products used in the construction that come in contact with drinking water shall meet the National Sanitation Foundation Standard 61 for Drinking Water System Components - Health Effects. The primary focus of the standard is on contaminants or impurities, which may be imparted indirectly to drinking water. The products and/or materials covered include, but are not limited to, protective materials (coatings, linings, liners, etc.), joining and sealing materials (solvent cements, welding materials, gaskets, etc.), and mechanical devices used in transmission/distribution systems, (valves, etc.).

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Packing, Shipping, Handling, and Unloading

1. Each shipment includes manufacturers’ Certificate of Conformance.

2. Inspect upon delivery and immediately reject products that do not conform to the specified requirements or has been damaged beyond repair and immediately remove from the Site.

C. Waste Management and Disposal

1. Remove damaged pipe from Site and legally dispose of.
1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 SERVICE TUBING

A. PE Tubing: High Density Polyethylene tubing conforming to the following:
   1. Color: UV stabilized blue exterior, natural interior,
   2. Diameter: 1-inch minimum, Copper Tubing Size (CTS)
   3. Pressure rating: 200 psi
   4. Factory sealed ends
   5. Conform to ASTM D3350, ASTM D2737, and AWWA C901
   6. NSF 61 certified.

2.02 CORPORATION STOPS

A. Materials: Cast “No-Lead” brass defined for this specification as UNS Copper Alloy NO. C89520 or C89833 in accordance with the chemical and mechanical requirements of ASTM B584 and AWWA C-800.

B. Type: Brass ball with fluorocarbon coating, double O-ring type stem seals

C. Pressure rating: 300 psig

D. Inlet threads: AWWA Standard (CC) inlet threads

E. Outlet Connection: Compression outlet for CTS O.D. tubing

F. Installation: Capable of being installed using a standard tapping machine.

G. Conform to AWWA Standard C800

H. Acceptable manufacturers
   1. Mueller Co
   2. A.Y. McDonald
   3. Ford Meter Box Company
   4. Red Hed Brass Manufacturing
5. or approved equal

2.03 CURB STOPS

A. Materials: Cast “No-Lead” brass as defined for this specification as UNS Copper Alloy No. C89520 or C89833 in accordance with the chemical and mechanical requirements of ASTM B584 and AWWA C-800.

B. Type: Brass ball with fluorocarbon coating, double O-ring type stem seals, straight-through / full port design

C. positive shut-off in either direction.

D. Pressure rating: 300 psig

E. Inlet Connection: Compression Connection.

F. Outlet Connection: Compression Connection.

G. Conform to AWWA Standard C800

H. Acceptable manufacturers
   1. Mueller Co
   2. A.Y. McDonald
   3. Ford Meter Box Company
   4. Red Hed Brass Manufacturing
   5. or approved equal

2.04 SERVICE BOXES

A. Materials: Heavy duty cast iron conforming to ASTM A48.

B. Style: 2-1/2 inch Buffalo style

C. Type: Two-piece, slide type

D. Cover: Heavy duty, flush fit, locking type with a brass pentagon head bolt and the word “WATER” cast in the cover.

E. Base: Arch Style. Provide enlarged base for 1-1/2 inch and 2-inch diameter water services.
2.05 SERVICE SADDLES

A. Materials: Ductile iron body conforming to ASTM A536 with Type 304 stainless steel double straps each a minimum of 2 inch width. Studs, nuts and washers Type 304 stainless steel. Nuts coated to prevent galling.

B. Gaskets: Epoxy or nylon coated body with Buna-N (Nitrile) or EPDM rubber gaskets.

C. Comply with ANSI/AWWA C800 and NSF/ANSI 61.

D. For PVC/PVCO water main use only services saddles specifically made for PVC/PVCO pipe.

E. Acceptable manufacturers
   1. Romac,
   2. Ford Meter Box Company,
   3. Smith Blair,
   4. Mueller,
   5. A.Y. McDonald,
   6. Or equal

2.06 REPAIR CLAMPS

A. Materials: Type 304 stainless steel band conforming to ASTM A240

B. Gaskets: Gridded Nitrile (Buna-N) or Styrene Butadiene Rubber (SBR) face gasket with tapered ends.

C. Comply with ANSI/AWWA C230 and NSF/ANSI 61.

D. Pressure Rating: Maximum working pressure of 150 psi

E. Manufacturers
   1. Romac
   2. Ford Meter Box Company
   3. Smith Blair
   4. Mueller
5. A.Y. McDonald
6. Or equal

2.07 TRACER WIRE

A. Tracer wire: 12-gauge solid copper clad steel, 21% conductivity, high strength with minimum 450 lb. break load, with minimum 30 mil high density, high molecular weight HMW- HDPE insulation suitable for direct bury at 30 volts and designed to carry an electrical signal for use in locating underground non-metallic pipe.

B. Tracer wire connectors: Provided by trace wire manufacturer, rated for direct bury, water and corrosion proof, impact and crush resistant and filled with silicone sealant.

2.08 ACCESSORIES

A. Service fittings: Conform to the following:

1. Materials: Cast “No-Lead” brass defined for this specification as UNS Copper Alloy NO. C89520 or C89833 in accordance with the chemical and mechanical requirements of ASTM B584 and AWWA C-800. Meet or exceed ASTM B62 and AWWA C800 standards.

2. Pressure Rating: Greater than the valve or fitting with which the fitting is used

3. Inlet Connection: Compression type

4. Outlet Connection: Compression type

5. Manufacturer’s
   a. Mueller Co
   b. A.Y. McDonald
   c. Ford Meter Box Company
   d. Red Hed Brass Manufacturing
   e. Or equal

B. PE tubing connections: Use stainless steel inserts in all tubing connections compatible with the tubing and fitting manufactures recommendations.
PART 3 – EXECUTION

3.01 GENERAL

A. Coordinate all Work with Owner.

B. Perform excavation and backfill in accordance with Section 31 00 00 – Earthwork.

C. Install utility service connections in accordance with the manufacturer’s installation instructions, as shown on the Drawings and as specified.

3.02 INSTALLATION

A. Corporation Stops

1. Install direct tapped connections for all for services 1-inch in diameter and smaller, in accordance with AWWA C600, manufacturer’s instructions and as shown on the drawings.

2. Install service saddles for all services larger than 1-inch in diameter and for all connections to PVC/PVCO water mains. Install service saddles for PVC/PVCO water main in accordance with AWWA C605 and Uni-Bell Publication UNI-PUB-08-07 “Tapping Guide for PVC Pressure Pipe”.

3. Install wet tap connections using a tapping machine.

4. Install taps on customer side of the water main.

5. When drilling, take care to completely cut through the water main wall. Thoroughly clean all tapped threads, making sure to remove any remnants of water main materials.


7. Make service taps water tight.

B. Water Service Tubing

1. Extend water service tubing of the size and in locations as indicated on the Drawings, or as directed by the Owner.

2. Install water service tubing in a single piece without joints between corporation stop and curb stop.

3. Install water service tubing at a right angle to the water main and in a straight path from the corporation stop to the curb stop.
4. Install water service tubing with no kinks, joints, gouges or crimps in the water service tubing.

5. Install water service tubing with moderate slack or snaking to accommodate any contraction.

6. Connect water service tubing to corporation stop, curb stop and existing water service tubing. Install stainless steel inserts at all connections.

7. Make connection to existing water service with service fitting.

8. Install new service tubing with a minimum of 5 feet of cover, measured from top of service tubing to finished grade, unless otherwise shown on the Drawings or approved, in writing, by the Owner.

9. Insulate all service tubing with less than 5 feet of cover (where approved) with a minimum 4-inch, 40 pound density Styrofoam material. Extend insulation the width of the trench, a minimum of 4 feet, above the pipe envelope and on the vertical sides of the trench bottom from the bottom to above the pipe envelope. Do not install pipe with less than 5 feet of cover without prior written approval of the Owner.

10. Remove and dispose of existing water service tubing.

C. Curb Stop and Box

1. Install curb stop in the trench on a precast solid concrete block support at an elevation to provide a minimum cover of 5 feet.

2. Perform operational testing of curb stops by opening and closing under water pressure to insure proper operation and to release any air in the water service tubing.

3. Prior to backfilling the trench, pressure test utility service connections under active line pressure.

4. Provide a service box for each curb stop.

5. Carefully set and brace curb box to ensure that it remains in a vertical position centered on the curb stop during and after backfilling. Maintain proper alignment and height of curb box until completion of project.

6. Install curb box so cover is flush with the existing grade.

7. Remove and dispose of existing curb stop and box.
D. Tracer Wire

1. Install in such a manner as to enable its detection with electronic locating equipment.

2. Install tracer wire along and secured to the water service tubing utilizing nylon zip cable ties at a maximum of eight foot intervals.

3. Install tracer wire from the corporation stop in one continuous piece to the curb stop and extend the trace wire up to the top of the curb box. For curb boxes located in paved areas or a sidewalk, run tracer wire on the inside of the curb box and leave a minimum of three feet of tracer wire coiled up inside the top of the curb box. For curb boxes located in lawn areas, run tracer wire on the outside of the curb box and wrap the tracer wire around the outside of the curb box.

4. For utility service connections connected to cast/ductile iron pipe, install tracer wire on corporation stop tracer wire connection.

5. For utility service connections connected to PVC pipe, install trace wire to water main tracer wire in a water tight splice connector.

3.03 REPAIR/RESTORATION

1. Repair all defective service taps with stainless steel split sleeve repair clamps.

2. Install repair clamps in accordance with AWWA C230. Do not retap water main within 12 inches of repair clamp.

3. Replace defective water service tubing with a single piece of tubing extending from the corporation stop to the curb stop.

4. Repair any defective work and retest until installation is accepted.

5. Repair leaks.

6. Repair any indoor plumbing problems including, but not limited to, plugged meters or faucets, damaged toilet valves, damaged regulator valves, or other problems on the consumer’s side such as leaks or plugged lines, as a result of work performed.

7. Restore disturbed surface areas as follows.

   a. Paved areas, including bituminous curbing and bituminous sidewalks: per Section – 32 12 16 – Asphalt Paving

   b. Lawn areas: per Section – 32 90 00 – Planting
8. Replace other materials and items removed, restore disturbed areas to original conditions.

3.04 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.05 CLEANING
   A. Clean and flush piping after Work is completed and before final acceptance.

3.06 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 33 31 11

PUBLIC SANITARY SEWERAGE GRAVITY PIPING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide gravity sewer pipe and appurtenances in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 01 51 40 - Temporary Sewage Bypass

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Referenced Standards

1. ASTM International (ASTM)

a. ASTM C923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals


d. ASTM D2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

e. ASTM D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings


g. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
2. American Water Works Association (AWWA)
   a. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

3. Uni-Bell PVC Pipe Association (UBPPA)
   a. UNI-B-06 Recommended Low-Pressure Air Testing of Installed Sewer Pipe
   b. UNI-TR-1 Deflection: The Pipe/Soil Mechanism
   c. Uni-Bell Handbook of PVC Pipe Design and Construction

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.

B. Schedule police details and coordinate traffic management for all Work locations with Owner.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Product data

C. Shop Drawings: catalog cuts for testing equipment, including go-no-go mandrel and air leakage testing equipment.

D. Source and field quality control submittals: weekly construction records of installed Work.

E. Closeout and maintenance material submittals: per Division 01 General Requirements.

1. Record pipe material and classes. Record depth and take ties to location of the following for construction records.
   a. Building service capped ends, cleanouts, bends, connection points to sewer main
   b. Repairs to existing pipes
   c. Pipe stub capped ends
   d. Chimneys and other pipe appurtenances
1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing conditions: per Division 01 General Requirements.
      1. Verify existing pipe material as shown on Drawings.
      2. Notify Owner immediately if Site conditions prevent access to manholes or pipes identified as part of the Work.

PART 2 – PRODUCTS

2.01 PVC GRAVITY SEWER PIPE
   A. Furnish ASTM D3034 with push-on joints per ASTM D3212. Pipe gaskets: ASTM F477 elastomeric seals or nitrile gaskets. Materials: equal or exceed cell class 12454 or 12364 in accordance with ASTM D1784.
   B. Pipe 4-feet to 16-feet of cover: SDR 35.

2.02 COUPLINGS
   A. Type A solid sleeve coupling: AWWA C219, ROMAC Model No. 501, Smith-Blair Model No. 411, Dresser Style 38, or equal.
   B. Type B neoprene sleeve: ASTM 1173. Acceptable level of quality: of equivalent to Fernco.
   C. Type C neoprene sleeve with stainless steel wrap: ASTM 1173. Acceptable level of quality: equivalent to Fernco Strongback coupling
   D. Type D PVC repair coupling: of same type and class of materials as pipe with single piece gasket. Provide with center stop or friction clamp.

2.03 FITTINGS
   A. Furnish single piece gasket of same type and class of materials as pipe except as otherwise specified. Provide wyes or tee wyes for service connections and manhole inside drop connections.
2.04 INSULATION
   A. Furnish 2-inch thick, 4-feet wide, extruded closed-cell rigid formed polystyrene. Acceptable level of quality: equivalent to Dow Styrofoam Highload 60.

2.05 NON-WOVEN FILTER FABRIC FOR WORKING MAT
   A. Acceptable level of quality: equivalent to TenCate Mirafi 160N.

2.06 SEWER CHIMNEY
   A. Furnish ductile iron tee, 6-inch ductile iron riser pipe, wye, bend, cap, and sonotube.

2.07 DETECTABLE WARNING AND IDENTIFICATION TAPE FOR BURIED UTILITY LINES
   A. Acceptable level of quality: equivalent to Trumbull Manufacturing.
   B. Aluminum core plastic encased tape: 6-inch minimum width, with warning and identification imprinted in bold black letters continuously over the entire tape length.
   C. Warning tape color code: Green - Sanitary Sewer Systems
   D. Color and printing: permanent and unaffected by moisture or soil.
   E. Minimum thickness: 0.003 inches.
      1. Minimum strength: 1,500 pounds per square inch lengthwise, and 1,250 pounds per square inch crosswise, with a maximum 350 percent elongation.

2.08 PRECAST CONCRETE MANHOLES CONNECTIONS
   A. Acceptable level of quality of sleeve seal for pipe less than 6 inches in diameter: equivalent to Link-Seal Model S-316 by Thunderline Corp.
   B. Boot type flexible connector with rubber gasket or boot, metal expansion ring and double metal take-up clamps: ASTM C923. Acceptable level of quality: equivalent to Kor-N-Seal.

2.09 CRUSHED STONE
   A. Furnish 3/4-inch crushed stone for sonotube installation.

2.10 SOURCE QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 PREPARATION

A. Provide bypass pumping in accordance with Section 01 51 40.

3.02 INSTALLATION

A. Install PVC pipe in accordance with manufacturer's recommendations. Use laser beam for line and grade unless alternate method are approved.

B. Secure each length of pipe with bedding before placing next length. Bed pipe as shown on Drawings. Plug open ends whenever Work is suspended.

C. Provide 30-inch minimum cover over top of pipe before trench is wheel-loaded.

D. Lay pipe to line and grade shown on Drawings. If grade is not shown, determine elevations of start and finish points for each run of pipe. Lay pipe to a uniform grade between these points. Line and grade may be adjusted by Engineer as required by field conditions.

E. Lay pipe in the dry. Dewater trench in accordance with Division 01 General Requirements. Do not use installed pipe to remove water from Work area.

F. Flush pipes and remove debris using method approved by Engineer. Do not use gravity flushing.

G. Install piping with less than 4-feet of cover or greater than 16-feet of cover complete from manhole to manhole. Do not mix pipe class, splicing or couplings. Use and location of flexible couplings: approved by Engineer.

H. Use center stop or restrain by friction clamp for Type D PVC repair coupling to prevent movement of coupling during backfilling or alternate method approved by Engineer.

I. Use nitrile gaskets in contaminated soil areas.

J. Connections to New Precast Concrete Manholes

1. Use link seal for pipe less than 6 inches in diameter.

2. Use boot type flexible connector for pipe greater than or equal to 6-inch diameter.

K. Connections to Existing Precast Concrete Manholes

1. Core existing manhole and repair manhole penetration to install flexible connector.
2. Repair manhole brick invert and bench to provide smooth transition from manhole to pipe.

L. Connections to Existing Non-Precast Concrete Manholes
   1. Core existing manhole and provide new boot type flexible connector. Repair manhole penetration to install flexible connector.
   2. Minimize size of penetration and provide non-shrink grout surrounding pipe to seal. Provide watertight pipe connection if manhole cannot be cored. Provide damp proofing to repair as specified in Section 33 39 13.
   3. Repair manhole brick invert and bench to provide smooth transition from manhole to pipe.

M. Service Laterals and Fittings
   1. Verify location and size of service laterals as shown on Drawings.
   2. Provide tee wye or wye fittings on main line pipe and connect existing service connections to main line as shown on Drawings.
   3. Provide clean-outs as required by building code and at locations shown on Drawings.
   4. Cap and stake ends of new service. Provide oak marker as shown on Drawings. Assist Engineer in measuring pipe installed and obtaining swing ties.

N. Enclose upright portion of sewer chimney with sonotube filled with 3/4-inch crushed stone. Cut sonotube to 1 foot below elevation of tee wye connecting chimney to service connection pipe. Install as shown on Drawings and as directed.

O. Vertical Separation from Water and Storm Drain lines
   1. Elevation where sewer piping crosses water or storm drain lines: minimum 18 inches below bottom of water or drain line. Provide protection as shown on Drawings and as follows when elevation of sewer piping cannot be buried as specified above.
      a. Provide adequate structural support to prevent excessive deflection of joints.
      b. For water pipe, center 1 full length of water pipe at crossing point so joints are equal distance and as far as possible from sewer piping.
P. Parallel Separation from Water and Storm Drain Lines

1. Lay sewer piping, sewer services and sewer manholes at least 10-feet horizontally, edge to edge, from water and drain lines. When conditions do not permit a horizontal separation of 10-feet, a sewer line may be laid closer to a water or drain line as shown on Drawings, and ensure bottom of water or drain line is at least 18 inches above top of sewer piping wherever possible.

3.03 INSULATION

A. Install insulation when gravity sewer pipe depth is less than 4-feet or as directed by Engineer.

B. Provide minimum 4-inch sand layers directly above and below insulation.

3.04 TESTING OF SANITARY SEWERS

A. Test sanitary sewer pipes after backfilling. Install house service leads on main pipe before testing. Perform tests in presence of Engineer. A maximum of 1,000-feet of pipe may be installed, but not tested.
B. Leakage test for PVC pipe: low-pressure air test in accordance with UNI-B-06. Conform minimum times for test to the more stringent of the following table or Table 1 of UNI-B-06.

1. Minimum specified time required for a 1.0 PSIG pressure drop for size and length of pipe indicated for Q=0.0015

<table>
<thead>
<tr>
<th>Pipe Diameter (inches)</th>
<th>Minimum Time (seconds)</th>
<th>Length for Minimum Time (feet)</th>
<th>Time for Longer Length (seconds)</th>
<th>Specification Time for Length (L) Shown (minimum: seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>100 feet</td>
<td>150 feet</td>
</tr>
<tr>
<td>8</td>
<td>7:34</td>
<td>298</td>
<td>1.520 L</td>
<td>7:34</td>
</tr>
<tr>
<td>18</td>
<td>17:00</td>
<td>133</td>
<td>7.692 L</td>
<td>17:00</td>
</tr>
</tbody>
</table>

2. Perform deflection test for PVC pipe within 30 days of completion of installation. Test 100 percent of pipe with go/no-go mandrel with outside dimension to permit no more than a 7.5 percent deflection. Base mandrel dimensions on a base pipe ID from ASTM D3034 SDR 35/SDR 21 or AWWA C900 DR 18 as appropriate, and the following calculation: per UNI-TR-1.

\[
\text{Mandrel O.D.} = ((100-7.5)/100) \times \text{base pipe ID}
\]

3. Repair or replace pipes not passing test using approved materials and methods and retest.

4. Clean and flush sewer pipe after Work is completed and before final acceptance.
3.05 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.

3.06 CLOSEOUT ACTIVITIES
   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 33 31 23.02

SANITARY UTILITY SEWERAGE FORCE MAINS – POLYVINYL CHLORIDE (PVC)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide PVC force main pipe and appurtenances, valves and fittings, and appurtenances in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Related Requirements

1. Section 01 51 40 – Temporary Sewage Bypass

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. ASTM International (ASTM)
   b. ASTM D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
   e. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

2. American Water Works Association (AWWA)
   a. AWWA C110 Ductile-Iron and Gray-Iron Fittings
   b. AWWA C153 Ductile-Iron Compact Fittings
SANITARY UTILITY SEWERAGE FORCE MAINS
– POLYVINYL CHLORIDE (PVC)
WOODARD & CURRAN

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.
B. Coordinate traffic management with Owner.

1.05 SUBMITTALS
A. Submit in accordance with Division 01 General Requirements.
B. Product Data
   1. Manufacturer's product data and installation instructions
   2. Catalog cuts, materials listing including ASTM/ANSI Standards, specifications, identify pipe color, installation instructions, and dimensioned drawings for each item. Include pressure drop curve or chart for each type and size item.
C. Valve Shop Drawings
D. Manufacturer’s certification of application for air release, combination valves, vacuum relief and specialty valves
E. Certified test results on pipe units.
F. Manufacturer operation and maintenance recommendations for each type of valve including spare parts list.
G. Depth and location of bends and other fittings, valves, thrust blocks, and limits of restrained joints in force mains and manholes installed submitted weekly
H. Closeout and maintenance material submittals: per Division 01 General Requirements.
   1. Clearly identify sections of force main that are to be restrained in accordance with Drawings on conformed to construction record drawings.

1.06 QUALITY ASSURANCE
A. Provide in accordance with Division 01 General Requirements.
1. Qualifications: per Division 01 General Requirements and as follows for valves and ductile iron pipe manufacturers.
   a. Regularly engaged in manufacture of types and sizes required
   b. Products have been in satisfactory use in similar service for minimum 5 years

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.
   B. Store materials and equipment in accordance with manufacturer’s instructions.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.
   B. Notify Owner immediately if Site conditions prevent access to manholes or pipes identified as part of the Work.

1.09 MAINTENANCE
   A. Furnish extra materials as specified below. Make interchangeable with and of same material and workmanship as corresponding original parts.
      1. Traceable warning tape - one full roll for future repairs.

PART 2 – PRODUCTS

2.01 PIPE, FITTINGS, AND MATERIALS
   A. PVC Pressure Pipe
      2. 4-inch Diameter and Larger (Cast Iron Outside Diameter, CIOD): ANSI/AWWA C900, SDR 18 (25), with Cast Iron pipe outside diameter, push-on joints, ASTM D3139, gaskets in accordance with ASTM F477. Pipe compound shall be meet ASTM D1784 Cells Class 12454.
   B. Fittings: same type and class of materials as pipe, unless otherwise specified, with single piece gasket. Provide with nitrile gaskets for contaminated soils areas.
C. Furnish Dresser style couplings for connection to existing sewer pipe appropriate for pipe material and outside diameter.

1. Straight couplings for connecting existing pipe to new pipe or new pipe to new pipe: provided with gaskets of a composition suitable for exposure to the liquid within the pipe and designed for compatibility with the pipe and operating pressures encountered. Couplings for exposed pipe: steel and provided with steel bolts and nuts.

   a. Acceptable manufacturers and type

      1) Dresser Style 38 by Dresser Industries, Inc.
      2) ROMAC 501 by ROMAC Industries, Inc.
      3) 411 by Smith Blair
      4) Or equal

2. Transition couplings to connect 2 pipes of differing O.D.: appropriate for sewer application.

   a. Acceptable manufacturers and type

      1) Dresser Style 62, 162 by Dresser Industries, Inc.
      2) ROMAC 501 by ROMAC Industries, Inc.
      3) 413 by Smith Blair
      4) Or equal


   1. Friction clamp-type restraints may be used for push-on pipe with Engineer approval.


E. Insulation (buried or exposed): 2-inch thick extruded closed-cell rigid formed polystyrene, with 175 mil polyethylene jacket established for exposure to UV light. Engineer may permit 4-foot by 8-foot sheets of 2-inch thick insulation for short lengths of buried force main.

G. Acceptable level of quality for elastomeric manhole pipe connections between new pipe and existing manholes: equivalent to Kor-n-Seal/Kor-n-Seal II manufactured by Trelleborg.

H. Detectable, traceable marking tape: minimum 6 inches wide with corresponding color and text “Buried Sewer Force Main Below” or similar description.

2.02 RESILIENT WEDGE GATE VALVES

A. Furnish gate valves of the same type, style, and duty, supplied by a single manufacturer.

B. Provide resilient seated gate valves manufactured in accordance with AWWA C509, AWWA C550, and AWWA C515, with fully encapsulated gate with minimum 1/8-inch thick molded rubber. Conduct bond meets tests for rubber to metal bond according to ASTM D 429.

1. Iron body, double disc, parallel seat, fully bronze mounted
2. Vertical open-left
3. Non-rising stem type mechanical joint ends and 2-inch square operating nut

C. Acceptable manufacturers

1. Clow Valve Company
2. Mueller Company
3. Kennedy Valve Company
4. M&H Valve Company
5. Or equal


1. Provide buried valves with adjustable iron, tar coated, sliding type valve box as shown on Drawings, with a cast iron cover. Bell end of the valve box: of sufficient size to fit over stuffing box of gate valve.
E. Face-to-face and end-to-end dimensions of flanged or welding-end valve bodies: ANSI B16.10. Connection: mechanical joint to mechanical joint.

F. Working pressure: shall be the operating pressure in the pumping system.

G. Hydrostatic test pressure: 1.5 x Working Pressure.

H. Provide T-handle valve extension stem wrenches for operating valves of various depths. Length of extension stem: designed for depth of valve.

2.03 PIPE SUPPORTS

A. Horizontal-Piping Hangers and Supports

1. Provide factory-fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.

2. Acceptable level of quality for pipe hangers: equivalent to MSS Type 5 by Anvil International.

3. Acceptable level of quality for adjustable steel band hangers: equivalent to Grinnell fig. 269 (MSS Type 7) by Anvil International.

4. Acceptable level of quality for adjustable roller hangers: equivalent to Grinnell fig. 181 (MSS Type 43) by Anvil International.

5. Acceptable level of quality for adjustable steel clevises: equivalent to Grinnell fig. 260 (MSS Type 1) by Anvil International.

6. Acceptable level of quality for steel pipe clamps: equivalent to Grinnell fig. 212 (MSS Type 4) by Anvil International.

7. Acceptable level of quality for pipe stanchion saddles: equivalent to Grinnell fig. 259 (MSS Type 37) including steel pipe base support and cast-iron floor flange by Anvil International.

8. Acceptable level of quality for pipe saddle supports: equivalent to Grinnell fig. 258 (MSS Type 36) including steel pipe base support and cast-iron floor flange by Anvil International.

9. Acceptable level of quality for pipe Rolls and Plates: equivalent to Grinnell fig. 277 (MSS Type 45) by Anvil International.
10. Acceptable level of quality for pipe roll stands: equivalent to Grinnell fig. 271 (MSS Type 44) by Anvil International.

11. Protective sleeves: galvanized, 14 gage sheet metal or half sections of plastic pipe, 8-inch long minimum.

12. Concrete pipe supports: as shown on Drawings.

B. Vertical-Piping Clamps

1. Provide factory-fabricated vertical-piping clamps complying with ANSI/MSS SP-58, selected to suit vertical piping systems in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe.
   a. Acceptable level of quality for two-bolt riser clamps: equivalent to Grinnell fig. 261 (MSS Type 8) by Anvil International.
   b. Acceptable level of quality for four-bolt riser clamps: equivalent to Grinnell MSS Type 42 by Anvil International.

2.04 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Provide bypass pumping in accordance with Section 01 51 40.

3.02 INSTALLATION

A. Force Mains

1. Grade and Line: Lay pipe to line and grade shown on Drawings. Do not allow positive-negative grade discontinuities.

2. Install valves as shown on Drawings and in accordance with manufacturer’s instructions. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward of horizontal plane. Allow sufficient room around valves for maintenance, removal, and proper operation.

3. Install traceable warning tape continuously along the entire length of force main. Splice tape with 3-foot overlap connected with duct tape at ends of rolls and repairs. Extend to grade at each manhole and at pump stations.
4. Provide thrust protection at all bends in force mains as shown on the Drawings.

B. Air Release Valves and Manholes
   1. Place automatic air release valves at high points in the sewer force main to prevent air locking.
   2. Install air release valves in precast manholes with frames and covers.
   3. Install valves as shown on the Drawings or as directed by the Engineer. Clean valve interiors of foreign matter before installation. Inspect valve in both open and closed positions to ensure parts are in proper working condition.
   4. Install thrust restraint as specified in Article 3.03.

3.03 THRUST RESTRAINT
   A. Construct sections of sanitary sewer force main identified on Drawings. Restrain associated plugs, caps, valves, tees, branches, and bends utilized in conjunction with force mains.
   B. Provide additional thrust restraint at any other points where hydraulic thrust may develop as directed by Engineer.

3.04 INSULATION
   A. Install insulation when gravity sewer pipe depth is less than 4 feet, or as directed.
   B. Provide minimum 4 inch sand layers directly above and below insulation material.

3.05 FIELD QUALITY CONTROL
   A. Provide in accordance with Division 01 General Requirements.
   B. Conduct hydrostatic testing in accordance with AWWA C605 and as follows, witnessed by Engineer.
      1. Pressure and Leakage Test duration: 2 hours.
      2. Test pressure: 150 percent of maximum operating pressure or 150 pounds per square inch, whichever is greater. Do not exceed design pressure rating of pipe.
      3. Allowable pressure loss, maximum variation: plus or minus 5 pounds per square inch for the duration of pressure test.
4. Conduct leakage test at maximum operating pressure as directed. Maintain leakage test pressure for minimum of 2 hours.

5. Determine allowable leakage for ductile iron pipe as follows.

\[
L = SD \frac{P}{148,000}^{1/2}
\]

Where \(L\) is allowable leakage in gallons per hour, \(S\) is length of pipe in feet, \(D\) is nominal diameter in inches, and \(P\) is average test pressure in psi.

a. Recommended Allowable Leakage Per 1,000-Feet of Pipeline in Gallons per Hour

<table>
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<th>Average Test Pressure (psi)</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
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<td>0.54</td>
<td>0.68</td>
<td>0.81</td>
<td>1.08</td>
</tr>
</tbody>
</table>

b. Allowable leakage will be the sum of computed leakage for each size if pipeline under test contains sections of various diameters.

C. Provide manhole testing in accordance with Section 33 39 13.

3.06 REPAIR/RESTORATION

A. Repair leaks and defective Work using methods recommended by manufacturer and approved by Engineer and retest until installation is accepted.

3.07 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 33 71 16

OVERHEAD ELECTRICAL UTILITY SERVICES

PART 1 – GENERAL

1.01 SUMMARY
A. Provide a complete overhead electrical distribution system and upgrades to existing overhead system as indicated on the contract drawings. The design of this system shall be in accordance with this section of the specifications and all contract drawings that apply.

B. The system shall be installed by a firm actively engaged in the installation of overhead electrical distribution systems with a minimum of 10 years’ experience.

C. The work covered under this section of the specification consists of providing labor, materials and services required for the design and utility installation of an overhead electrical distribution system in accordance with the Contract Documents and as approved by the engineer.

D. The contract drawings identify general overhead distribution upgrades. However, it is the responsibility of the Contractor to coordinate with utility on any utility work. Contractor to work around timeline with utility in construction. Contractor is responsible for any fees associated with construction and prolonged schedule.

1.02 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

B. Related Sections
1. Section 26 05 00 Common Work Results For Electrical

1.03 REFERENCES
A. The complete installation shall comply with the latest issue of the following standards and form a part of this specification:

1. NFPA 70, National Electrical Code (NEC) with Massachusetts Amendments

2. IEEE C2, National Electrical Safety Code (NESC) with Massachusetts Amendments
1.04 SUBMITTALS

A. Submittal Package: Submit shop drawings, product data, and quality control submittals specified below at the same time as one complete package. The shop drawings, scope of work and product data shall bear the seal of a professional engineer licensed to practice in the State of the project location. Submit in accordance with Division 01 General Requirements.

B. Shop Drawings: Provide detailed/scaled design drawings of the proposed system design to be installed. The shop drawings shall be submitted to the Engineer prior to receiving approval of the overhead distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.

C. Scope of Work Report: Provide a report including calculations for pole line sag and tension, along with recommended pole sizes, pole depths, pole guy minimum strengths, lead lengths, tension, etc. Report shall include recommended construction requirements for crossarm and insulators. Report shall also identify any required/recommended upgrades to the existing utility pole crossarms, insulators, etc. to accommodate the system upgrades detailed on the Contract Drawings. Provide proof that all recommended system upgrades adhere to the requirements outlined in the National Electrical Safety Code (NESC).

   1. Contractor to coordinate requirements with utilities

D. Product Data

   1. Catalog Sheets, specifications, and installation instructions

   2. Bill of materials

E. Quality Control Submittals

   1. Proof that the firm installing the system is actively engaged in the installation of overhead electrical distribution systems with a minimum of 10 years’ experience.

   2. Installer’s Qualifications Data: Include the following for each person who will be performing the Work:

      a. Name

      b. Employers name, business address, and telephone number

      c. Name and addresses of the required number of similar projects on which meet the experience criteria

      d. Proof that the Registered Electrical Engineer is licensed to practice in the State of the project location.
1.05 QUALITY ASSURANCE

A. The system shall be installed by a firm actively engaged in the installation of overhead electrical distribution systems with a minimum of 10 years’ experience.

B. The overhead electrical distribution system design shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in designing overhead electrical distribution systems. The registered electrical engineer shall have a minimum of five (5) years’ experience in designing overhead electrical distribution systems. System requirements are to be coordinated with utility standard guidelines and practices.

C. The approved design engineering firm shall demonstrate their experience by submitting documentation of at least five (5) overhead electrical distribution designs performed.

D. 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.

E. Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

PART 2 – PRODUCTS

2.01 POLES

A. Wood poles machine trimmed by turning either Douglas Fir, Lodgepole Pine, Western Larch, or Southern Yellow Pine conforming to ATIS ANSI O5.1 and RUS Bull 345-67. Wood specified by local utility standards. Wood poles shall be pressure treated. Gain, bore and roof poles before treatment. Should additional gains be required subsequent to treatment, metal gain plates shall be provided. The quality of each pole shall be ensured with "WQC" (wood quality control) brand on each piece, or by an approved inspection agency report.
2.02 CROSSARMS AND BRACKETS

A. Wood Crossarms

1. Conform to RUS Bull 1728H-701. Pressure treat crossarms with pentachlorophenol, chromated copper arsenate (CCA), or ammoniacal copper arsenate (ACA). Treatment shall conform to AWPA C25. Crossarms shall be solid wood, distribution type, and a 1/4 inch 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 8 feet in length, except that 10 foot crossarms shall be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

B. Crossarm Braces

1. Provide flat steel or steel angle as indicated. Provide braces with 38 inch span for 8 foot crossarms and 60 inch span for 10 foot crossarms.

C. Armless Construction

1. Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators shall be as shown. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of the pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to IEEE C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case less than 2800 pound cantilever strength.

2.03 HARDWARE

A. Hardware shall be hot-dip galvanized in accordance with ASTM A153/A153M and ASTM A123/A123M.
B. Hot-Line Clamps

1. Make connections to overhead primary conductors with hot-line clamps of the screw type with concealed threads. Fill thread chamber with corrosion-resistant compound.

2.04 INSULATORS

A. Bare Conductor: One-piece radio free, pin type, porcelain insulators of the appropriate ANSI class shall be used to support the phase conductors. A one-piece polymer dead-end insulator of proper voltage rating shall be used to dead-end the conductor.

B. Tree wire/spacer cable: A one piece, plain top, pin type, polyethylene insulator of the appropriate ANSI class shall be used to support the phase conductor. A one-piece polymer dead-end insulator of proper voltage rating shall be used to dead-end the conductor (Note: do not remove conductor covering at insulator location).

2.05 OVERHEAD CONDUCTORS

A. Overhead conductors shall be bare aluminum conductor steel reinforced (ACSR) of sizes and types indicated conforming to ASTM B232/B232M. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486A-486B shall be used.

2.06 CONNECTORS AND SPLICES

A. Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition, aluminum-composition to copper, and copper-to-copper shall comply with UL 486A-486B.

2.07 GUY WIRE

A. ASTM A475 high-strength or extra high strength, Class A or B, galvanized strand steel cable, specified by local utility standards. Provide guy terminations designed for use with the particular strand and developing at least the ultimate breaking strength of the strand.

B. Guy Markers: Vinyl or PVC material, yellow colored, 8 feet long and shatter resistant at sub-zero temperatures

C. Guy Attachment: Thimble eye guy attachment
2.08 ANCHORS AND ANCHOR RODS

A. Anchors shall present holding area indicated on drawings as a minimum and as required for the installation. Anchor rods shall be triple thimble-eye, size and type as recommended. Anchors and anchor rods shall be hot dip galvanized.

B. The complete guy-anchor assembly shall provide strength conforming to IEEE C2 for the grade of construction of the line.

2.09 FUSED CUTOUTS

A. Provide fused cutouts rated as indicated on the Contract Drawings at 15 kV ungrounded, conforming to IEEE C37.42. Type K fuses conforming to IEEE C37.42 with ampere ratings as indicated.

2.10 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Provide overhead pole line installation conforming to requirements of IEEE C2 and NFPA 70 for overhead services. Provide material required to make connections into existing system and perform excavating, backfilling, and other incidental labor. Consider street, alleys, roads and drives "public." Pole configuration shall be as indicated and required.

B. Tree Trimming

1. Where lines pass through trees, trees shall be trimmed as needed. No branch shall overhang horizontal clearances.

3.02 WOOD POLE INSTALLATION

A. Provide pole holes at least as large at the top as at the bottom and large enough to provide 4 inch clearance between the pole and side of the hole.
B. The minimum setting depths of the poles shall be as follows:

<table>
<thead>
<tr>
<th>Pole length (ft.)</th>
<th>Setting in Soil</th>
<th>Setting in Solid Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
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<td>3.0</td>
</tr>
<tr>
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<td>7.5</td>
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</table>

C. Setting in Soil, Sand and Gravel

1. "Setting in Soil" depths, as specified in paragraph entitled "Setting Depth of Pole," apply where the following occurs:

2. Where pole holes are in soil, sand, or gravel or any combination of these;

3. Where soil layer over solid rock is more than 2 feet deep;

4. Where hole in solid rock is not substantially vertical; or

5. Where diameter of hole at surface of rock exceeds twice the diameter of pole at same level. At corners, dead ends and other points of extra strain, poles 40 feet or more long shall be set 6 inches deeper.

D. Setting in Solid Rock

1. "Setting in Solid Rock," as specified in paragraph entitled "Setting Depth of Pole," applies where poles are to be set in solid rock and where hole is substantially vertical, approximately uniform in diameter and large enough to permit use of tamping bars the full depth of hole.

2. Setting with Soil over Solid Rock
3. Where a layer of soil 2 feet or less in depth over solid rock exists, depth of hole shall be depth of soil in addition to depth specified under "Setting in Solid Rock" in paragraph entitled "Setting Depth of Pole," provided, however, that such depth shall not exceed depth specified under "Setting in Soil."

E. Setting on Sloping Ground

1. On sloping ground, always measure hole depth from low side of hole.

F. Backfill

1. Thoroughly tamp pole backfill for full depth of the hole and mound excess fill around the pole.

G. Setting Poles

1. Set poles so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where gains of last two poles shall be on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, they shall be on opposite side of pole from gain, with flat side against pole.

H. Alignment of Poles

1. Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they shall be set and raked against the strain. Set not less than 2 inches for each 10 feet of pole length above grade, nor more than 4 inches for each 10 feet of pole length after conductors are installed at required tension. When average ground run is level, consecutive poles shall not vary more than 5 feet in height. When ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top. Holes shall be dug large enough to permit the proper use of tampers to full depth of hole.

I. Pole Caps

1. Provide plastic pole caps with 1/4 inch sealing rings and four nailing tabs. Fill sealing area with either a bituminous, elastigum roof cement or an acceptable preservative paste to level of sealing ring to eliminate possibility of condensation. Place on pole top and nail each tab down with a 1 1/4 inch nail.
3.03 ANCHORS & GUYS

A. Place anchors in line with strain. The length of the guy lead (distance from base of pole to the top of the anchor rod) shall be as recommended.

B. Set anchors in place with anchor rod aligned with, and pointing directly at, guy attachment on the pole with the anchor rod projecting 6 to 9 inches out of ground to prevent burial of rod eye.

C. Backfill plate anchors with tightly tamped earth for full depth of hole.

D. Install screw anchors by torqueing with boring machine

E. Install rock anchors minimum depth of 12 inches in solid rock.

F. Provide guys where indicated, with loads and strengths as indicated, and wherever conductor tensions are not balanced, such as at angles, corners and dead-ends. Where single guy will not provide the required strength, two or more guys shall be provided. Where guys are wrapped around poles, at least two guy hooks shall be provided. Provide pole shims where guy tension exceeds 6000 pounds. Guy clamps 6 inches in length with three 5/8 inch bolts, or offset-type guy clamps, or approved guy grips shall be provided at each guy terminal. Securely clamp plastic guy marker to the guy or anchor at the bottom and top of marker. Complete anchor and guy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that line section. Provide strain insulators at a point on guy strand 8 feet minimum from the ground and 6 feet minimum from the surface of pole. Effectively ground and bond guys to the system neutral.

3.04 HARDWARE

A. Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Locknuts shall be M-F style and not palnut style.

3.05 GROUNDING

A. Unless otherwise indicated, grounding shall conform to IEEE C2 and NFPA 70. Pole grounding electrodes shall have a resistance to ground not exceeding 5 ohms. When work in addition to that indicated or specified is directed in order to obtain specified ground resistance, provisions of the contract covering changes shall apply.
B. Grounding Electrode Installation

1. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 6 bare copper conductor.

2. Plate electrodes - Plate electrodes shall be installed in accordance with the manufacturer's instructions and IEEE C2 and NFPA 70.

C. Grounding electrode conductors shall be sized as indicated. Secondary system neutral conductors shall be connected directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor as indicated. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

D. Make above grade grounding connections on pole lines by exothermic weld or by using a compression connector. Make below grade grounding connections by exothermic weld. Make exothermic welds strictly in accordance with manufacturer's written recommendations. Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not acceptable. No mechanical connectors are required at exothermic weldments. Compression connectors shall be type that uses a hydraulic compression tool to provide correct pressure. Provide tools and dies recommended by compression connector manufacturer. An embossing die code or similar method shall provide visible indication that a connector has been fully compressed on ground wire.

E. Grounding and Grounded Connections

1. Where no primary or common neutral exists, surge arresters and frames of equipment operating at over 750 volts shall be bonded together and connected to a dedicated primary grounding electrode.

2. Where no primary or common neutral exists, transformer secondary neutral bushing, secondary neutral conductor, and frames of equipment operating at under 750 volts shall be bonded together and connected to a dedicated secondary grounding electrode.

3. When a primary or common neutral exists, connect all grounding and grounded conductors to a common grounding electrode.
3.06 CONDUCTOR INSTALLATION

A. Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved sags and tensions. Conductors shall be handled with care necessary to prevent nicking, kinking, gouging, abrasions, sharp bends, cuts, flattening, or otherwise deforming or weakening conductor or any damage to insulation or impairing its conductivity. Remove damaged sections of conductor and splice conductor. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, or around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

B. Conductor splices, as installed, shall exceed ultimate rated strength of conductor and shall be of type recommended by conductor manufacturer. No splice shall be permitted within 10 feet of a support. Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper.

C. Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator.
D. Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inches. For span lengths of 200 feet or more, preformed round armor rods shall be used.

E. Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

F. Low-voltage cables shall be supported on clevis fittings using spool insulators. Dead-end clevis fittings and suspensions insulators shall be provided where required for adequate strength. Dead-end construction shall provide a strength exceeding the rated breaking strength of the neutral messenger. Clevis attachments shall be provided with not less than 5/8 inch through-bolts. Secondary racks may be used when installed on wood poles and where the span length does not exceed 200 feet. Secondary racks shall be two-, three-, or four-wire, complete with spool insulators. Racks shall meet strength and deflection requirements for heavy-duty steel racks, and shall be rounded and smooth to avoid damage to conductor insulation. Each insulator shall be held in place with a 5/8 inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Racks for dead-ending four No. 4/0 AWG or four larger conductors shall be attached to poles with three 5/8 inch through-bolts. Other secondary racks shall be attached to poles with at least two 5/8 inch through-bolts. Minimum vertical spacing between conductors shall not be less than 8 inches.

G. Dead end fittings, clamp or compression type, shall conform to written recommendations of conductor manufacturer and shall develop full ultimate strength of conductor.

H. Make aluminum connections to copper or other material using only splices, connectors, lugs, or fittings designed for that specific purpose. Keep a copy of manufacturer's instructions for applying these fittings at job site for use of the inspector.

3.07 POLE TOP SWITCH INSTALLATION

A. Install pole top switch strictly according to manufacturer's installation drawings and information.

B. Locate operating handle approximately 5 feet above ground on field side of pole.
3.08 CROSSARM MOUNTING

A. Crossarms shall be bolted to poles with 5/8 inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8 inch or more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Metal crossarm braces shall be provided on crossarms. Flat braces may be provided for 8 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

B. Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turns where shown. Buck arms shall be installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure and where lines not attached to the same pole cross each other.

C. Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

3.09 FIELD QUALITY CONTROL

A. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests on all overhead distribution equipment. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the engineer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field reports will be signed and dated by the Contractor.

B. The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.
C. Medium Voltage Preassembled Cable Test: After installation, prior to connection to an existing system, and before the operating test, the medium-voltage preassembled cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors at one terminal and connecting grounds or metallic shieldings or sheaths of the cable at the other terminal for each test. Prior to the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 74/ICEA S-93-639 for the particular type of cable installed, and shall not exceed the recommendations of IEEE 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

D. Sag and Tension Tests: The Engineer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading requirements and cable weight.

E. Pre-Energization Services: The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

1. Switches
F. Performance of Acceptance Checks and Tests: Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

1. Grounding System
   a. Inspect ground system for compliance with contract plans and specifications.
   b. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

G. Devices Subject to Manual Operation: operate each device subject to manual operation at least three times, demonstrating satisfactory operation each time.

H. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. The Engineer shall be given 10 working days advance notice of the dates and times of checking and testing.

3.10 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 40 05 13

PROCESS PIPE AND FITTINGS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide all materials, equipment, and incidental required for process pipe and fittings in accordance with this Section and applicable reference standards listed in Article 1.03.

B. Provide all materials, equipment, and incidental required for process pipe and fittings. All piping systems shall be complete with all accessories in compliance with the Contract Documents. Provide all related appurtenances, including but not limited to attachments, foundations, anchors, supports, couplings, restraints and all related accessories to provide complete operational piping systems as specified herein and as shown on the Drawings.

C. Unless otherwise indicated, all fittings and appurtenances shall be of the same type and grade of materials as the connecting pipe. All products provided under this section shall conform to current AWWA and ANSI specifications as appropriate to the type of pipe specified.

D. Process pipe shall be defined as "Interior", "Above Grade Exterior Piping", and "Below Grade Exterior Piping". Process piping shall include but is not limited to wastewater, sludge, chemicals, utility water, city/town water, non-potable water (plant water), and air piping systems as shown on the Drawings and as specified herein. The following sections reference the process pipe type and specification reference number shown in the piping tag symbols in the Contract Documents.

E. Piping without tag symbols is specified elsewhere. The piping included in this specification section may or may not all be required for the work outlined in the Contract Documents. Provide all piping that is indicated on the Drawings, is specified, and/or is required to complete the work outlined in the Contract Documents.

F. SPECIAL TOOLS - Furnish one set of all special tools required to completely assemble, disassemble, or maintain the process piping and appurtenances. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.
1.03 REFERENCES

A. ASME International (ASME)

1. ASME A13.1 Scheme for the Identification of Piping Systems
2. ASME B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)
3. ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
4. ASME B16.3 Malleable Iron Threaded Fittings Classes 150 and 300
5. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
6. ASME B16.26 Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
7. ASME B16.15 Cast Bronze Threaded Fittings Classes 125 and 250
8. ASME B1.20.1 Pipe Threads, General Purpose (Inch)
9. ASME B16.9 Factory-Made Wrought Buttwelding Fittings
10. ASME B16.26 Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
11. ASME B16.2 Nonmetallic Flat Gaskets for Pipe Flanges
12. ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
13. ASME B31.1 Power Piping

B. ASTM International (ASTM)

1. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. ASTM A 153/A 153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. ASTM A 181 Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
5. ASTM A 197 Standard Specification for Cupola Malleable Iron
6. ASTM A 234 Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

7. ASTM A 240 Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

8. ASTM A 269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

9. ASTM A 307 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength


13. ASTM A 479/A 479M Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

14. ASTM A 733 Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

15. ASTM A 774/A 774M Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

16. ASTM A 778 Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

17. ASTM B 117 Standing Practice for Operating Salt Spray (Fog) Apparatus

18. ASTM B 61 Standard Specification for Steam or Valve Bronze Castings

19. ASTM B 62 Standard Specification for Composition Bronze or Ounce Metal Castings

20. ASTM B 88 Standard Specification for Seamless Copper Water Tube


22. ASTM D 1238 Melt Flow Rates of Thermoplastics by Extrusion Plastometer
23. ASTM D 1248 Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

24. ASTM D 1598 Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

25. ASTM D 1599 Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings


27. ASTM D 1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120


32. ASTM F 402 Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

33. ASTM A 530/A 530M General Requirements for Specialized Carbon and Alloy Steel Pipe

34. ASTM A 632 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service

35. ASTM F 493 Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

36. ASTM F 593 Stainless Steel Bolts, Hex Cap Screws, and Studs

37. ASTM F 594 Standard Specification for Stainless Steel Nuts

C. American Water Works Association (AWWA)

1. AWWA C104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
2. ANSI/AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (75 mm through 1200 mm), for Water and Other Liquids

3. ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

4. AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings for Water

5. ANSI/AWWA C115/A21.15 Water Treatment-Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

6. AWWA C115/A21.15 Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

7. AWWA C150/A21.50 Thickness Design of Ductile-Iron Pipe

D. International Organization For Standardization (ISO)

1. ISO 228-1 Pipe Threads Where Pressure-Tight Joints Are Not Made on The Threads - Part 1: Dimensions, Tolerances and Designation

E. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS SP-58 Standard for Pipe Hangers and Supports - Materials, Design and Manufacture

2. MSS SP-89 Pipe Hangers and Supports - Fabrication and Installation Practices

3. MSS SP-69 Standard for Pipe Hangers and Supports - Selection and Application

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Shop Drawings

1. Shop Drawings shall show layout and dimensions of equipment, major components, key alignment locations, and locations of bolt-holes. Drawings shall also indicate where access points for maintenance and operations are located on the equipment. Drawings shall show critical field dimensions. All Drawings shall show actual pipe lengths, diameters, fittings, and appurtenances.
2. Joint couplings and fittings shall be shown on the Drawings and product submittals and shall be specifically identified with the applicable style or series designation. The Drawings shall show layouts and dimensions of the piping and pipe supports for the pipe systems.

C. Product Data

1. Provide manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions. Provide spare parts data for each different item of material and equipment specified, after approval of the detail Drawings and not later than one month prior to the date of beneficial occupancy.

2. Product data shall also include catalog cut sheets and dimensional data for each type of process pipe, tube, and fitting.

3. Prior to shipment of pipe, submit a certified affidavit of compliance from the pipe manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this Project have been manufactured and tested in accordance with AWWA and ASTM standards as well as the requirements specified herein.

D. Reports

1. Submit test reports for each section of piping tested for pressure and leakage.

E. Operation & Maintenance Data

1. Submit operation and maintenance data in accordance with Division 01 requirements, Data Package 4. In addition to the requirements of Data Package 4, the manual shall include but is not limited to the following

   a. All required cuts, Drawings, equipment lists, descriptions, which are required to instruct operation and maintenance personnel unfamiliar with such equipment. The O&M manuals shall include instructions for cleaning and maintenance.

1.06 QUALITY ASSURANCE

A. Inspection of piping and fittings shall be conducted upon delivery to Site. Piping shall be subject to rejection at any time because of failure to meet standards outlined. Mark pipe rejected after delivery for non-use and remove from Site. Acceptance of manufacturer's pipe Samples prior to shipment shall not be equal to Engineer's acceptance of piping delivered to Site.
B. Welding shall be conducted under qualified welding procedures. All welders and operators shall be certified in accordance with the latest applicable AWS and ANSI codes for shop and Project Site welding of piping work. Provide written proof of certifications upon request from the Engineer.

C. All piping systems, components, and appurtenances in contact with potable water (including potable water during any stage of treatment or conditioning) shall be certified to meet the requirements of ANSI/NSF 61 for water service.

1.07 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Plastic pipe shall be packed, packaged, and marked in accordance with ASTM D 3892 standards.

C. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 COPPER PIPE, TUBING & FITTINGS - TYPE (CU/1)

A. All interior copper piping and tubing for potable water, protected water, process fluids, compressed air, vacuum, inert gas, plant water, general use, and other pressurized service shall conform to ASTM B 88, Type L, Hard Temper. Pipe sizes and end connections shall be as shown on the Drawings or as specified. Provide all necessary end connections and appurtenances as required to connect to the end uses.

2.02 FLANGED JOINTS – TYPE (CU/1)

A. Where copper piping is connected to equipment the end connection shall be flanged. Flanges and flanged fittings shall be faced and drilled Class 150 in accordance with ASME B16.26 standards. For tie-in to existing flanges, field check existing flanges for non-standard bolt-hole configurations. Provide adaptors and fittings to assure new pipes and flanges mate properly. All flanged joints shall be in alignment with the holes mating with the centerline of the piping.
B. All bolts for flanged connections shall be lubricated with a graphite and oil mixture prior to tightening. All bolts shall be tightened with proper tools to avoid overstressing the piping, bolts, and sealing gaskets beyond the proper designed limits.

C. Alloy bolts ASTM A 193/A 193M, Grade B7 shall be tightened to obtain a stress of 45,000 psi. Carbon steel bolts ASTM A 307, Grade B shall be tightened to obtain a stress of 15,000 psi based on the root thread area. All flange bolts shall be of sufficient length so as to allow a minimum of 2 full threads to extend beyond the fastening nut. Provide dielectric isolation between dissimilar metals.

2.03 THREADED JOINTS – TYPE (CU/1)

A. Threaded joints shall be made with an Engineer approved joint compound applied to the male thread only. The use of caulking on the threaded joint shall not be acceptable. All threaded connections shall be in accordance with ASME B1.20.1 standards. The threaded connections shall be full thread, true taper type, machined accurately to gauge. Size reductions shall be through the use of reducing fittings. All plugs shall be steel or brass with a square head design. Bushings and close nipples shall not be acceptable.

2.04 SOLDER & FLUX – TYPE (CU/1)

A. Solder and flux shall conform to ASTM B 32 standards. The solder alloy shall be 95 percent tin and 5 percent antimony on all pressure piping and potable water piping. No lead-bearing solder shall be permitted under any circumstances. All soldering shall conform to ASTM B 813 standards. Silver solder with 45 percent brazing silver alloy shall be utilized.

B. All tubing shall be square cut with reamed ends to prevent improperly sized ends or burrs prior to soldering. Prior to soldering all surfaces shall be cleaned to a bright metal finish and be free of dirt, grease, or other foreign materials prior to fluxing and soldering. All cleaning shall be conducted using an emery cloth, sandpaper, or steel wool.

C. Both the outside and inside ends of the pipe to be soldered shall be cleaned to a length of at least 3/4 inches greater than the depth of the fitting. All joints shall be assembled using non-corrosive flux. Acid solder or flux shall not be permitted under any circumstances. Any cracks, holes, areas of incomplete penetration, or other related defective connections shall not be acceptable. Peening of defects is not permitted under any circumstances.

D. All soldered joints shall be heated uniformly to the solder melting point to allow a complete draw of the solder into the connecting joint. All excess solder shall be completely removed with a cloth brush. A fillet shall be left around the end of the fitting. All connections shall be required to have full penetration of solder throughout the entire connection joint. The cooling of soldered joints via quenching is not permitted.
2.05 BRAZING – TYPE (CU/1)

A. All flux shall be applied in strict accordance with the recommendations of the brazing manufacturer. Flux is required when joining copper tubing to cast bronze fittings. Flux is not required when joining copper tubing to wrought copper fittings. Parts to be joined shall be heated 1 inch from the edge of the fitting. Once the flux has become transparent, the heating of the fitting at the base of the cup shall commence. The torch flame shall move continuously throughout the process.

B. Brazing materials shall be applied where the tubing enters the socket or fitting. Direct flames shall not be applied to the brazing material. Capillary action from the heated joint shall draw the brazing material into the joint. A properly made joint shall show a visible fillet completely around the pipe joint. No additional filler shall be added once a fillet has been formed.

C. All flux material shall be removed once the brazing material has solidified. All fittings shall be allowed to cool naturally without the aid of separate quenching. Any cracks, holes, areas of incomplete penetration, or other related defective connections is not acceptable. Peening of defects is not permitted under any circumstances.

2.06 COPPER TUBING – TYPE (CU/1)

A. All seamless copper alloy tubing shall conform to ASTM B 88M standards, alloy C12200, Type L, with an O60 annealed temper. Copper tubing shall only be used where specified or specifically indicated on the Drawings.

2.07 COPPER JOINTS – TYPE (CU/1)

A. All copper pipes shall be joined using soldered or brazed fittings and flanged connections to equipment. Tubing shall be joined using solder, flared or compression fittings as indicated by the Engineer or as indicated in the Contract Documents. If the joint type is not specified elsewhere, use soldered joints. Dielectric fittings or isolation joints and materials shall be provided between all dissimilar metals.

B. Flared fittings shall not be used without prior written approval from the Engineer.

C. Unions shall be installed to allow for ease of disassembly for any future piping alterations or repairs. All unions shall be installed as shown on the Drawings and as directed by the Engineer. Unions shall also be installed in long piping runs, equipment bypasses, connections to equipment, pumps, tanks, and between shutoff valves.
2.08 COPPER FITTINGS – TYPE (CU/1)

A. All component castings of flanges and fittings shall be copper alloy and shall conform to ASTM B 61 or ASTM B 62 standards. Solder joint fittings shall conform to ASME B16.22 and ASME B16.18 standards. Fittings for flared copper tube shall conform to ASME B16.26 standards. Cast bronze threaded fittings shall conform to ASME B16.15 standards and shall be threaded in accordance with ASME B1.20.1 standards. Tubing compression fittings shall be forged brass alloy C37700, conforming to ASTM B 124/B 124M standards.

2.09 BOLTING FOR COPPER PIPING – TYPE (CU/1)

A. All bolting materials shall meet the requirements of ASME B31.1 standards. Bolts shall be provided with washers of the same material as the bolts. Provide flange bolt isolators for all dissimilar metals.

2.10 COPPER PIPING SUPPORTS – TYPE (CU/1)

A. All copper piping systems shall be supported using copper or brass piping supports that conform to MSS SP-58, MSS SP-69, and MSS SP-89 standards. Conventional steel and galvanized pipe hangers shall not be used for copper piping systems. All valves, instruments and other equipment attached to the piping system shall be individually and independently supported.

2.11 PIPE BENDING – TYPE (CU/1)

A. All bending of copper piping shall be in accordance with the recommendations of the pipe manufacturer. All bends shall be free from damage including, but not limited to, holes, cracks, or buckles.

2.12 DUCTILE IRON PIPE & FITTINGS - TYPE (DI/1)

A. All Type (DI/1) ductile iron piping shall be Class 53 flanged pipe and fittings per AWWA C150/A21.50, AWWA C115/A21.15, and AWWA C110/A21.10 standards. Flanges shall conform to the drilling and facing of ASME B16.1/ANSI Class 125/150 unless otherwise noted or as required to connect to valves, tanks, equipment, and other appurtenances.

B. The minimum class thickness for flanged pipe shall be Class 53 for sizes up through 54 inches. All flanged pipe joints shall be assembled using gaskets. All pipes shall be provided and installed in standard lengths whenever possible.
C. All Type (DI/1) ductile iron pipe of the same type, style, and duty shall be supplied by a single manufacturer. All Class 53 ductile iron piping shall be a product of the following manufacturer

1. U.S. Pipe & Foundry Company Inc.
2. American Cast Iron Pipe Company
3. Clow Water System Company

2.13 FLANGES & CONNECTORS – TYPE (DI/1)

A. All ductile iron flanges shall conform to ANSI/AWWA C115/A21.15 and be flat faced type unless otherwise specified or indicated on the Drawings. All ductile iron fittings shall conform to ANSI/AWWA C110/A21.10 standards and be pressure rated for 250 psi. As a minimum, all fittings shall be rated equally to the connecting piping.

B. Unless otherwise specified or indicated on the Drawings, all ductile iron piping and fittings shall utilize ANSI standard flanged connections. The use of alternative joining methods, including but not limited to couplings, and flanged adaptors shall be acceptable where specifically indicated and as approved by the Engineer. Grooved connections with rigid connectors shall be acceptable where specified or indicated on the Drawings or as approved by the Engineer.

2.14 GASKETS – TYPE (DI/1)

A. All gaskets shall conform to ANSI/AWWA C111/A21.11 standards. The gaskets shall be provided by a pipe manufacturer unless otherwise noted or approved by the Engineer. for interior and exterior (below grade) wastewater service installations, gaskets shall be full-face type nitrile butadiene rubber (NBR) Buna-N. For exterior (above grade) wastewater service installations, gaskets shall be full-face type ethylene propylene diene monomer (EPDM). All gaskets shall provide a positive sealing for all flanged joints. All gaskets shall be a minimum of 1/8 inches thick unless otherwise specified or shown on the Drawings.

2.15 INTERIOR LININGS – TYPE (DI/1)

A. Unless otherwise specified or shown on the Drawings, all type (DI/1) ductile iron piping shall be provided with a cement-mortar lining. The cement-mortar lined piping shall conform to AWWA C104/A21.4 standards except that 2 times the standard thickness shall be provided. The cement used shall be Type II and be in accordance with ASTM C 150.

B. Ductile iron piping used for high temperature applications such as air piping shall be unlined.
2.16 CERAMIC EPOXY LINING – TYPE (DI/1)

A. Provide a ceramic epoxy lining only where specified or indicated on the Drawings. All ceramic epoxy linings shall be in accordance with the following

1. The ceramic epoxy lining shall be an amine-cured Novolac epoxy containing at least 20 percent by volume of ceramic quartz pigment. The dry film thickness shall be at least 40 mils (minimum thickness for any one test shall be 35 mils). The lining shall meet the following requirements (provide certified test reports if requested by Engineer)

   a. A permeability rating of 0.00 when tested according to Method A of ASTM E 96/E 96M, Procedure A, with a duration of 30 days

   b. The following tests shall be run on coupons from factory lined ductile iron pipe

      1) ASTM B 117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after 2 years

      2) ASTM G-95 Cathodic Disbondment 1.5 volts at 77 degrees F. Results to equal no more than 0.5 mm undercutting after 30 days

      3) Immersion Testing rated using ASTM D-14-87

         a) 20 percent Sulfuric Acid - No effect after 2 years

         b) 140 degrees F 25 percent Sodium Hydroxide - No effect after two years

2. An abrasion resistance of no more than 3 mils loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion

2.17 EXTERIOR COATINGS – TYPE (DI/1)

A. An exterior coating shall be provided for all ductile iron pipe, fittings, and flanges. Unless otherwise specified or noted on the Drawings, the prime coat shall be factory applied. The top coat (finished coat) shall be field applied as approved by the Engineer. The top coat shall match the color coding for the material to be handled by the pipe. All prime and finish painting shall be in accordance with Section 09 90 00 Painting and Coatings. Unless approved in writing by the Engineer the finished coat shall be applied prior to assembly of the pipe in moist areas. Stainless steel flange hardware shall not be painted with epoxy paint. Submerged piping shall not require a urethane finish.
B. The pipe shall not be coated at pipe and fitting ends to allow for Engineer approved installation of joint connections in the field. The pipe manufacturer shall provide all necessary coating materials for application at factory supplied uncoated piping locations. All field applied coatings shall be a product of the same manufacturer as the factory prime coating to ensure compatibility. All flange bearing surfaces shall be left uncoated.

C. Field repair of damaged pipe coatings shall receive prior written approval by the Engineer. If the Engineer deems the coating damage to be beyond repair, all damaged piping shall be replaced at no additional cost to the Owner or the Engineer.

2.18 FLANGE HARDWARE – TYPE (DI/1)

A. All nuts, bolts, washers and other flange or coupling fastening hardware shall be 304 stainless steel for interior and above grade exterior installations. Provide 316 stainless steel flange hardware for submerged, below grade, and in tank installations. Threads shall be coated with mineral oil or other anti-seize compound. Bolts shall be square headed machine bolts with hexagonal nuts in accordance with ANSI B18.2 standards. All threads shall conform to ANSI B1.1 standards. The bolts shall be of an adequate length such that they protrude through the nut following tightening. The bolt protrusion shall not exceed 1/2 inch.

2.19 PIPE MARKINGS – TYPE (DI/1)

A. All ductile iron pipe and fittings as specified in this section shall be permanently marked with the manufacturer, date of manufacture, size, type, class/wall thickness, and standard produced to (ASTM, AWWA, ANSI, etc.).

2.20 NON-STANDARD FITTINGS – TYPE (DI/1)

A. Fittings with non-standard dimensions shall only be allowed with prior written approval of the Engineer. Unless approved in writing by the Engineer, all non-standard fittings shall meet the Specification requirements for standard fittings and be of the same thickness and diameter. Laterals or reducing elbows not meeting the requirements of ANSI A21.10 standards shall meet the requirements of ANSI B16.1 - Class 125.

2.21 JOINT BRACING – TYPE (DI/1)

A. Provide joint bracing as shown on the Drawings and as required to prevent piping from being pulled apart when under pressure. If used, all bridles and tie rods shall be a minimum of 3/4 inches in diameter except when they replace flange bolts of a smaller size. If replacing flange bolts of a smaller size, the bridles shall be fitted with a nut on each side of the pair of flanges.
B. All pipe which requires joint bracing shall be provided with Engineer approved lugs and hooks cast integrally for use with pipe clamps, tie rods, or bridles. All pipe clamps, tie rods, and bridles shall be provided with the same coating as the piping system for interior applications. Buried applications shall be provided with a bituminous coating system. If required, the coating system shall be applied prior to assembly.

2.22 DUCTILE IRON PIPE AND FITTINGS - TYPE (DI/2)

A. All Type (DI/2) ductile iron piping shall be of Class 350 mechanical joint pipe and fittings for buried applications as per AWWA C151/A21.51 standards. Pipe shall be supplied in standard lengths whenever possible. The pipe thickness design shall be in accordance with AWWA C150/A21.50 standards, except provide a minimum of Class 350 for all piping 12 inches and smaller. Provide a minimum Class 350 for piping from 14 inches to 24 inches and provide a minimum of Class 250 for piping larger than 24 inches.

B. All Type (DI/2) ductile iron pipe of the same type, style, and duty shall be supplied by a single manufacturer. All Class 350 ductile iron process piping shall be a product of the following manufacturer

1. U.S. Pipe & Foundry Company Inc.
2. American Cast Iron Pipe Company

2.23 MECHANICAL JOINT FITTINGS – TYPE (DI/2)

A. Mechanical joint compact body fittings shall be ductile iron class 350 and shall be produced in strict accordance with AWWA C153/A21.53 and AWWA C111/A21.11 standards. All pipe and fittings shall be provided with a cement and mortar lining in accordance with AWWA C104/A21.4 standards for sizes 3 inches through 12 inches. Pipe and fittings 14 inches through 24 inches shall be a manufacturer's standard and produced to AWWA C153/A21.53 standards. Mechanical joint fittings shall be Underwriters Laboratories (UL) listed and rated at 350 psi.

B. All joints shall be rated for pressure service. Joints shall be restrained rubber-gasket mechanical joints and fittings conforming to AWWA C111/A21.11 standards. All gaskets shall be as specified. All restrained type joints shall be locked type and be produced by the pipe and fitting manufacturer. The joints shall utilize restraint independent of the joint gasket.
C. All restrained joints of the same type, style, and duty shall be supplied by a single manufacturer. All restrained joints for mechanical joint ductile iron piping shall be a product of the following manufacturer:

1. U.S. Pipe & Foundry Company Inc. - TR FLEX
2. American Cast Iron Pipe Company - Lok-Ring

2.24 MECHANICAL JOINT GASKETS – TYPE (DI/2)

A. Mechanical joint gaskets shall meet or exceed the minimum requirements of AWWA C111/A21.11 Specifications latest revision for styrene-butadiene rubber (SBR) gaskets. Standard mechanical joint glands shall be ductile iron per ASTM A 536 standards, Grade 65-45-12.

2.25 MECHANICAL JOINT HARDWARE – TYPE (DI/2)

A. Mechanical joint nuts and tee-head bolts shall be from Corten Steel Company and shall meet or exceed the requirements of AWWA C111/A21.11, 11-7.5 and ANSI A-21.22 for high strength, low alloy steel, having the following composition: a maximum of 0.20 percent carbon, 1.25 percent manganese, 0.50 percent sulfur, 0.25 percent nickel, 0.20 percent copper with a minimum combined of 1.25 percent of nickel, copper and chromium. The mechanical joint nuts and tee-head bolts shall have minimum yield strength of 45,000 psi and an elongation in 2 inch increments of 20 percent.

2.26 DUCTILE IRON PIPE & FITTINGS – TYPE (DI/3)

A. All Type (DI/3) ductile iron piping shall be Class 350 push on joint pipe and fittings for buried applications as per AWWA C151/A21.51 standards. Pipe shall be supplied in standard lengths whenever possible. The pipe thickness design shall be in accordance with AWWA C150/A21.50 standards, except provide a minimum of Class 350 for all piping 12 inches and smaller. Provide a minimum Class 350 for piping from 14 inches to 24 inches and provide a minimum of Class 250 for piping larger than 24 inches.

B. All Type (DI/3) ductile iron pipe of the same type, style, and duty shall be supplied by a single manufacturer. All push-on joint ductile iron process piping shall be a product of the following manufacturer

1. U.S. Pipe & Foundry Company Inc.
2. American Cast Iron Pipe Company
2.27 PUSH ON JOINT FITTINGS – TYPE (DI/3)

A. Push-on joint fittings shall be ductile iron class 350 and shall be produced in strict accordance with AWWA C153/A21.53 and AWWA C111/A21.11 standards. All pipe and fittings shall be provided with a cement and mortar lining in accordance with AWWA C104/A21.4 standards for sizes 3 inches through 12 inches. Pipe and fittings 14 inches through 24 inches shall be a manufacturer's standard and produced to AWWA C153/A21.53 standards. Fittings shall be UL listed and rated at 350 psi.

B. All joints shall be rated for pressure service. Provide concrete thrust blocks for joint restraint as specified and as indicated on the Drawings.

2.28 PUSH ON JOINT GASKETS – TYPE (DI/3)

A. Push-on joint gaskets shall meet or exceed the minimum requirements of AWWA C111/A21.11 Specifications latest revision for SBR gaskets.

2.29 PIPE LINING – TYPE (DI/3)

A. Unless otherwise specified or shown on the Drawings, all Type (DI/3) ductile iron piping shall be provided with a cement-mortar lining. The cement-mortar lined piping shall conform to AWWA C104/A21.4 standards. Provide a 1/8 inch minimum double cement lining. The cement used shall be Type II and be in accordance with ASTM C 150.

2.30 EXTERIOR COATING – TYPE (DI/3)

A. Pipe outside coating shall be an asphaltic bituminous coating approximately 1 mil thick as specified in AWWA C151. The coating shall be applied to the outside of all pipe, unless otherwise specified or indicated on the Drawings.

2.31 PVC PIPE & FITTINGS - TYPE (PVC/1)

A. All type polyvinyl chloride (PVC) pipe and fittings shall be flanged or socket welded Schedule 80 PVC pipe. The pipe shall conform to ASTM D 1785 standards, PS 21-70, PVC 1120. Pipe material shall be Type I, Grade I, compound cell classified 12454-B per ASTM D 1784 standards. The PVC compound shall be gray in color. The pipe marking shall indicate the pressure rating in psi for water at 73 degrees F, per ASTM D 1785 standards, as well as the manufacturing date code. Schedule 80 fittings shall comply with ASTM D 2467 standards. Flange dimensions shall conform to ASME B16.1, Class 125 standards unless otherwise indicated or required for connection to pumps, tanks, equipment, and appurtenances. Unions shall utilize Viton O-Rings or a material compatible with the process fluid. The pipe shall have a minimum hydrostatic design stress of 2,000 psi at 73 degrees F.
B. Pipe, fittings, and solvent cement for use with potable water shall be certified by National Sanitation Foundation (NSF) Standard No. 14 and the seal shall be included on the pipe.

C. All Type (PVC/1) of the same type, style, and duty shall be supplied by a single manufacturer. All Type PVC/1 piping shall be a product of the following manufacturer

1. CertainTeed Corporation
3. Harvel Plastics, Inc.

2.32 PVC CEMENT FOR SOCKET FITTINGS – TYPE (PVC/1)

A. All cement for socket welded connections shall be low volatile organic compound (VOC) emission, heavy bodied, medium setting, high strength solvent cement. When bonding sodium hypochlorite piping, sodium hydroxide piping or any other acid piping system, the cement shall be specially formulated for the chemical application. The PVC cement shall conform to ASTM F 402,

B. ASTM D 2564 and ASTM F 493 standards; All Schedule 80 PVC piping solvent cement for acid and chemical piping systems shall be a product of the following manufacturer

1. IPS Corporation - Series 724
2. Engineer Approved Equal

2.33 FLANGED JOINTS – TYPE (PVC/1)

A. Where indicated on the Drawings or as specified, all flanged joints shall be supplied with 1/8 inch thick full-faced gaskets. The gaskets shall be of materials as specified in this section based on the respective process fluid. Flanged bolt spacing shall conform to ANSI B16.5 standards. The flanges shall be rated for a minimum pressure of 150 psi. All flanges shall be single piece and be suitable for solvent cementing to the pipe. Two piece sleeve flanges are not acceptable. All gaskets shall be compatible with the process fluid.

B. All bolts, nuts, washers, and other fastening devices shall be designed for use in corrosive service environments. All fastening devices shall be 316 stainless steel and conform to ASTM F 593 and ASTM F 594 standards. All nuts and bolts shall be installed with an anti-seize compound of molybdenum disulfide base.
2.34 CLEAR PVC TUBING - TYPE (PVC/2)

A. All Type PVC/2 piping shall be braid-reinforced, clear, PVC tubing. PVC tubing in chemical feed lines shall be installed as one continuous length of tubing from the source to the application point. No intermediate joints are allowed.

B. Tubing fittings shall be compression type and be comprised of forged brass alloy C37700 or other suitable material of construction which is compatible with the process fluid. All tube fittings shall conform to ASTM B 124/B 124M standards. All nuts, ferrules, bodies, elastomeric O-ring seals, and holding nuts shall be rated to a minimum 125 psi pressure. All straight threads shall conform to ASME B1.1 standards. Tube fittings on chemical feed lines shall be of a material compatible with the process fluid.

1. The tubing shall be constructed with open mesh polyester braiding permanently encapsulated in walls of clear, flexible PVC. All PVC tubing shall be made from non-toxic ingredients conforming to United States Pharmacopoeia (USP) Class VI and Food and Drug Administration (FDA) standards. The PVC tubing shall be of a crystal-clear compound to provide full visual flow indication. The tubing interior shall be mirror smooth to permit uniform flow characteristics. All PVC tubing shall be corrosion and abrasion resistant. All clear PVC tubing shall be designed and constructed in accordance with the following

2. Size: In Accordance with the Drawings

3. Maximum pressure: 150 psi

4. Minimum shore A

5. Hardness: 72

6. Tensile strength: 2,500 psi

7. Elongation at break: 320 percent

8. Brittle temperature: minus 50 degrees F

9. Maximum operating temperature: 175 degrees F

C. All Type (PVC/2) tubing of the same type, style, and duty shall be supplied by a single manufacturer. All clear PVC tubing shall be a product of the following manufacturer

1. NewAge Industries Inc. - Nylobrade

2. ALSCO Industrial Products, Inc.
2.35 PVC DOUBLE CONTAINMENT PIPING - TYPE (PVC/3)

A. Provide a complete double-containment piping system including piping, fittings, anchors, terminations, access tees, carrier pipe supports, and associated pipe joints. The system design shall meet the requirements of ASME/ANSI B31.3 for design criteria where temperature and pressure fall within the limits of that code. The system design shall meet the stated minimum requirements of Federal Regulations 40 CFR-280. The system shall provide access tees, pull ropes, and low-point instrumentation taps as specified by the leak detection vendor and as shown on the Drawings.

B. The system shall be a flexible design with provisions to allow the inner and outer pipe the ability to move independent of one another. Anchors shall be selectively used to direct thermal expansion into expansion loops and offsets. The manufacturer shall be consulted for the proper location of anchors and expansion compensation design. All pipe and fittings shall be listed to NSF Standard 61 or the health effects portion of NSF Standard 14 when used in potable water applications.

C. All Type PVC/3 piping of the same type, style, and duty shall be supplied by a single manufacturer. All PVC double containment piping shall be a product of the following manufacturer

1. Asahi America, Inc. - ChemProlok
2. Spears Manufacturing Company

2.36 PRODUCT PIPE – TYPE (PVC/3)

A. The product pipe and fittings shall be PVC with a Cell Classification of 12454-B in accordance with ASTM D 1784 standards. The product pipe shall be Schedule 80 PVC and shall be of iron pipe size dimensions manufactured in accordance with ASTM D 1785 standards. Fittings shall be produced in accordance with ASTM D 2467 standards. The product pipe shall be of sizes as shown on the Drawings.

2.37 CONTAINMENT PIPE – TYPE (PVC/3)

A. The containment pipe shall be Schedule 80 PVC Pipe and shall be of iron pipe size dimensions and manufactured in accordance with ASTM D 1785 standards. Fittings shall be produced in accordance with ASTM D 2467 standards. The containment pipe shall be at least 2 sizes larger than product pipe. Consult the manufacturer for recommendations when using pull cables.
2.38 PIPE SUPPORTS – TYPE (PVC/3)

A. Supports and guides for product pipe shall be provided of the same resin as the product pipe. The supports shall be placed in a manner that a maximum of 0.1-inch deflection is allowed between supports. The supports shall allow axial movement of the product pipe within the containment pipe. The supports shall maintain a concentric relationship between the product pipe and the containment pipe. The supports shall be designed to allow the pulling of leak detection cable through the pipe.

2.39 ANCHORS – TYPE (PVC/3)

A. Anchors shall be provided of same resin as the product pipe and containment pipe. Anchors shall be of the same wall thickness as the product and containment pipe and shall be of unitary construction. Anchors shall be fully pressure rated. Anchors shall be dog bone style. Standard dog bones shall be used for buried systems, while hung systems shall use restrained dog bones.

2.40 FITTING SUPPORT DISKS – TYPE (PVC/3)

A. Support disks used to centralize fittings shall lock the product (carrier) fitting to the containment fitting. Free-floating fittings are not allowed. Support disks shall be designed to allow for flow and access cable in the annular space.

2.41 VENTS AND DRAINS – TYPE (PVC/3)

A. High-point vents and low-point drains shall provide adequate flows to completely drain the annular space. Vents and drains shall be located per the Drawings. Vents and drains shall be the same resin as the product pipe.

2.42 DOUBLE CONTAINED FLANGES – TYPE (PVC/3)

A. All double contained flange connections shall consist of a double O-ring flange and a flat-faced flange. The flange design shall provide adequate flow of fluid through the annular space. All flanges shall be of the same resin as the connecting pipe.

2.43 DOUBLE CONTAINMENT PIPE INSTALLATION – TYPE (PVC/3)

A. Install double-containment piping in accordance with the manufacturer's recommendations. All joining shall be conducted utilizing a two-step process of primer and cement in accordance with ASTM D 2564 standards. Hot gas welding is not allowed.
2.44  DOUBLE CONTAINMENT PIPE TESTING – TYPE (PVC/3)

A. Testing shall be conducted in accordance with the manufacturer's recommendations. The product pipe shall be tested hydrostatically to 150 percent of operating pressure per ASME B31.3 Part 345, or per local code. The containment piping shall be tested hydrostatically to 150 percent of operating pressure per ASME B31.3, or per local codes.

B. The product pipe shall be pressurized to the same pressure as the test to prevent collapsing. To avoid moisture in the containment space, an air test may be conducted on the containment pipe. Air testing shall only be conducted with prior written approval of the Engineer. Pressure testing shall be as specified or as directed by the Engineer. The inner carrier pipe shall be full of water and under pressure to avoid any possible collapse. When testing with air, the ambient temperature shall be above 40 degrees F and extra safety precautions for personnel shall be put in place during the test.

2.45  CPVC PIPE - TYPE (PVC/4)

A. All Type PVC/4 pipe and fittings shall be flanged or socket welded Schedule 80 CPVC pipe. All pipe shall conform to ASTM D 1784 and ASTM F 441/F 441M standards, with a minimum cell classification of 23447. All pipe shall be manufactured to an standard dimension ratio (SDR) rating in accordance with ASTM F 442/F 442M standards so that the pressure rating of the pipe shall be consistent for all pipe sizes. The schedule rating for fittings shall not be less than that for the associated pipe. All fittings shall be manufactured in accordance with ASTM D 1784 standards with a cell classification 23447. All socket fittings shall be in accordance with ASTM F 438 and ASTM F 439 standards.

B. The pipe marking shall indicate the pressure rating in psi for water at 73 degrees F, per ASTM D 1784 standards, as well as the manufacturing date code. Flange dimensions shall conform to ASME B16.1, Class 125 standards unless otherwise indicated or required for connection to pumps, tanks, equipment, and appurtenances. Unions shall utilize Viton O-rings or a material compatible with the process fluid. The pipe shall have a minimum hydrostatic design stress of 2,000 psi at 73 degrees F.

C. Pipe, fittings, and solvent cement for use with potable water shall be certified by NSF standard No. 14 and the seal shall be included on the pipe.
D. All Type PVC/4 of the same type, style, and duty shall be supplied by a single manufacturer. All Type PVC/4 piping shall be a product of the following manufacturer

1. CertainTeed Corporation
2. J-M Manufacturing Company
3. Harvel Plastics, Inc.

2.46 SOLVENT CEMENT FOR CPVC PIPE – TYPE (PVC/4)

A. All cement for socket welded connections shall be low VOC emission, heavy bodied, medium setting, high strength solvent cement. When bonding sodium hypochlorite piping, sodium hydroxide piping or any other acid piping system the cement shall be specially formulated for the chemical application. The chlorinated polyvinyl chloride (CPVC) cement shall conform to ASTM F 402, and ASTM F 493 standards. All Schedule 80 CPVC piping solvent cement for acid piping systems shall be a product of the following manufacturer

1. IPS Corporation - Series 724

2.47 FLANGED JOINTS – TYPE (PVC/4)

A. All CPVC flanges and flanged fittings shall be Class 125/150, one piece, molded hub type, flat faced, conforming to ASME B16.1 standards.

B. Provide backing flanges as required for each piping system and as directed by the Engineer. All backing flanges shall be 304 stainless steel with ASME B16.1 drilling. All flanges shall be complete with one-piece, molded CPVC stub ends. At a minimum, all flanged connections shall have the same pressure rating as the connecting pipe.

C. All bolting shall be 304 stainless steel in accordance with ASTM A 193/A 193M standards. All bolts shall be provided with washers of the same material as the bolts. All gaskets shall be full-faced in accordance with ASME B16.21 standards. When the mating flange has a raised face, a flat ring gasket shall be used and a filler gasket shall be provided between the outer diameter of the raised face and the flange outer diameter to protect the CPVC flange from bolting moments.
2.48 HIGH DENSITY POLYETHYLENE PIPING - TYPE (PE/1)

A. All Type PE/1 high density polyethylene piping shall be extruded from ultra-high molecular weight polyethylene conforming to ASTM D 3350 standards with a minimum cell classification of 324433-C. The polyethylene pipe shall be Schedule 80 with dimensions conforming to ASTM D 2447 standards.

B. All polyethylene piping shall be manufactured to an SDR rating in accordance with ASTM D 3035 standards for piping systems less than 4 inches in diameter. All piping systems with a diameter of 4 inches and larger shall be manufactured with an SDR rating in accordance with ASTM F 714 and ASTM D 2239 standards. All insert fittings shall be manufactured to an SDR rating in accordance with ASTM D 2239 standards so that the pressure rating of the pipe will be consistent for all pipe sizes.

C. All high-density polyethylene pipe shall meet the requirements of Type III, Class C, Category 5, Grade P34 polyethylene as defined by ASTM D 1248 standards for polyethylene plastics mold and extrusion materials. In addition, the flow rate by extrusion psi as to meter, as measured according to the procedure outlined in ASTM D 1238, Measuring Flow Rates of Thermoplastics by Extrusion Plastometer, shall be not more than 0.25 gms/10 minutes when determined at a test temperature of 310 degrees C and using a plunger load of 27.5 pounds. Pipe shall be designated PE 3406, with a hydrostatic design stress of 630 psi for water at 73.4 degrees F.

D. All pipe shall be permanently imprinted with the manufacturer's brand name, pipe size, product standard, ASTM Specification, recommended working pressure and production code. The letters shall be at least 3/16 inches high and repeated on the pipe at intervals of no less than every 5 feet.

E. The pipe dimensions and tolerances shall correspond with the values listed in ASTM D 2239 standards for flexible plastic pipe. The pipe shall have a bending radius of 20 inches or less.

F. The pipe shall have working pressure of at least 160 psi. The pipe shall be capable of maintaining a pressure of 430 psi at 73.4 degrees F for 1000 hours when tested in accordance with ASTM D 1598 standards. All piping shall have a minimum quick burst of at least 630 psi when tested in accordance with ASTM D 1599 standards.

G. All interior and exterior pipe surfaces shall be mirror smooth, and shall be free from bumps and irregularities. The pipe material shall be completely homogenous and uniform in appearance.
2.49 HIGH DENSITY POLYETHYLENE (HDPE) TUBING - TYPE (PE/2)

A. All Type PE/2 flexible high-density polyethylene tubing shall conform to ASTM D 3350 standards and be dimensioned in accordance with ASTM D 2737 standards. The polyethylene shall be cross-linked, conforming to ASTM D 3350 standards with a minimum cell classification of 35400. All high-density polyethylene tubing shall be dimensioned in accordance with ASTM F 876 standards. Provide high-density polyethylene tubing with nominal sizes in accordance with that shown on the Drawings. The tubing shall be flexible, lightweight, and durable. The tubing shall be translucent for ease of flow verification.

B. Fittings shall be compression type comprised of forged brass alloy C37700, conforming to ASTM B 124/B 124M standards. Fittings for tubing used in chemical feed service shall have nuts, ferrules and bodies constructed of polypropylene with elastomeric O-ring seals, which are compatible with the process fluid. If specified or indicated on the Drawings, barbs and holding nuts shall be rated to a minimum 150 psi with straight threads conforming to ISO 228-1 and ASME B1.1 standards.

2.50 GASKETS

A. Gaskets shall be used on all flanged piping joints. All gaskets shall be a minimum of 1/8 inches thick unless otherwise specified or indicated on the Drawings. Unless otherwise noted, gaskets shall be low torque, full face to ANSI B16.5 dimensions for 125/150 pound flanges. Gaskets shall have two concentric, convex, molded rings between the center hole and bolt hole circle.

B. Gaskets for all water and wastewater applications (sludge, septage, etc.) in flanged piping systems shall be NBR Buna-N unless otherwise indicated. The NBR Buna-N shall have a minimum durometer shore A hardness of 60 in accordance with ASTM D 2000 standards. The gasket finish shall be smooth. The gaskets shall be designed for use in plastic piping systems, as well as metal or plastic-lined metal piping systems.

C. Gaskets for strong acids and bases shall be Hypalon. Gaskets for oil and gasoline shall be NBR Buna-N. Gaskets subject to abrasion, heat, or flame shall be Hypalon or Neoprene. Gaskets for low pressure air service piping shall be EPDM and be suitable for a temperature range of up to 225 degrees F.

D. If for a specific application a pipe or valve manufacturer recommends a different type of gasket than that specified, the Contractor shall submit to the Engineer the gasket information for review and approval.
E. Provide gaskets constructed of the following materials for process fluid piping systems as required and as shown on the Drawings:

1. Aluminum Sulfate: EPDM
2. Ferric Chloride: EPDM
3. Ferrous Chloride: EPDM
4. Sodium Bisulfite: Viton
5. Sodium Hydroxide: EPDM
6. Sodium Hypochlorite: Viton
7. Sulfuric Acid: Viton
8. Citric Acid: Viton
9. Wastewater (Interior/Below Grade): NBR Buna-N
10. Wastewater (Exterior/Above Grade): EPDM
11. Grit Slurry: Neoprene

F. All gaskets of the same type and material shall be provided by a single Manufacturer. All gaskets shall be a product of the following Manufacturer:

1. Asahi America, Inc.
2. Allstate Gasket & Packing, Inc.
3. Metro Industries, Inc.

2.51 UNIONS

A. When joining pipe segments, provide unions where called for on the Drawings and as specified. Provide additional unions to allow for disassembly of piping segments. Provide unions at pumps, equipment, and valves to allow for removal without disassembly of the piping systems.

2.52 PIPE AND FITTINGS COATINGS

A. An exterior coating shall be provided for all ferrous metallic pipe, fittings, and flanges. The prime coat shall be factory applied. The finish coat shall be field applied. The finish coat may be factory applied for all submerged piping applications. The finish coating color shall match existing color coding for retrofit or upgrade Projects. For new Projects and systems, the color coding shall be as directed by the Engineer.
B. The color coding shall be in accordance with section 4.4.5 Plant Paint & Equipment Identification of the TR-16 Guides for Design of Waste Water Treatment Works; a unique color shall be selected for each fluid carried. Fluid designations are provided on the Drawings.

C. All ferrous metallic pipe shall be finish painted. Refer to Section 09 90 00 Painting and Coating as well as the piping manufacturer's recommendations for coating types and requirements. Coat pipes, fittings, hangers and supports using the same paint system. Attachment hardware shall not be painted. Stainless steel pipe, stainless steel pipe supports and appurtenances shall not be painted. All ferrous metallic pipe in submerged applications does not require a urethane finish. The finished coating shall be a product of the same manufacturer as the prime coat to ensure compatibility.

D. Confirm the final color-coding with the Owner and Engineer prior to any application.

2.53 ATTACHMENT HARDWARE

A. All attachment hardware, including but not limited to nuts, bolts, washers and all related fastening devices shall be 304 stainless steel. Threads shall be coated with mineral oil or another anti-seize compound prior to installation. Hardware for submerged applications shall be 316 stainless steel.

2.54 PIPE LABELS

A. All piping shall be labeled on 2 sides at maximum 15-foot intervals. A flow direction arrow shall follow the label legend and be of the same color. The labels shall meet or exceed ASME A13.1 and ANSI standards. The legend letters shall be capitalized and be black or white, depending on the background color. The labels shall be self-adhesive vinyl type. The labels shall be suitable for a pipe temperature range of minus 40 degrees F to 175 degrees F. Clip on or zip tied labels are not acceptable.

B. The pipes shall be labeled according to the fluid carried. The labels shall match the fluid designations as shown on the Drawings. Provide a detailed submittal, which shall include each pipe label for each of the respective fluid designations for review by the Engineer. Pipe labels shall be installed on the exterior of all piping insulation jacket.

C. The piping labels shall spell out the entire fluid designation, not the abbreviation. Confirm the naming convention with the Engineer and Owner prior to ordering the labels. Color coding of labels shall be as approved by the Engineer.
D. All pipe labels of the same type, style, and duty shall be supplied by a single manufacturer. All pipe labels shall be a product of the following manufacturer:

1. MSI Marking Services, Inc.
2. Brimar Industries, Inc.

PART 3 – EXECUTION

3.01 PROTECTION

A. During installation, piping shall be capped to keep out dirt and other foreign matter. A Material Safety Data Sheet (MSDS) in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical product delivered for use in pipe installations. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling of chemicals for piping installation shall be in accordance with ASTM F 402 standards.

3.02 STACKING & UNLOADING

A. All piping shall be stacked in accordance within the limits recommended by its manufacturer. The bottom row of the piping stack shall be elevated from the ground surface. The piping shall be supported off the ground through the use on timbers, rails, or concrete as recommended by the piping manufacturer.

B. The interior of all piping and fittings shall be kept clean and free from dirt or other foreign material at all times. Utilize suitable caps or wrapping to prevent entry of dirt or foreign material into the piping. Exercise extra care when handling cement lined pipe. Damage to interior lining of piping shall render it unfit for use.

C. Unload all piping in strict accordance with the manufacturer's recommendations. Take care not to damage the pipe during unloading. Utilize padding on all hooks, slings, and pipe tongs used for unloading to prevent damage to the piping, its' exterior coating and interior lining. Dropping of pipe during unloading is not acceptable. Care shall be taken to not skid piping against stationary piping during unloading or stacking.

3.03 STAINLESS STEEL PIPE

A. Specifically take care to avoid contacting stainless steel piping with ferrous surfaces or materials. Contact with ferrous surfaces or materials may lead to rusting of particles embedded in the walls of stainless steel piping. If rusting of stainless steel piping occurs after installation, the Contractor shall be responsible for its removal at no additional cost to the Owner or Engineer. Pickle the affected surface area of the piping with a deoxidizer as recommended by the pipe manufacturer and as approved by the Engineer. Scrub all affected areas of the piping with stainless steel brushes and then thoroughly rinse the affected area.
B. All stainless steel piping shall be stored on supports constructed of non-ferrous metal materials. All tools for stainless steel piping installation shall be specifically designated for use on stainless steel piping to ensure no contamination from ferrous metals occurs. All piping storage and fabrication supports shall be constructed from non-ferrous metal, stainless steel, or provided with a rubber lining.

3.04 INSTALLATION - GENERAL

A. Piping systems shall be fabricated and installed in accordance with ASME B31.1 standards. Install each run of piping with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes, where indicated on the Drawings, by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerances.

B. Locate piping runs, except as indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown, or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of buildings.

C. Horizontal piping shall pitch uniformly 1 inch in 40 feet and drain to a minimum number of low points. All low points shall be provided with a minimum 1 inch tapped Type SS/2 drain pipe, 316 stainless steel isolation ball valve Type V26, and 316 stainless steel hose connection. Provide Type PVC/1 drain piping and a Type V20 PVC ball valve for drain connections off of PVC piping. Drain connections may or may not be shown on the Drawings. Confirm the final location of all drain connections with the Engineer and Owner prior to installation. Provide larger drain connections as required and as directed by the Engineer and Owner.

D. Provide unions in piping as shown on the Drawings and as specified herein. Unions shall be provided in locations, including but not limited to the following: equipment, pumps, tanks, valves, long piping runs, piping bypasses around equipment, or any other location as directed by the Engineer or Owner. Unions shall be located to as to allow for piping disassembly, alterations, and repairs.

E. Provide all field routing and coordination of process piping routing as required to accommodate all necessary coordination with other Work of the Contract, including, but not limited to heating, ventilating, and air-conditioning (HVAC), electrical, structural, architectural, plumbing, and civil work.
F. Provide concrete thrust blocks at all pipe fittings and changes in direction or alignment. For clarity, thrust blocks may or may not be shown at every bend, fitting, or directional change. Thrust blocks which have not been shown shall not relieve the Contractor of the responsibility for providing and installing them.

3.05 COPPER PIPE & TUBING INSTALLATION - TYPE (CU/1)

A. All threaded connections shall conform to ANSI B2 and ASME B1.20.1 standards. All threaded connections shall be true, accurate, and of full thread. All threaded plugs shall be brass with a square head. All threaded joints shall be made with a joint compound approved by the piping manufacturer. The joint compound shall be applied to the male thread only. Caulking of threaded joints is not acceptable. All reductions and expansions in piping diameters shall be through the use of reducers and expansion fittings. Bushings or close nipples are not acceptable.

3.06 SOLDERING – TYPE (CU/1)

A. All joints for copper pipe 2 inches and smaller shall be soldered. Prior to soldering, all surfaces shall be thoroughly cleaned and polished, and free from dirt, grease, grime or other foreign materials before fluxing and soldering. The cleaning shall be performed by using an emery cloth, sandpaper, or steel wool. Clean the outside end of the copper tubing for a length of a least 1/2 inch greater than the depth of the fitting. The inside of the fittings shall be cleaned in a similar manner. Apply non-corrosive flux and assemble the joint. Insert ends of tubes into fittings to the full depth of the sockets. Acid solder and acid flux are not acceptable.

B. The copper piping and tubing surfaces to be joined shall be heated up slowly and uniformly. The surface being soldered shall be heated to the melting point of the solder. Apply heating to draw the solder completely into the joint. Form continuous solder beads around the entire circumferences of the joints. Once solder is plasticized, remove all excess with a brush or other suitable cleaning device. Excess solder shall be removed from the interior and exterior of the piping. Provide a fillet around the end of all fittings and joints. Allow soldered joints to cool slowly via the surrounding air. The use of water for quenching is not acceptable. Provide full penetration of solder within all joints.

C. All cutting of copper tubing shall be square. The ends of all-cut piping shall be reamed or filed to remove burrs. The use of piping with out-of-round ends is not acceptable. Any type of defects, including but not limited to, cracks, holes, and incomplete solder penetration is not acceptable. Peening for the closing of defects is not acceptable under any circumstances.

D. Utilize heating torches of sufficient size based on the size of the piping to be joined. Utilize combination torches with ring burners or multiple tips for heating of copper fittings 1-3/4 inches and larger.
3.07 BRAZING – TYPE (CU/1)

A. All joints for interior copper pipe larger than 2 inches shall be brazed. Apply all flux in strict accordance with the recommendations of the manufacturer of brazing filler material. Apply flux to the outside of fittings and avoid allowing the flux to enter the inside of the tubing. Apply heat to the brazed sections of piping beginning 1 inch from the edge of each fitting.

B. Once the flux becomes transparent, heat the fitting at the base of the cup. All heating shall be conducted while continuously moving the torch flame. Continuously maintain heating along the joint between the fitting and tubing connection axis.

C. Apply the brazing material at the joint where the tubing enters the socket of a fitting. Heat the joint to melt the brazing material. Do not apply the torch flame directly on the brazing material. A properly assembled joint shall consist of a fillet of filler being visible around the complete circumference of the joint. Once a complete fillet is visible, stop adding filler metal. Remove any excess flux residue.

D. Allow all joints to cool slowly via the surrounding air. The use of water for quenching is not acceptable. Any type of defects, including but not limited to, cracks, holes, and incomplete filler material penetration is not acceptable. Peening for the closing of defects is not acceptable under any circumstances.

3.08 FLANGES – TYPE (CU/1)

A. Install flanged connections as required as shown on the Drawings and as approved by the Engineer. Install all flange faces in perfect alignment. The flange holes shall straddle the vertical center line of the piping.

B. Flange bolts shall be alloy steel, ASTM A 193/A 193M Grade B7, or commercial grade carbon steel, ASTM A 307, Grade B. Alloy steel bolts shall be tightened to obtain a stress of 45,000 psi and carbon steel bolts shall be tightened to obtain approximately 15,000 psi of stress. The stress shall be based on the root area of the bolt thread. Provide flange bolt isolators for dissimilar metals.

C. Lubricate all bolts over the entire thread length with a heavy graphite and oil mixture prior to tightening. Tighten bolts with proper wrenches. Secure flanges with uniform pressure on the bolts and gaskets. Flanged joints with flange dishing and over-compression of the gaskets due to overstressing of the bolts is not acceptable. Utilize bolts of adequate length to allow for a minimum of 2 full thread lengths to extend beyond the fastening nut.
3.09 DUCTILE IRON PIPE INSTALLATION - TYPE (DI/1)

A. Install Type DI/1 ductile iron piping and fittings true to alignment. Provide rigid pipe supports and anchorage. The support spacing shall be in strict accordance with the recommendations of the piping manufacturer.

B. The installation and piping support system shall not allow deflection of piping greater than 50 percent of the maximum deflection as recommended by the piping manufacturer. Each section of piping and fittings must be cleaned, free of dirt, debris and other foreign material prior to installation. All cleaning shall be in accordance with the recommendations of the piping manufacturer.

C. All ductile iron piping and fittings shall be installed in accordance with requirements of AWWA C600 standards. Provide all fittings for field routing of piping in addition to those shown on the Drawings to provide for a complete and operational piping system. Provide additional flanges as directed by the Engineer where piping interferes with existing facilities.

3.10 PIPE CUTTING – TYPE (DI/1)

A. Pipe cutting shall be as approved by the Engineer. Any damage to the interior pipe linings shall be repaired to the satisfaction of the Engineer before installation. If approved by the Engineer, cutting shall be conducted using a saw with blades specifically designed for cutting iron pipe. All cuts shall be at right angles to the axis of the piping. The cuts shall leave smooth edges. Damages to interior pipe linings caused by cutting of pipe shall be repaired to the satisfaction of the Engineer and Owner.

B. Seal the ends of all cut pipe in accordance with the recommendations of the pipe manufacturer.

C. Field cutting and threading of ductile iron pipe is not acceptable under any circumstances. All pipe shall be pre-cut and threaded for flanges at the factory of origin.

3.11 JOINTS & CONNECTIONS – TYPE (DI/1)

A. Connect piping to equipment in accordance with the instructions of the equipment manufacturer. When manufacturers indicate that equipment shall not support dead loads from piping, the Contractor shall submit, in writing, that the piping installation does not transfer loading from the piping to the equipment, and that all the manufacturer's requirements have been met. Install piping so as not to impart any strain or loading on the connected equipment.

B. All bolts for flanged joints shall be tightened evenly. All bolts shall conform to the size of the flange and well as all ANSI standards. Flanged joints shall be made using gaskets, bolts, and bolt studs with a nut on each end. Utilize studs with nuts where the flange is tapped.
C. Provide tapped pipe connections as shown on the Drawings and as directed by the Engineer. All piping shall be drilled and tapped perpendicular to the longitudinal access of the pipe. All taps shall be designed to seal watertight. The pipe taps shall be of sufficient strength to prevent blowouts in pressurized applications. Follow the manufacturer's instructions when tapping into fittings. All pipe taps shall be in accordance with ANSI A21.51 standards.

3.12 DUCTILE IRON PIPE INSTALLATION - (TYPE DI/2 & DI/3)

A. Install Type DI/2 and DI/3 ductile iron piping and fittings true to alignment. All pipe shall be thoroughly cleaned prior to laying and shall be kept clean throughout the duration of the Work. Piping shall conform to the lines and grades indicated in the Contract Documents. All ductile iron piping and fittings shall be installed in accordance with the requirements of AWWA C600, unless otherwise specified or indicated on the Drawings.

B. A firm, even bearing shall be constructed by digging bell holes at each joint and by tamping screened gravel at the sides of the pipe up to mid-diameter. Provide fill at least 1 foot over the top of the pipe in accordance with the details shown on the Drawings. Blocking is not permitted. All defective pipe shall be removed even after it has been laid. The pipe shall be replaced with a sound, non-defective pipe in a satisfactory manner, by the Contractor, at no additional cost to the Owner or Engineer.

C. All pipe shall be sound and clean prior to laying. When laying is not in progress, including lunch breaks, the open ends of piping shall be closed by watertight plugs or other Engineer approved means. Proper alignment shall be preserved in laying. Deflection of joints shall not exceed that recommended by the pipe manufacturer. All fittings shall be provided, for crossing utilities, which may be encountered upon opening the trench. Solid sleeve couplings may only be utilized where indicated on the Drawings, or with written approval of the Engineer.

3.13 PIPE LAYING – TYPE (DI/2) & (DI/3)

A. All Type DI/2 ductile iron pipe shall be installed in accordance with the trench detail as shown on the Drawings.

3.14 PIPE CUTTING – TYPE (DI/2) & (DI/3)

A. When cutting of pipe is required, the cutting shall be done by a machine, leaving a smooth cut at right angles with the axis of the pipe. Cut ends of pipe shall be joined with a bell and shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged. Field cut ends shall be sealed with an Engineer approved epoxy, in accordance with the pipe manufacturer's instructions. Cutting of restrained joint pipe is not acceptable unless approved in writing by the Engineer. If approved, cutting shall be at specific locations, and the Contractor shall provide all restrainer glands or field adaptable restrained joints.
3.15 PUSH-ON JOINTS – TYPE (DI/3)

A. All push on joints shall be installed in accordance with the recommendations of the pipe manufacturer as well as all AWWA C600 standards. All pipe shall be laid with bell ends facing ahead. A rubber gasket shall be inserted in the groove end of the pipe, and the joint surfaces shall be cleaned and lubricated. The plain end of the pipe shall be aligned and inserted in the bell end of the pipe to which it is to be joined, and pushed home with a jack or other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

3.16 MECHANICAL JOINTS – TYPE (DI/2)

A. Mechanical joints shall be assembled in accordance with Appendix A of AWWA C111/A21.11 and the pipe manufacturer's instructions. Thoroughly clean and lubricate the joint surfaces and rubber gaskets with soapy water before assembly. Bolts shall be tightened to the specified torques. Under no conditions shall extension wrenches or pipe over handle of ordinary ratchet wrenches be used to secure greater leverage. Bolts in mechanical or restrained joints shall be tightened evenly and alternately.

3.17 PVC PIPE INSTALLATION - TYPE (PVC/1) AND TYPE (PVC/4)

A. Install Type PVC/1 and Type PVC/4 pressure piping in strict accordance with the manufacturer's instructions as well as specified herein. When cutting of piping is required, all burrs, chips, filings, and other associated defects shall be removed from both the pipe inside diameter and outside diameter before joining. Cutting of piping shall be with a hand saw or pipe cutter with blades. The use of pipe cutters with rollers is not acceptable. All cut pipe ends shall be beveled approximately 1/16 inch back from the edge of the pipe, at an angle of 10 to 15 degrees. All cutting of PVC piping shall be in strict accordance with the recommendations of the piping manufacturer.

3.18 SOLVENT WELDING – TYPE (PVC/1) & (PVC/4)

A. All joints for plastic pipe shall be solvent welded except where flanged joints are required. All pipe and fittings to be socket welded shall be clean of all loose dirt and moisture from the inside and outside diameter of the pipe end and the inside diameter of the fitting. Do not socket weld wet piping surfaces.

B. The solvent cement shall be a grade specifically recommended by the piping manufacturer for the size and schedule of the pipe as well as the process fluid carried. Solvent cements for acidic chemicals shall be in accordance with that previously specified. Prior to solvent welding, all fittings and couplings shall be exposed to the installation atmosphere for at least 1 hour to the same temperature conditions as the pipe, in order to assure proper thermal balance between the piping and associated fitting.
C. Apply low VOC solvent cement to the pipe in accordance with the manufacturer’s recommendations. A minimum of 2 coats shall be applied when recommended by the pipe, fitting, or solvent cement manufacturer. All piping system joints shall use a primer and finished solvent cement coating prior to assembly. Apply the solvent cement to the socket while keeping both the surface and applicator wet and in motion for approximately 5 to 15 seconds. Take care not to add excess solvent cement. Joints shall not be cramped.

D. The atmospheric and weather conditions affect the solvent welding procedure. In cold weather, sufficient time shall be allowed for proper penetration of the solvent cement. Joining of PVC pipe and fittings shall not be conducted in atmospheric conditions below 40 degrees F, above 90 degrees F, or when exposed to direct sunlight. Allow for a minimum of 48 hours of drying time before moving the socket welded joint or subjecting any internal or external pressure or force.

E. When solvent welding piping to valves or other appurtenances, take specific care not to allow solvent cement to enter the valve. Solvent cement shall not be allowed to run free from joints. All valves shall be solvent welded in strict accordance with the recommendations of the valve manufacturer.

F. All solvent welded joints shall remain undisturbed for a minimum of 48 hours to allow for the development of complete strength.

3.19 FLANGED JOINTS – TYPE (PVC/1) & (PVC/4)

A. When connecting Type PVC/1 piping to metallic piping, assemble the metallic piping first. Flanged connections shall be used to connect all PVC piping to metallic piping unless otherwise specified or shown on the Drawings. Tighten all bolts evenly to prevent warping and dishing of the PVC flange. A wrench may be used to provide a tight seal between the flanges and gaskets. All joints shall conform to the piping manufacturer's recommendations.

3.20 STAINLESS STEEL PIPE INSTALLATION - TYPE (SS/1) (SS/2) (SS/3) & (SS/4)

A. Install all Type SS/1 and Type SS/2 pipe and fittings in strict accordance with the recommendations of the pipe manufacturer. The installation shall be true to alignment. All piping shall be pitched to low points and shall be provided with condensate drains as required and as shown on the Drawings. All pipe supports and restraints shall be provided as recommended by the pipe Manufacturer.

B. If pipe cutting is required for installation, a machine shall be used. All cuts shall be neat, true, and smooth at 90 degree angles to the pipe longitudinal axis/center line.
C. Prior to assembly in the field, clean all flanges, gaskets or threads with a soap and warm water solution. All flanged bolts shall be tightened alternately and evenly to the manufacturer's required torque. Take care not to over-tighten any flange bolts. Do not utilize extension or pipe ratchet wrenches, which may cause over-torque of flange bolts. All flange joints shall be assembled with gaskets, bolts and nuts, bolt studs with a nut on each end, or studs and nuts when the pipe is tapped. Ensure all flange holes are provided with connectors.

D. Cut threads full and clean using sharp dies. Ream all threaded ends to remove burrs and restore the full inside pipe diameter. Apply pipe joint compound or Teflon pipe joint tape as recommended by the pipe and fitting manufacturer on male threads at each joint, and tighten the joint to leave not more than 3 threads exposed.

E. All pipe and fittings shall be cleaned of all dust, oil, grease, water, dirt or any other foreign matter prior to installation. Ensure no foreign matter, tools, or other construction materials are left in the piping. All stainless steel piping shall be washed clean with steam or warm water to remove any other remaining foreign matter or debris.

F. Stainless steel piping used in low pressure air or other associated hot applications shall be designed to account for thermal expansion and contraction over a temperature range of 0 degrees F to 200 degrees F.

G. Welding in the field shall only be conducted with prior written approved by the Engineer. All welds shall be made by welders certified under ASME Section IX, and be equal or exceed shop welds in all respects. Field welding shall only be conducted after a demonstration weld is successfully completed by each welder, at no additional cost to the Owner or Engineer. All field-welded joints shall be thoroughly cleaned and buffed using deburring and finishing wheels.

H. Provide certifications that all welders on-site are qualified in accordance with ANSI B31.1, Paragraph 127.5 for shop and Project Site welding of pipe work. The Contractor shall provide certified copies of current welding certificates for all welders on Site to the Engineer and Owner.
3.21 INSTALLATION OF SLEEVES AND SEALS

A. Install pipe sleeves of types as indicated on the Drawings where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of Work, except as detailed on the Drawings, or as approved by the Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation will have free movement in the sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than the piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface, except floor sleeves. Extend floor sleeves 4 inches above the level floor finish, and 4 inches above floor finishes sloped to drain. Provide temporary support of sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

B. Sleeve Seals shall be installed in accordance with the following

1. Mechanical sleeve seals: Loosely assemble rubber links around the pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

2. Install wall pipe where indicated on Drawings. Joints shall be as indicated for connection to adjacent piping.

3.22 CLEANING

A. Thoroughly clean the interior and exterior of all piping prior to testing. Provide removal of all dirt, dust, oil, grease and other foreign materials from the piping. Exercise care while cleaning piping to avoid damage to linings and coatings. Clean all piping in strict accordance with the recommendation of the piping manufacturer.

B. Flush out piping systems, except odor control piping, with clean water prior to proceeding with the required tests. Inspect each run of piping for completion of joints, supports, accessory items, and appurtenances prior to testing.

3.23 PIPE TESTING - GENERAL

A. Test all piping in the presence of Engineer or by Owner. Test in accordance with requirements of local and state plumbing codes and as specified. Provide all labor, equipment, materials, taps, water, gauges, pumps, and appurtenances to conduct all piping tests.

B. When requested by the Engineer or local plumbing inspector, building gravity drains shall be tested prior to backfilling or concealing. All other piping may be tested after backfilling. Provide lawful disposal of all waste after the testing.
C. Test all piping systems before insulation is installed. Remove all control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where the test pressure exceeds the valve pressure rating. Test each section with water or other fluids as directed by Engineer and Owner. Pressurize the pipe to the specified level for the required time period.

3.24 HYDROSTATIC PRESSURE TESTING

A. All liquid service pipe and fittings shall be pressure tested using water to the test pressures specified or as directed by the Engineer. All pipe and fittings shall be pressure tested with water at the maximum service temperature specified or as directed by the Engineer. Test pressures for designations and systems not listed shall be as directed by the Engineer prior to testing. All testing shall be in accordance with the procedures of ASME B31.1 standards.

B. Provide water or other test fluid as directed by the Engineer, of sufficient capacity to deliver the required test pressure specified. Provide all valves on the suction and discharge side of the pump as well as a strainer on the inlet side of the pump to prevent foreign matter from entering the system. Provide pressure gauges capable of reading 50 percent higher than the specified test pressure. The pressure gauges shall be located at the pump discharge and any other place as directed by the Engineer. Provide a pressure relief valve set at a pressure 20 to 25 percent above the specified test pressure. Provide heaters, if required, to heat the test water to the specified test temperature.

3.25 PREPARATION FOR TESTING

A. Coordinate the testing fluid to be used with the Engineer and Owner. When the fluid test temperature is not ambient, the Contractor shall consult the Engineer for the appropriate test temperature. All testing equipment shall be compatible with the piping and test fluid. Provide vents at all high points of the system if not already installed. Provide drains in locations where venting or draining devices do not exist.

B. Remove all discs, pistons, balls etc., from check valves if they prohibit testing of the piping system. Ensure all valves and appurtenances are fully open within the section of piping to be tested. Remove all control instruments and alarms prior to testing. Block off or remove all pressure relief valves prior to testing and temporarily close all external openings of the piping section to be tested. All closures shall be specifically designed for the test pressure. All joints in the piping section to be tested shall be left exposed for examination and inspection during the test period. Pipe insulation shall not be installed prior to conducting pipe testing.

C. Provide temporary supports for vapor or gas piping to support the weight of the test fluid if the vapor or gas piping is directed to be hydrostatically tested.
D. Provide temporary support, restraint or isolation for all expansion joints.

E. Hydrostatic Test

1. Slowly fill the piping system, expelling entrapped air from all high points. The fill rate shall be controlled so that the fluid velocity within the pipe system is less than 2 feet per second. Once the filling process has been completed the piping system shall be brought up to the specified test temperature, if required or directed by the Engineer. The pressure shall be held at 20 percent less than the test pressure until the temperature has been stabilized. Once the temperature has stabilized, raise the pressure to the test level as specified or as directed by the Engineer.

2. The pipe system shall be slowly brought up to the test pressure. Take care not to create shock, surge, or water hammer in the pipe system.

3. For pressure piping, test each piping system at 150 percent of the design operating pressure, but not less than 25 psig test pressure, whichever is greater. Pressure piping shall be defined as piping systems in which the process fluid does not flow via gravity. The minimum test pressure for all gravity piping shall be 10 psig. Provide the Engineer and Owner with a minimum 24 hour notice prior to the testing. Tests which are not witnessed by Engineer are not acceptable. In the absence of specified test pressures, the Contractor shall consult the Engineer for determining the test pressure for each system. The required test period shall be a minimum of 2 hours.

4. The test duration time limit shall not begin until the full pressure specified or indicated by the Engineer has been reached and the system has been stabilized to within plus or minus 5 percent of the test temperature. The system temperature shall be maintained to within plus or minus 5 percent of the specified or Engineer indicated value for the entire duration of the test. The test pressure shall be maintained at plus or minus 5 psi of the specified or Engineer indicated test pressure for the entire duration of the test.

5. The pressure test shall be monitored by a recording type pressure gauge. When temperature and pressure control is required, the Contractor shall use a combination temperature and pressure recording gauge. Record the entire test process. The records shall include, but are not limited to, the date of testing, piping section tested, test pressure, testing equipment, testing results, test fluid, test temperature, and signatures of the Engineer, Contractor, and Owner.
3.26 INSPECTION

A. Observe each test section for leakage during the test period. The hydrostatic test shall be deemed acceptable if no visible leaks are detected and the pipe system pressure can be maintained within plus or minus 1 percent but no more than 5 psi of the specified value.

B. Upon completion of the test, the pressure shall be slowly removed by opening a valve or other pressure-relieving device at a location remote to the location of the pressure and temperature monitoring equipment. The pressure shall be reduced to approximately 20 percent of the specified or Engineer indicated test pressure. Stabilize the system pressure at that point while the entire system is inspected for leaks, cracks, or other piping system defects. If any defects are found, the Contractor shall alleviate all pressure in the piping system, drain the test fluid, correct all defects, and retest the piping system.

C. Repair all piping system sections which fail the hydrostatic pressure piping test, by disassembly and re-installation using new materials to the extent required to overcome leakage or pressure drop. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. Repair and retest all defective piping sections at no additional cost to the Owner or Engineer. Drain and dispose of all fluids from the piping systems after testing and repair Work has been completed.

3.27 PNEUMATIC PRESSURE TESTING

A. All low pressure air service pipe and fittings shall be pneumatically pressure tested using air to the test pressures specified or as directed by the Engineer. All pipe and fittings shall be pressure tested with air at the maximum service temperature specified or as directed by the Engineer. Test pressures for designations and systems not listed shall be as approved by the Engineer prior to testing. All testing shall be in accordance with the procedures of ASME B31.1 standards.

3.28 PREPARATION FOR TESTING

A. Coordinate the testing pressure with the Engineer. When the air test temperature is not ambient, the Contractor shall consult the Engineer for the appropriate test temperature. All testing equipment shall be compatible with the piping. Provide vents at all high points of the system if not already installed.
B. Remove all discs, pistons, balls etc., from check valves if they prohibit testing of the piping system. Ensure all valves and appurtenances are fully open within the section of piping to be tested. Remove all control instruments and alarms prior to testing. Block off or remove all pressure relief valves prior to testing and temporarily close all external openings of the piping section to be tested. All closures shall be specifically designed for the test pressure. All joints in the piping section to be tested shall be left exposed for examination and inspection during the test period. Insulation shall not be installed prior to conducting tests. Provide a soapy water solution and test all fittings, joints, couplings, valves, etc., for air leakage.

C. Personnel not directly involved in pneumatic pressure testing of piping shall be evacuated from the area. The maximum length of piping to be tested at 1 time shall be 400 feet. Examine all connections prior to testing to ensure proper fit and tightness. Determine the pressure rating for all connected devices and appurtenances to ensure they are rated for the required test pressure. Isolate all equipment and appurtenances, which may be damaged by testing. Plug all test, drain, and vent ports, which are not required for the test. If the section of pipe being tested is isolated from other sections by in-line valves, ensure that the portion not being tested is open to the atmosphere. Protect expansion joints against system pressures by suitable movement-limiting devices.

3.29 PNEUMATIC PRESSURE TEST

A. Slowly fill the piping system. Each piping system shall be brought up to the specified test temperature. The pressure shall be held at 20 percent less than the required test pressure until the temperature has been stabilized. Once the temperature has stabilized, raise the pressure to the test level as specified or as directed by the Engineer.

B. Test each piping system at 150 percent of the design operating pressure, but not less than 25 psi test pressure, whichever is greater. Provide the Engineer and Owner with a minimum of 24 hour notice prior to the testing. Tests which are not witnessed by Engineer are not acceptable. In the absence of specified test pressures, the Contractor shall consult the Engineer for determining the test pressure for each system. The required test period shall be 2 hours.

C. The test duration time limit shall not begin until the full pressure specified or indicated by the Engineer has been reached and the system has been stabilized to within plus or minus 5 percent of the test temperature. The system temperature shall be maintained to within plus or minus 5 percent of the specified or Engineer indicated value for the entire duration of the test. The test pressure shall be maintained at plus or minus 0.5 psi of the specified or Engineer indicated test pressure for the entire duration of the test.
D. The pressure test shall be monitored by a recording type pressure gauge. When temperature and pressure control is required, use a combination temperature and pressure recording gauge. Record the entire test process. The records shall include, but are not limited to, the date of testing, piping section tested, test pressure, testing equipment, testing results, test temperature, and signatures of the Engineer, Contractor, and Owner.

3.30 INSPECTION

A. Observe each test section for leakage during the test period. Once the test segment has been pressurized to the specified levels, the source of pressurization shall be isolated and all piping, connections, etc., shall be tested for leaks by swabbing with standard high film soap solution conforming to MIL-L-25567 standards, while also observing for the formation of air bubbles. Each pneumatic pressure test shall be deemed acceptable if no visible leaks (air bubbles) are detected and the pipe system pressure can be maintained to within plus or minus 1/2 percent but no more than 0.5 psi of the specified value.

B. Upon completion of the test, the pressure shall be slowly removed by opening a valve or other pressure-relieving device at a location remote to the location of the pressure/temperature monitoring equipment. If any defects are found, the Contractor shall alleviate all pressure in the piping system, correct all defects, and retest the piping system.

C. Repair all piping system sections which fail the pneumatic pressure-piping test, by disassembly and re-installation, using new materials to the extent required to overcome leakage or pressure drop. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. The Contractor shall be responsible for repairing and retesting all defective piping sections at no additional cost to the Owner or Engineer.

3.31 POTABLE WATER SYSTEM FLUSHING

A. Before operational tests or disinfection, all potable water piping systems shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Engineer or designated representative shall specify the number of fixtures to be operated during flushing.
B. Provide adequate personnel to monitor the flushing operations and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. The Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All end points or devices as outlined in NSF/ANSI 61, Section 9 standards shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

C. After flushing, the system shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Comply with ASHRAE 90.1-IP for minimum efficiency requirements. The water supply to the building or facility shall be tested separately to ensure that any lead contamination found during potable water system testing is due to Work being performed inside the facility.

3.32 WATER SYSTEM OPERATIONAL TESTING

A. Upon completion of flushing and prior to disinfection procedures, subject the plumbing/water systems to operating tests to demonstrate satisfactory installation, connections, adjustments, functional and operational efficiency. Such operating tests shall cover a period of not less than 2 hours for each system and shall include the following information in a report with conclusion as to operation of system.

1. Time, date, and duration of test
2. Water pressures at the most remote and the highest fixtures
3. Operation of each valve, hydrant, or faucet
4. Pump suction and discharge pressures
5. Operation of each floor drain by flooding with water
6. Operation of each vacuum breaker and backflow preventer
7. Complete operation of each water pressure booster system, including pump start pressure and stop pressure
B. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests. The Contractor shall also provide all the necessary water, electricity, fuel, and related appurtenances for testing.

3.33 DISINFECTION OF POTABLE WATER SYSTEMS

A. After all system components are provided and operational tests are complete, the entire water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

B. Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this Specification. The chlorinating chemical shall be hypochlorites or liquid chlorine. The chlorinating chemical shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

C. Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each connection and fixture shall be opened and closed several times.

D. After the second 24-hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24-hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

E. Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than 1 part per million. During the flushing period, each connection and fixture shall be opened and closed several times.

F. Take additional Samples of water in disinfected containers, for bacterial examination, at locations specified by the Engineer. Test these Samples for total coliform organisms in accordance with AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

G. Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the Samples for at least 2 full days. The system will not be accepted or considered complete until satisfactory bacteriological results have been obtained.

END OF SECTION
SECTION 40 05 17

PROCESS PIPE SLEEVES AND SEALS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide labor, materials, equipment, incidentals, and appurtenances required to install pipe penetration assemblies as indicated on Drawings, in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Refer to the Drawings for additional details and requirements for each penetration configuration.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: Per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American Water Works Association (AWWA)
   a. AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings for Water
   b. AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
   c. AWWA C115/A21.15 Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
   d. AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water
   e. AWWA C153/A21.53 Ductile-Iron Compact Fittings for Water Service

2. ASTM International (ASTM)
   a. ASTM D 2000 Standard Classification System for Rubber Products in Automotive Applications
   b. ASTM D 297 Rubber Products - Chemical Analysis
c. ASTM D 395 Standard Test Methods for Rubber Property - Compression Set

d. ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

e. ASTM F 593 Stainless Steel Bolts, Hex Cap Screws, and Studs

f. ASTM F 594 Standard Specification for Stainless Steel Nuts

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: Per Division 01 General Requirements.

1.05 SUBMITTALS

A. Submit in accordance with the Division 01 General Requirements.

B. Product Data

1. Product data shall include manufacturer's descriptive data, technical literature, performance charts, catalog cuts, and installation instructions. Include all spare parts data for each different item of material and equipment specified. Provide literature, installation instructions, and where applicable, fire ratings and certified test results of the various components on all sleeves and seals.

C. Closeout and maintenance material submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the production of such products and shall essentially duplicate items that have been in satisfactory use in identical applications in other wastewater treatment facilities. Manufacturer shall have a minimum of 5 years of documented experience in the design and production of pipe sleeves and seals of all types, and not less than 5 years of experience in the production of equal or larger sized models or designs of the exact products as specified.

C. Manufacturer shall provide installation list of at least 10 similar installations, including contact names and phone numbers. Products shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the Site to ensure parts and service can be acquired in a timely fashion.
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing Conditions: per Division 01 General Requirements.

PART 2 – PRODUCTS

2.01 SPECIAL TOOLS
   A. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the equipment and appurtenances. Special tools shall refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

2.02 PIPE SLEEVES
   A. Provide pipe wall sleeves and seal penetrations as indicated or required to complete the Work. Unless otherwise specified or indicated on the Drawings, all pipe sleeves 24 inches and smaller be constructed of high-density polyethylene (HDPE). The use of ferrous metallic sleeves is not acceptable. All pipe sleeves larger than 24 inches shall be constructed of 304L stainless steel. Pipe sleeves of all sizes and materials shall include a 2 inch (minimum) circumferential water stop welded or integrally molded to the exterior of the sleeve at its midpoint. The sleeve length shall be specifically coordinated with the respective thickness of the penetrated structural wall, floor or ceiling. Unless otherwise indicated, ends of sleeves shall be flush with the wall or ceiling and extend a minimum of 4 inches above finished floors. Refer to the piping penetration details on the Drawings for additional information and requirements. Pipe sleeves which penetrate masonry block walls do not require an integral water stop.

   B. Pipe sleeves which are to be sealed with mechanical seals shall be sized in accordance with the recommendations of the seal manufacturer.

   C. Sleeves to be sealed by caulking or sleeves for insulated piping shall be sized, constructed and installed as specified or as indicated on the Drawings. Unless otherwise indicated, all pipe sleeves which penetrate fire rated walls, floors or ceilings shall be 304L stainless steel, regardless of size.

   D. All pipe sleeves shall be supplied by a single manufacturer. All wall pipe sleeves shall be a product of the following manufacturers

      1. Pipeline Seal & Insulator, Inc.
      2. Advance Products & Systems, Inc. - Infinity Series

      1. Engineer Approved Equal
2.03 WALL CASTINGS (WALL PIPE)

A. Provide wall castings (wall pipe) as specified or indicated on the Drawings. All wall castings shall be constructed of ductile iron conforming to AWWA C151/A21.51 standards, Class 53, with a diameter to match the connecting piping system. Ductile iron wall castings shall be grade 60-42-10. All wall castings shall have minimum physical properties in accordance with the following:

1. Minimum tensile strength: 60,000 psi
2. Minimum yield strength: 42,000 psi
3. Minimum elongation: 10 percent

B. Flanges and mechanical joint bells shall be drilled and tapped for studs where flush with the wall. Castings shall be provided with a 2 inch minimum circumferential flange/waterstop integrally cast with or welded to the pipe. All welded flanges/waterstops shall include a continuous 360 degree fillet weld on both sides of the collar over the entire circumference of the wall pipe. The pipe collar shall be designed for use as both a thrust collar and a water stop mechanism.

C. Unless otherwise noted, all cast flanges shall be in accordance with AWWA C110/A21.10, AWWA C153/A21.53 and AWWA C115/A21.15 standards. All mechanical joints shall be in accordance with AWWA C111/A21.11 standards. Fabricated mechanical joint bells shall be in accordance with applicable portions of AWWA C153/A21.53 standards. Flanges shall be designed for a 125 pound drilling pattern.

D. For castings set flush with walls, locate the flange/waterstop at the center of the overall length of the casting. For castings which extend through the wall, locate the flange/waterstop within the middle third of the wall. All ductile iron wall castings shall be provided with a 2-part epoxy prime and finished coating system in accordance with Specification 09 90 00 PAINTING AND COATING. As an alternative to epoxy coating, provide a bituminous coating on all surfaces of wall castings which are in contact with concrete.

E. Stainless steel wall pipes shall be provided for all stainless steel piping systems to match the connecting piping. All stainless steel wall pipes shall be Schedule 10S, Type 304L stainless steel with a 2 inch minimum circumferential flange/waterstop integrally cast with or welded to the pipe. All stainless steel wall pipes shall be in accordance with the requirements of Types SS/1 piping as noted in Specification 40 05 13 PROCESS PIPE AND FITTINGS.

F. All ductile iron wall castings shall be supplied by a single manufacturer. All wall castings shall be a product of the following manufacturers:

1. American Cast Iron Pipe Company
2. Clow Water Systems Company

3. Engineer Approved Equal

2.04 MECHANICAL PIPE SEALS

A. Unless otherwise specified or indicated on the Drawings, all core drilled or sleeved wall, floor and ceiling penetrations shall be provided with a modular, mechanical type, sealing system. The sealing system shall consist of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the cored opening or pipe sleeve. The elastomeric element shall be sized and selected in accordance with the manufacturer's recommendations and sizing guidelines. Coloration shall be throughout the elastomer as indicated below for the respective seal materials to allow for positive field identification. Each link shall have a permanent identification of the size and manufacturer's name molded into it. Each seal shall be rated by the manufacturer for positive sealing at a minimum pressure of 40 feet of water or 20 psig. All mechanical pipe seals shall have the following properties

1. For General Service Applications, utilize ethylene propylene diene monomer (M-class) rubber (EPDM) seals per ASTM D 2000 standards. Color shall be black. Pressure plates shall be constructed of reinforced nylon polymer or composite material. Seals shall be rated for a temperature range of minus 40 to 250 degrees F. The minimum EPDM durometer hardness (Shore A) shall be 50 plus or minus 5. Areas where this type of seal shall be used include but are not limited to the following
   a. Dry process areas
   b. Below grade vaults
   c. Ultraviolet (UV) channel
   d. Effluent wet well

2. For Thin Wall Pipe Applications utilize EPDM seals per ASTM D 2000 standards. Color shall be blue. Pressure plates shall be constructed of reinforced nylon polymer or composite material. Seals shall be rated for a temperature range of minus 40 to 250 degrees F. The minimum EPDM durometer hardness (Shore A) shall be 40 plus or minus 5. Examples of thin walled pipe applications include but are not limited to the following
   a. Copper Tubing (Type CU/1)
3. For wastewater or corrosive chemical service applications where sewage gas or solvents may present, utilize EPDM seal elements per ASTM D 2000 standards. Color shall be black. Pressure plates shall be constructed of reinforced nylon polymer or composite material. Temperature rating shall be minus 40 degrees F to 250 degrees F. The minimum EPDM durometer hardness (Shore A) shall be 50 plus or minus 5. Areas where this type of seal shall be used include, but are not limited to the following:

a. Pumping station wet wells
b. Sewer manholes
c. Tanks
d. Channels (wastewater)
e. Exterior areas exposed to direct sunlight
f. Influent wet well
g. Equalization tank
h. Headworks
i. Aeration tanks
j. Sludge storage tanks
k. Membrane tanks
l. De-oxygenation zone
m. Equalization overflow structures

4. For Fire Rated or High Temperature penetration applications utilize silicone or rubber seal elements. All seals shall meet or exceed the fire rating requirements of the wall, floor or ceiling which is penetrated. Provide a double seal for all fire rated penetrations. Color shall be gray or red. All seals shall be rated for a temperature range of at least minus 67 to 400 degrees F. Pressure plates shall be constructed of corrosion resistant zinc plated steel. All fire rated seals shall be factory mutual (FM) approved for the rating of the constructed element being penetrated. Refer to the Drawings for the fire ratings of each respective area.
5. For Oil Resistant Applications utilize Nitrile (NBR/Buna-N) seal elements. Typical oil resistant applications include, but are not limited to areas with exposure to solvents, oil, and hydraulic fluid. Color shall be green. Pressure plates shall be constructed of reinforced nylon polymer or composite material. Temperature rating shall be minus 40 degrees F to 210 degrees F. The minimum durometer hardness (Shore A) shall be 50 plus or minus 5.

B. Provide mechanical seals with wall sleeves for new construction where specified or as indicated on the Drawings. Provide seals for cored openings for existing construction where pipe penetrations pass through a sound concrete wall. When a pipe penetration into a tank or other vessel is below the high-water level, provide 2 mechanical seals, 1 flush with the inside wall and 1 flush with the outside wall. Mechanical seal hardware shall be oriented towards the wall side which allows for future access. Refer to the Drawings for additional details and requirements.

C. All mechanical pipe seals shall be supplied by a single manufacturer. All pipe seals shall be a product of the following manufacturers:

1. Pipeline Seal & Insulator, Inc. - Link-Seal
2. Advance Products & Systems, Inc. - Innerlynx
3. Engineer Approved Equal

2.05 MECHANICAL PIPE SEAL PROPERTIES

A. All EPDM mechanical pipe seals shall be designed and constructed in accordance with the following minimum physical and chemical properties

1. Tensile strength: 1,450 psi per ASTM D 412
2. Elongation at break: 400 percent per ASTM D 412
3. Compression set: 15 percent after 22 hours at 150 degrees F per ASTM D 395
4. Specific gravity: 1.10 per ASTM D 297

B. All silicone mechanical pipe seals shall be designed and constructed in accordance with the following minimum physical and chemical properties

1. Tensile strength: 860 psi per ASTM D 412
2. Elongation at break: 250 percent per ASTM D 412
3. Compression set: 38 percent after 22 hours at 150 degrees F per ASTM D 395
4. Specific gravity: 1.30 per ASTM D 297
C. All Nitrile (NBR/Buna-N) mechanical pipe seals shall be designed and constructed in accordance with the following minimum physical and chemical properties:

1. Tensile strength: 1,200 psi per ASTM D 412
2. Elongation at break: 300 percent per ASTM D 412
3. Compression set: 45 percent after 22 hours at 150 degrees F per ASTM D 395
4. Specific gravity: 1.15 per ASTM D 297

2.06 SEALING OF FLAMMABLE PIPE

A. Unless otherwise indicated, all pipe sleeves which penetrate fire rated walls, floors or ceilings shall be 304L stainless steel regardless of size. In cases where small diameter flammable plastic pipes penetrate fire rated construction, provide an intumescent pipe wrap with a rating which meets or exceeds the fire resistance requirements of the area. Examples of flammable plastic pipes include but are not limited to polyvinyl chloride (PVC), unplasticized polyvinyl chloride (UPVC), acrylonitrile-butadiene-styrene (ABS), polypropylene, and polyethylene. All intumescent pipe wrap shall be water resistant as well as halogen and plasticizer free. Provide a minimum fire expansion rate of 40:1.

B. Where larger diameter flammable plastic pipes penetrate fire rated construction, provide an intumescent pipe collar with a rating which meets or exceeds the fire resistance requirements of the area. The collar shall be surface mounted for existing construction. Provide centrally cast flush fitted collars for new construction.

C. Pipe collars shall be epoxy coated steel and contain high-performance intumescent material. On exposure to heat from a fire, the pipe collars shall rapidly expand inwards to squeeze the collapsing flammable pipe until the aperture is completely sealed. For horizontal installations the collar may be surface mounted or recessed depending upon the construction installation requirements. Install a collar on 1 or both sides of walls, floors, or ceilings according to the direction of risk. Provide fire rated insulation, caulk, putty, mortar, pillows and hardware to provide a complete installation.

D. Supply fire rated sealing systems by a single manufacturer. Provide fire rated pipe collars, wraps and related appurtenances from the following manufacturers.

1. 3M Fire Protection Products
2. Hilti Corporation
3. RectorSeal Corporation - Bio Fireshield
4. Or equal
2.07 HARDWARE

A. All process pipe sleeve and seal hardware, including mechanical seal hardware shall be 316 stainless steel in accordance with ASTM F 593 and ASTM F 594 standards. The minimum hardware tensile strength shall be 60,000 psi. Provide dielectric insulation or isolation between ferrous metal surfaces and stainless steel hardware.

2.08 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

A. Install pipe sleeves, seals and wall castings of the types and configurations as indicated on the Drawings. Provide sleeves, seals and wall castings where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of Work, except as detailed on the Drawings, or as approved by the Engineer. Install all sleeves and castings accurately centered on pipe runs. Size wall sleeves so that piping and insulation (if any) will have free movement in the sleeve, including allowance for thermal expansion, but not less than 2 pipe sizes larger than the piping run.

B. Provide and install sleeves and wall castings with a length equal to thickness of the construction being penetrated. Unless otherwise specified or indicated on the Drawings, all wall sleeves and castings shall be finished flush to the wall construction being penetrated. Unless otherwise indicated, floor sleeves shall be extended a minimum of 4 inches above the finished floor in process areas. Provide temporary supports of sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves during construction.

3.02 MECHANICAL PIPE SEAL INSTALLATION

A. Center the pipe in the cored or sleeved opening. Provide temporary support for the pipe on both ends. Loosen the rear pressure plate with nut just enough so mechanical links move freely. Connect both ends of belt around the pipe. Check to be sure all bolt heads are facing the installer. Extra slack or sag is normal. Do not remove links if extra slack exists. On smaller diameter pipe, links may require stretching. Slide belt assembly into annular space. For larger size belts, start inserting the mechanical seal assembly at the 6 o’clock position and work both sides up toward the 12 o’clock position in the annular space.
B. Using a hand socket or offset wrench only, start at 12 o’clock. Do not tighten any bolt more than 4 turns at a time. Continue in a clockwise manner until links have been uniformly compressed. Approximately 2 or 3 rotations are typical. Make 2 or 3 more passes at 4 turns per bolt maximum, tightening all bolts clockwise until all sealing elements bulge around all pressure plates. If the mechanical seals include type 316 stainless steel bolts, hand wrench tighten only without use of power tools to prevent galling.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 40 61 01

INSTRUMENTATION AND CONTROLS GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide instrumentation and controls in accordance with this Section and applicable reference standards listed in Article 1.03.

2. Work by Engineer
   a. PLC Programming
   b. OIT Programming
   c. HMI Programming
   d. Integration of new SCADA system

B. Related Requirements

1. Division 26 Electrical – Specifications for electrical wiring standards and practices
2. Section 40 63 43 – Programmable Logic Controllers
3. Section 40 67 00 – Control System Equipment Panels and Racks
4. Section 40 70 00 – Instrumentation for Process Systems

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American National Standards Institute (ANSI)
2. ASTM International (ASTM)
3. FM Global (FM)
4. International Society of Automation (ISA)
   a. ISA-RP60.3 Recommended Practice
5. National Electrical Code (NEC)
6. National Electrical Manufacturers Association (NEMA)
7. National Fire Protection Association (NFPA)
   a. NFPA 70
   b. NFPA 79 Electrical Standard for Industrial Machinery
8. Occupational Safety and Health Administration (OSHA)
9. Underwriters Laboratories (UL)
   a. Standard 508A - Standard for Industrial Control Panels

B. Definitions
1. PLC – Programmable Logic Controller
2. RIO – Remote Input/Output Rack
3. OIT – Operator Interface Terminal
4. HMI – Human Machine Interface
5. RTU – Remote Terminal Unit
6. I/O – Input/Output
7. SCADA – Supervisory Control and Data Acquisition
8. Modules – devices that plug into a chassis or connect to an adjacent module and are keyed to allow installation in only one direction

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: per Division 01 General Requirements.

1. Coordinate equipment, instrument and material delivery with Project schedule. Notify Engineer if delivery schedule of equipment, instruments, or material affects Project schedule. Include documentation from equipment Supplier indicating revised delivery schedule and reason for change.
2. Coordinate delivery of equipment, instruments or materials for installation in system or control panel provided under Sections 40 63 43; 40 67 00 and 40 70 00.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product Data

1. PLC and OIT: in accordance with Section 40 63 43.

2. SCADA Computers and Software: in accordance with Section 40 70 00.

C. Shop Drawings

1. SCADA control panels: in accordance with Section 40 67 00.

D. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1. Provide operation procedures, equipment descriptions, intended modes of operation, system unit testing procedures and safety measures during operation.

2. Provide record drawings and instructions for maintenance of system equipment. Incorporate maintenance procedures and schedules, coordinate and cross-reference to detailed operational procedures provided by manufacturers.

3. Include a list of local, authorized distributor’s service departments stocking manufacturer’s parts and equipment and providing local service.

4. Instrument list or ISA data sheets, including tag numbers

5. Configuration and programming manuals for each type of PLC and each type of OIT.

6. Copies of all Shop Drawings, reports, maintenance data, and schedules, description of operation, and spare parts information.

7. Control panel section of O&M manuals shall include

   a. Record drawings of control panels updated to reflect the panels after checkout and startup.
b. Installation and operation manuals for all major control panel components, network switches, PLCs, I/O modules, and communication equipment.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Acceptance at Site

1. Check equipment, instruments and materials for damage or defects within 7 days of delivery.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 MAINTENANCE

A. Extra Materials and Spare Parts: as specified below. Make interchangeable with and of same material and workmanship as corresponding original parts.

B. Control Panel Spares: one of each type of the following.

1. Surge arrestor
2. Fuses (minimum 10 percent spares of each type)
3. 24 VDC communication power supply
4. Intrinsic safety barrier
5. Radio

C. Programmable Logic Controllers: one of each type of the following.

1. PLC power supply
2. PLC processor
3. I/O module
4. Communication module
5. Memory module
PART 2 – PRODUCTS

2.01 MATERIALS

A. Provide instruments, SCADA control panels, and materials in accordance with Division 01 General Requirements.

1. Verify availability of equipment, instruments and materials and submit an “or-equal” or substitute if production is discontinued.

2.02 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.02 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

1. Test instruments and SCADA control panels for proper termination and operation, in presence of Engineer.

2. Calibrate instruments in accordance with manufacturer’s recommended procedure.

3.03 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
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SECTION 40 63 43

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes
   1. Provide programmable logic controllers and operator interface terminals in accordance with this Section and applicable reference standards listed in Section 40 61 01.

B. Work by Engineer: as specified in Section 40 61 01.

C. Related Requirements
   1. Section 40 61 01 – Instrumentation and Controls General Requirements
   2. Section 40 67 00 – Control System Equipment Panels and Racks

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards: in accordance with Section 40 61 01.

B. Definitions: in accordance with Section 40 61 01.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: in accordance with Section 40 61 01.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Closeout and Maintenance Material Submittals: per Division 01 General Requirements.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Provide PLCs and OITs supplied from manufacturers regularly engaged in the production of such products. Provide standard products where possible.
1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

B. Acceptance at Site
   1. Check equipment, instruments, and materials for damage or defects within 7 days of delivery. Repair or replace to satisfaction of Engineer.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 MAINTENANCE

A. Extra Materials and Spare Parts: as specified in Section 40 61 01.

PART 2 – PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS

A. PLC hardware and programming software: by same manufacturer.

B. House PLCs in new or existing control panel as specified in Section 40 67 00 and Drawings. Provide 120VAC, 60 Hz, single phase power to control panel.

C. Minimum PLC input/output (I/O) requirements as indicated on Drawings. Provide additional 20 percent active spare I/O wired to terminal blocks; relay outputs, wired to interposing relays.

D. Provide PLC rack or mounting space to accommodate additional 20 percent minimum spare slots for future expansion.

E. Provide microprocessor based PLC devices with power supplies, processors, process input and output modules, communication cards and chassis, mounted in control panel.
   1. Size power supplies to accommodate analog signals, including spares, and card's entire I/O capacity.

F. Provide PLC capable of stand-alone operation in the event of SCADA network or SCADA computer failure.

G. Provide UL listed PLC system using modular, field expandable design.

H. Module design shall prohibit upside down insertion or connection of modules, and be compatible with processor type specified.
I. Operate programmable controller hardware at ambient temperature of 32-140 degrees F. Ambient temperature rating for storage: minus 40-185 degrees F.

J. Provide PLC hardware to function continuously in relative humidity range of 5-95 percent, non-condensing.

K. Provide PLC system designed and tested to operate in the high electrical noise environment of an industrial plant.

L. Module-expandable PLCs and associated modules shall meet the following acceptable level of quality:
   1. Processor:
      Allen Bradley CompactLogix 5380 L3 series, 5069-L320ER (Primary).
      Allen Bradley MicroLogix 1400 L3 series, 1766-L32BXB (Secondary)

2.02 OPERATOR INTERFACE TERMINALS

A. House OITs in new or existing control panel as specified in Section 40 67 00 and Drawings.

B. Operator interface terminal: color graphic display connecting directly to PLC communication port or a communication module, allowing viewing and changing of PLC parameters, rated NEMA 4/4X, powered by 24VDC with integrated real-time clock and battery backup.

C. The OIT shall have a minimum resolution of 1024 x 600 WSVGA graphics with 16 bit color graphics.

D. Provide OIT with 26MB internal project memory with SD memory card slot. Provide 2 GB SD memory card for each operator terminal.

E. Minimum display size shall be 10.4 inch with a display area of 8.3 inch by 6.2 inch (width by height).

F. Provide OIT with ability to display a selectable screen based on specific alarm bits.
G. Provide all communication modules and cables for OIT - PLC communications. PLC interface: Ethernet/IP.

H. Provide and coordinate communications protocol drivers to establish reliable communications between PLC and OIT.

I. Provide OIT programming & configuration cables.

J. Provide OIT with licensed copy of programming software.

K. OITs shall be C-more EA9 series 10.4-inch Color TFT Touch Panel, part number EA9-T10WCL, or approved equivalent.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION (NOT USED)

END OF SECTION
SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide all wiring, labor, tools, materials, and equipment to furnish, install, and test control panels, networking equipment, and enclosures in accordance with this Section and applicable reference standards listed in Section 40 61 01.

B. Work by Engineer: as specified in Section 40 61 01.

C. Related Requirements

1. Section 26 05 00 – Common Work Results for Electrical
2. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
3. Section 26 27 26 – Wiring Devices and Miscellaneous Electrical Equipment
4. Section 40 61 01 – Instrumentation and Controls General Requirements
5. Section 40 63 43 – Programmable Logic Controllers

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards: as specified in Section 40 61 01.

B. Definitions: in accordance with Section 40 61 01.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, Sequencing, and Scheduling: in accordance with Section 40 61 01.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements and Section 40 61 01.
B. Product Data:

1. Bill of materials (BOM) for each control panel, including panel tag name or number and component description, quantity, manufacturer name and model number for each component used in fabrication. BOM: keyed to easily correlate components shown in bill of materials with components shown on control panel equipment layout Drawings.

2. Manufacturer’s literature for each component identified on BOM. Clearly designate part number with highlights or arrows.

3. Equipment layout drawings for each control panel

4. Panel communication diagrams for each control panel

5. Power wiring diagrams for each control panel

6. Programmable logic controllers (PLC) input/output (I/O) wiring diagrams, on a module-by-module basis

C. Closeout and Maintenance Material Submittals: per Division 01 General Requirements and Section 40 61 01.

1. As-Built Drawings

a. After fabrication of control panels and factory acceptance testing is complete, panel shop shall provide drawings of control panels, representing as-built conditions. Submit panel drawings in AutoCAD DWG and Adobe PDF file formats, on DVD-R or USB drive media.

b. Submit with panels at delivery.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Qualifications: per Division 01 General Requirements and as follows.

1. Control panel fabricator/panel shop fabrication facility: UL 508A certified, in operation at least 5 years, regularly engaged in furnishing, installing, and wiring similar equipment for use in water and wastewater treatment facilities, and minimum of 3 projects of similar scope in past 5 years.

2. Surge protection: provided by manufacturer with minimum of 5 years’ experience in production of this equipment.
C. Panel Shop

1. Following control panel fabrication, apply power to each panel to ensure panels are wired correctly and devices contained within panels power up correctly. Provide written confirmation that a power up test was completed.

2. Complete point-to-point wiring checkout for wiring contained in control panels and correct any errors or omissions found. Provide written confirmation that checkout was completed.

3. Provide Engineer 5 days’ notice of completion of control panel fabrication and have control panels available in their facility for Factory Acceptance Test by Engineer or System Integrator. Control panels may not be shipped prior to execution of Factory Acceptance Test unless indicated in writing by Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements and Section 40 61 01.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 MAINTENANCE

A. Extra Materials and Spare Parts: as specified below. Make interchangeable with and of same material and workmanship as corresponding original parts.

B. Control Panel Spares: in accordance with Section 40 61 01.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Procurement of materials and manufacture of control panels shall not begin until related submittals have been reviewed and approved by the Engineer.
# CONTROL PANEL COMPONENTS

## A. Control Panel Components and Recommended Manufacturers

<table>
<thead>
<tr>
<th>Control Panel Components</th>
<th>Expected level of quality: equivalent to listed manufacturers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosures</td>
<td>Hoffman, Hammond, Saginaw</td>
<td>Suitable for use in environments where located per (NEMA, NFPA, etc.)</td>
</tr>
<tr>
<td>Programmable Logic Controllers (PLCs)</td>
<td></td>
<td>Refer to Section 40 63 43</td>
</tr>
<tr>
<td>Operator Interface Terminals (OITs)</td>
<td></td>
<td>Refer to Section 40 63 43</td>
</tr>
<tr>
<td>Wireway</td>
<td>Panduit, Hoffman</td>
<td></td>
</tr>
<tr>
<td>DIN Rail</td>
<td>Allen Bradley, Phoenix Contact</td>
<td></td>
</tr>
<tr>
<td>Terminal Blocks</td>
<td>Allen Bradley, Phoenix Contact, Entrelec</td>
<td>Utilize 2-tier terminal blocks wherever possible to conserve panel space.</td>
</tr>
<tr>
<td>Terminal Block Fuse Holders</td>
<td>Allen Bradley, Phoenix Contact, Entrelec</td>
<td>Specify fuse holders with blown fuse indicators.</td>
</tr>
<tr>
<td>Circuit Breakers</td>
<td>Square D, Allen Bradley</td>
<td></td>
</tr>
<tr>
<td>120VAC Surge Suppressors</td>
<td>Phoenix Contact, Square D</td>
<td></td>
</tr>
<tr>
<td>Analog Surge Suppressors</td>
<td>Phoenix Contact, Citel</td>
<td></td>
</tr>
<tr>
<td>Media Converters</td>
<td>N-Tron, B&amp;B Electronics, L-Com</td>
<td>Provide with DIN rail mount converters as required on the network architecture</td>
</tr>
<tr>
<td>Fuses</td>
<td>Bussman, Ferraz Shawmut</td>
<td>All glass fuses in control panels shall be fast acting style. Motor circuit protection and/or inductive load fuses shall be time delay style.</td>
</tr>
<tr>
<td>Control Panel Components</td>
<td>Expected level of quality: equivalent to listed manufacturers</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Control Relays</td>
<td>Allen Bradley, Square D, Omron</td>
<td>Include all required bases, hardware, etc.</td>
</tr>
<tr>
<td>Power Supplies</td>
<td>Sola, Phoenix Contact, Allen Bradley</td>
<td>Provide with power supplies sized as required for equipment contained within the enclosures and to supply field equipment connected to the enclosure.</td>
</tr>
<tr>
<td>Intrinsic Safety Barriers</td>
<td>Pepperl &amp; Fuchs, MTL, Phoenix Contact</td>
<td>Discrete barriers shall be 2-channel barriers. Analog barriers shall be 2-wire barriers.</td>
</tr>
<tr>
<td>Ethernet Switches (Unmanaged)</td>
<td>Refer to Section 3.01</td>
<td></td>
</tr>
<tr>
<td>Ethernet Switches (Managed)</td>
<td>Refer to Section 3.01</td>
<td></td>
</tr>
<tr>
<td>Fiber Patch Panels</td>
<td>L-Com, DIN Space, B&amp;B Electronics</td>
<td>Provide with panel mount patch panels for incoming fiber optic cables as required.</td>
</tr>
<tr>
<td>Emergency Power System</td>
<td>Sola, Phoenix Contact, Allen Bradley</td>
<td>Include uninterruptible power supply (UPS) in each control panel sized to furnish with at least 10 minutes of emergency power. UPS shall be 24VDC, DIN-rail, with remote monitoring and control module.</td>
</tr>
<tr>
<td>Panel Heaters</td>
<td>Hammond, Hoffman</td>
<td>Provide with panel heaters for outside control panels where temperature is a concern for electronic components.</td>
</tr>
<tr>
<td>Receptacles</td>
<td>Pass &amp; Seymour, Hubbel, Leviton</td>
<td>Provide with receptacle for UPS and convenience receptacle in each PLC control panel.</td>
</tr>
<tr>
<td>Pilot/Status Lights (Push to test)</td>
<td>Allen Bradley, General Electric, Square D</td>
<td>Color code as follows: Red-Fault, Green-Run</td>
</tr>
<tr>
<td>HOR, On/Off, L/R switches and push buttons</td>
<td>Allen Bradley, General Electric, Square D</td>
<td>Refer to Section 26 27 26. Furnish switches and push buttons with matching nameplate</td>
</tr>
</tbody>
</table>
2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

PART 3 – EXECUTION

3.01 CONTROL PANEL FABRICATION

A. General

1. Fabricate panel per Drawings.

2. Control panel shall include PLC, required I/O modules with chassis, if applicable, power supply, cables, and all appurtenances. Furnish panels and materials from one Supplier.

3. Provide electronic equipment utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture, and fungus. Solid-state components: rated to provide reliable performance over ambient atmosphere fluctuations between 0 – 140 degrees F and 0 – 95 percent relative humidity, non-condensing. Field mounted equipment and system components: designed for installation in dusty, humid, and slightly corrosive service conditions.

4. Equipment installed in a hazardous area shall meet Class, Group, and Division to comply with the NFPA 70.

5. Provide heavy duty equipment, cabinets, and devices designed for continuous industrial service using current production products.

6. Fabrication requirements of control panels, enclosures, consoles, and cabinets.

   a. Size enclosures to fit all required equipment, accommodate all field wires and provide adequate working space.

   b. Size control panel enclosures to provide at least 20 percent spare space for future expansion.

   c. Provide PLC hardware to accommodate minimum 20 percent spare of each I/O type used in panel, wired to terminals and interposing relays during fabrication process.

   d. Provide drawing pocket to hold as-built and service documentation.

   e. Provide control panel assemblies in compliance with UL 508A Standards.
B. Wiring

1. Interconnecting wiring: stranded and have 600-volt insulation.

2. Power distribution wiring on line side of fuses in accordance with Section 26 05 19.

3. Power and low voltage direct current (DC) wiring systems: routed in separate wireways. Crossing of power distribution wiring and control wiring: at right angles. Different system wires routed parallel to each other: separated by at least 6 inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs may not be filled to more than 60 percent visible fill.

4. All wiring shall terminate onto single-or-double tier terminal blocks, where each terminal is sequentially numbered with a unique identifier. Direct interlock wiring between equipment is not allowed. Control panel: fabricated with minimum 20 percent spare terminals. Terminal blocks: arranged in vertical rows and separated into groups; power, alternating current (AC) control, DC signal. Terminal blocks: compression screw type. Spring-clamp style terminals will not be accepted.
   a. Discrete inputs (DI) and discrete outputs (DO) shall have 2 terminals per point with adjacent terminal assignments. Active and spare points: wired to terminal blocks.
   b. Analog inputs (AI) and analog outputs (AO) shall have a minimum of 3 terminals per shielded pair. Provide 3 terminals for direct connection of powered, 4-wire loops. Provide 4 terminals for direct connection of loop powered, 2-wire loops. Provide 5 terminals for connection of analog loops incorporating a local indicator or recorder. One terminal is for shielded ground connections for cable pairs. Ground the shielded signal cable at the PLC cabinet. Wire active and spare points to terminal blocks.
   c. Wire and tube markers in accordance with Section 26 05 00.
   d. Only 1 side of a terminal block row shall be used for internal wiring. Field wiring side of terminal shall not be within 6 inches of side panel or adjacent terminal, or within 8-inches of bottom of panel.
   e. Locate terminals for field wiring to reduce amount of routing through wireway to carry wiring to termination point.

5. Provide wiring, internal to panel and field wiring, with service loop to allow for future adjustment of termination point. Service loop: no more than 4-5 inches, stored in associated wireway.
6. Identify live circuit wiring, independent of the panel's normal circuit breaker protection.

7. All wiring shall be clearly tagged and color-coded in accordance with NEC. All tag numbers and color-coding shall correspond to panel wiring diagrams prepared by Engineer. All power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. Utilize the following color coding scheme.
   a. Incoming 120 VAC Hot – Black
   b. 120 VAC Hot Wiring (control circuit wires downstream of panel circuit breaker) – Red
   c. 120 VAC Neutral – White
   d. Ground – Green with yellow stripe
   e. DC Wiring – Blue
   f. DC Common – White with blue stripe
   g. Intrinsically Safe Wiring - Light Blue
   h. Foreign Voltage – Yellow

C. Control Panel Loss of Power
   1. Each control panel containing a PLC shall have an input configured to alarm the operators upon loss of main control panel power. Display alarm on SCADA nodes to alert operators that attention is required.

D. Control Panel Overcurrent Protection
   1. Overcurrent protection devices: properly sized to protect associated devices and loads.
   2. Circuit breakers: sized to protect associated equipment and provide necessary power to operate.
   3. Fuses
      a. Glass fuses not associated with motor circuit protection or inductive loads: specified as fast-acting style. Fuses associated with motor circuit protection or inductive loads: specified as time delay style.
E. Lightning/Surge Suppression

1. Provide to protect control panel and associated equipment from surges on incoming power circuits, or those induced by lightning strikes and propagated along signal or power lines connected to control panels. Surge protection: sized properly for intended purpose.

2. 120 VAC Surge Suppression

   a. Provide incoming 120 VAC power source for control panel with surge suppression located in the control panel. Surge protection device rated at a minimum of 10 kilo amperes (kA).

   b. Provide surge suppressors with auxiliary contact, connected to PLC to indicate surge suppressor failure. If there are multiple circuits within the same control panel, provide each incoming 120 VAC power source with surge suppression.

3. Analog Signal Surge Suppression

   a. Supply analog signals connected to equipment or instrumentation located outside the building where the control panel is installed with DIN rail mounted surge suppression in control panel. Provide surge protection at both ends of signal cable and mount surge protection as close to equipment, instrument, or termination point as possible. Provide minimum of 10 kA surge current suppression.

4. Ethernet Surge Suppression

   a. Provide Ethernet cabling connected to control panel that leaves the building that houses the control panel with surge suppression in the control panel. Provide surge protection at both ends of telephone or Ethernet cabling and mount surge protection as close to termination point as possible.

F. Uninterruptible Power Supplies

1. Control panel mounted UPS shall be 24VDC and din-rail mountable. UPS shall have remote monitoring features with relay contact outputs, connected to the PLC to indicate UPS fault and UPS low battery conditions, at a minimum.

2. Size UPS to provide minimum of 10 minutes of power in event of main control power loss.

G. DC Power Supply

1. Din Rail mounted power supply shall be housed in a rugged metal case with large, accessible, multiple connection screw terminals.
2. Power supply shall be enclosed and finger safe. Open power supplies shall not be acceptable.

3. Power supply shall feature Auto selecting 115/230 VAC, 50/60 Hz single phase input, adjustable voltage, power factor correction, short circuit, overvoltage and over-temperature protection, 90% or greater efficiency, power supply shall be UL listed.

H. Unmanaged Ethernet Switches

1. Configure ethernet switches to accept number of connections shown on Drawings.

2. Provide ethernet switches with minimum of 20 percent spare RJ-45 ports available for future expansion.

3. Ethernet switch acceptable level of quality equal to: MOXA EDS208.

I. Interposing / Control Relays

1. DIN rail mounted Miniature plug-in style relays sealed, 10A resistive rating at 120VAC, double throw Form C contact outputs, UL Listed. Life expectancy shall be 50 million operations, minimum.

J. Courtesy Equipment

1. Provide in panel:
   a. External panel mounted programming port directly connected to the ethernet switch to allow external access to the PLC for programming without the need to open the panel enclosure door (Including 120VAC receptacles).
   b. Enclosure Ventilator Unit.

K. Field Powered Instruments

1. Provide for each instrument requiring 120VAC or 24VDC power with an individual fused disconnect or circuit breaker.

L. Seal Fail and Motor Temperature Relays

1. Pumps, mixers and other equipment equipped with proprietary seal fail and motor temperature relays, require relays to be mounted in the SCADA control panel. Seal fail and motor over temperature alarm contacts: connected to PLC as discrete inputs.
M. Intrinsic Safety Barrier Panels

1. Mount intrinsic safety barriers required for interfacing with equipment and instruments located in a classified area, in a panel separate from control panels.

2. Panels housing intrinsic safety barriers: laid out to facilitate separation of hazardous and non-hazardous wiring. Wireway containing hazardous area wiring: clearly indicated.

N. Equipment Mounting/Arrangement

1. Mount components in a manner that permits servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Mount components on inside of panels on removable plates, not directly to enclosure. Mounting: rigid and stable unless shock mounting is required by manufacturer to protect from vibration. Identify components with plastic or metal engraved tags attached with drive pins adjacent to each component, identifying the component in accordance with the Drawings and Specifications.

2. Install exterior panel mounted equipment with suitable gaskets, faceplates, and other measures required to maintain NEMA rating of panel.

3. Provide minimum of 1-1/2 inches between panel wireway and terminal blocks for easy access to wiring.

4. Maintain manufacturer recommended spacing around panel-mounted equipment.

5. ISA-RP60.3 Recommended Practice: used as a guide in layout and arrangement of panels and panel mounted components.

O. Nameplates

1. Furnish panels and panel devices with nameplates identifying panel and individual devices with the following.

   a. Device tag number: as shown on Drawings.

   b. Functional description

   c. Functional control description

2. Furnish 3/32-inch thick, black and white, Lamacoid nameplates with engraved inscriptions, unless escutcheon plates are specified or noted on Drawings. Letters: black against a white background. Edges of nameplates: beveled and smooth. Affix to panels using #4-40 threaded stainless steel button head hex screws.
3.02 INSTALLATION AND MOUNTING

A. Location of control panel shown on Drawings is approximate. Obtain information relevant to process control placement Work in the field. Exact location: approved by Owner or Engineer during construction. In case of interference with other Work, proceed as directed by Engineer.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING

A. Provide in accordance with Division 01 General Requirements.

B. Power up SCADA Panels upon delivery to Owner.

C. Power up control panels upon installation. Test field wiring for proper termination. Analog signals: simulated for a full scale 4-20mA test.

D. Provide testing of SCADA system with Integrator after installation of control panels and instruments, and termination of field wiring to panels is complete. Start up and testing: witnessed by Owner.

3.05 CLOSEOUT ACTIVITIES

A. Provide in accordance with Division 01 General Requirements.

END OF SECTION
SECTION 40 70 00

INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide labor, materials and equipment necessary to install and start-up instruments as specified in accordance with this Section and applicable reference standards listed in Section 40 61 01.

B. Work by Engineer: as specified in Section 40 61 01.

C. Related Requirements: as specified in Section 40 61 01.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards: in accordance with Section 40 61 01.

B. Definitions: in accordance with Section 40 61 01.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: in accordance with Section 40 61 01.

1.05 SUBMITTALS

A. Submit in accordance with Section 40 61 01.

B. Product Data and Shop Drawings

1. Instrument data sheet for each instrument

2. Product name and tag number as shown on the Drawings

3. Manufacturers complete model number

4. Location of device

5. Input - output characteristics

6. Range, size, and graduations
7. Physical size with dimensions, NEMA enclosure classification and mounting details

8. Materials of construction of components

9. Calibration certificates provided by manufacturer

C. Closeout and maintenance material submittals: in accordance with Division 01 General Requirements and Section 40 61 01.

1.06 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS

A. Existing Conditions: per Division 01 General Requirements.

1.09 MAINTENANCE

A. Provide in accordance with Section 40 61 01.

PART 2 – PRODUCTS

2.01 INSTRUMENTATION – GENERAL

A. Provide brackets and hangers for all equipment.

B. Instrumentation supplied must be the manufacturer's latest design and produce or be activated by signals that are established standards for the water and wastewater industries.

C. Instrumentation requiring power supplied from a source other than the control panel to which it is connected must operate on 120 VAC, single phase, 60 HZ current, unless specifically indicated otherwise. This power will be supplied from the closest local electrical lighting panel with a breaker for each circuit.

D. Electronic instrumentation must be solid-state. Analog control signals shall be linear and be industry standard currents of 4 to 20 mA DC, however, signals between instruments within the same panel or cabinet may be 1-5 VDC, or the like. No zero based signals are allowed.

E. Outputs of equipment that are not of the standard signals as outlined, will have the output immediately raised or converted to compatible standards signals for remote transmission. No zero-based signals are allowed.
F. Instruments shall be provided with stainless steel mounting hardware or galvanized steel floor stands, wall brackets, or instrument racks as appropriate for each location.

G. Equipment installed in a hazardous area shall meet class, group, and division as shown on the electrical Drawings, to comply with the National Electrical Code.

H. Indicators and recorder readouts must be linear in the process units.

I. Transmitters shall be provided with either integral indicators or remote-mount indicators with process units accurate to plus or minus 2 percent.

J. Electronic equipment must be the manufacturer's latest design. Circuit boards and associated components must have suitable conformal coating to prevent contamination by dust, moisture, and fungus. Solid-state components must be conservatively rated for their purpose to assure optimum long-term performance and dependability over normally anticipated atmospheric conditions of temperature, pressure, and humidity. The field-mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

K. Instruments furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and will consist of equipment models that are currently in production. All equipment provided shall be of modular construction and be capable of field expansion.

L. Lightning/Surge Suppression - Provide individual surge protection means for each field instrument mounted outside the building from the control panel to which they are connected. Instruments mounted inside the same building as the control panel to which they are connected shall not require surge protection.

M. Instruments shall be provided as indicated on the instrument index and in the Instrument Data Sheets, included as an attachment at the end of this Section. These documents include the instrument tag names, physical requirements, control requirement, and basis of design manufacturer and model number information.

2.02 INSTRUMENTS

A. Provide as specified in Instrumentation Index and Data Sheets.

2.03 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.
PART 3 – EXECUTION

3.01 INSTALLATION AND MOUNTING

A. Provide labor, tools, material, and equipment required to install instruments in the locations shown on the Drawings, in accordance with manufacturer-recommended installation and mounting practices. The location of equipment, transmitters, alarms, and similar devices shown on the Drawings are approximate only. Exact locations shall be approved by the Engineer during construction. Obtain in the field information relevant to the placing of process control Work and in case of any interference with other Work, proceed as requested by the Engineer.

B. Make necessary mechanical changes to install new instrumentation and associated equipment provided under this Contract. This Work includes fittings, fabrications, supports, guides, restraints, bolting, gaskets, and accessories.

C. The instrumentation Drawings indicate the intent of the interconnections between the individual instruments. Any exceptions should be noted and communicated to the Engineer in writing.

D. Instrument cabinets located outdoors or in unheated locations shall be provided with heating or cooling devices as necessary to maintain all instruments and/or electronics installed in those cabinets within their design temperature limits.

E. Install brackets and hangers to avoid interference with other equipment.

F. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment, but in no case shall more than 1 ground point be employed for each shield.

G. Coordinate the installation, placing and location of system components, their connections to the process equipment panels, cabinets, and devices. Ensure field wiring for power and signal circuits is done in accordance with best Industry Practice and provide for necessary system grounding to ensure a satisfactory and functioning installation.

3.02 INSPECTION AND TESTING

A. Submit detailed test, procedure, and startup instructions for each instrument.

B. Provide the services of a qualified service representative for checking the installation, making the necessary adjustments and calibrations, placing the equipment in operation, and performing the acceptance tests. The representative will be available for not less than 2 days to instruct operating personnel in the use, operation, and maintenance of the equipment during the initial operating period.
C. Test and calibrate in place the instrumentation to demonstrate that it meets the accuracy requirements for the conditions specified. Provide labor, equipment, and incidentals required for the tests, including electric power, water, instrument air, etc. required for tests. The Engineer will witness field tests and conduct field inspections. Provide the Engineer a minimum of 10 working days’ notice of the dates and times scheduled for tests. Rectify any deficiencies found and retest Work affected by such deficiencies at the Contractor’s expense. Record data from each field test will be recorded and documented in a formal field test report.

3.03 FIELD QUALITY CONTROL
A. Provide in accordance with Division 01 General Requirements.

3.04 STARTUP & COMMISSIONING
A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES
A. Provide in accordance with Division 01 General Requirements.

3.06 ATTACHMENTS
A. Instrument index and associated data sheets.

END OF SECTION
## INSTRUMENT INDEX

<table>
<thead>
<tr>
<th>Drawing Number</th>
<th>Instrument Tag</th>
<th>Data Sheet</th>
<th>Instrument Description</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>PI-0101</td>
<td>C-1</td>
<td>Sanitary Sewage Pump #1 Pressure Gauge</td>
<td></td>
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<td></td>
<td>PI-0102</td>
<td>C-1</td>
<td>Sanitary Sewage Pump #2 Pressure Gauge</td>
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<tr>
<td></td>
<td>LT-0101</td>
<td>A-1</td>
<td>Sanitary Sewage Wet Well Level Transmitter</td>
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<td></td>
<td>LSL-0101</td>
<td>A-2</td>
<td>Sanitary Sewage Wet Well Low Low Level Switch</td>
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<td>LSL-0101</td>
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<td>Sanitary Sewage Wet Well Low Level Switch</td>
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<td>LSH-0101</td>
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<td>Sanitary Sewage Wet Well High High Level Switch</td>
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<td></td>
<td>FE/FIT-0101</td>
<td>B-1</td>
<td>Sanitary Sewage Flow Meter</td>
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<tr>
<td></td>
<td>PI-0201</td>
<td>C-1</td>
<td>Stormwater Pump #1 Pressure Gauge</td>
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<td>Stormwater Flow Meter</td>
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<tr>
<td></td>
<td>CO-301</td>
<td>D-1</td>
<td>Pump Station Building Carbon Monoxide Detector</td>
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<td></td>
<td>TT-301</td>
<td>E-1</td>
<td>Pump Station Building Temperature Transmitter</td>
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<tr>
<td></td>
<td>PT-0301</td>
<td>F-1</td>
<td>Municipal Water Pressure Transmitter</td>
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</tbody>
</table>

The Strand Pump Station Improvements
City of Quincy, MA

Issue Date: April 2020

INSTRUMENTATION FOR PROCESS SYSTEMS
WOODARD & CURRAN

40 70 00-7
## Submersible Level Transducers – Instrument Data Sheet A-1

### General

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Type</td>
<td>Cage Style</td>
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<tr>
<td>Mounting</td>
<td>Immersion</td>
</tr>
<tr>
<td>Span Range Min/Max</td>
<td>0-23 ft</td>
</tr>
<tr>
<td>Press/Temp Rating</td>
<td>3x FSPR / 0 - 140°F</td>
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<tr>
<td>Accuracy</td>
<td>0.5% Full scale</td>
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<td>Area Classification</td>
<td>C1/D1, XP</td>
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<td>Sealed/Vent Tube</td>
<td>Vent Tube</td>
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<tr>
<td>Process (0% / 100%)</td>
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<tr>
<td>Output (4mA/20mA)</td>
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<tr>
<td>Proc Fluid / State</td>
<td>Sanitary Wastewater / Liquid</td>
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<td>Viscosity</td>
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<tr>
<td>Tank Material</td>
<td>Concrete</td>
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### Calibration

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<tr>
<td>Level (Min/Oper/Max)</td>
<td>0 6 23 ft</td>
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<tr>
<td>Pressure (Min/Oper/Max)</td>
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<td>Temperature (Min/Oper/Max)</td>
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### Process Data

<table>
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<tbody>
<tr>
<td>Tank No.</td>
<td>Ind. Scale/Range: N/A Option-1: Aneroid Bellows Option-2: Terminal box</td>
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### Acceptable Level of Quality Equal to

Manufacturer: KPSI 750 Series

### Comment

1. Provide strain relief for cable & provide weight & chain assembly as shown on the Drawings
2. Cable length to be verified in the field prior to ordering.

### Notes

- 0229766.05 – CWSRF #4508
- The Strand Pump Station Improvements
- City of Quincy, MA
- INSTRUMENTATION FOR PROCESS SYSTEMS
- WOODARD & CURRAN
- 40 70 00-8
**SUBMERSIBLE LEVEL TRANSDUCERS – INSTRUMENT DATA SHEET A-1**

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<td>0229766.05</td>
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<tr>
<td>REV</td>
<td>REVISION DESCRIPTION</td>
</tr>
<tr>
<td>0</td>
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**SERVICE:** Stormwater Wet Well Level

**GENERAL**

- **Type:** Cage Style
- **Body Material:** 316SS
- **Mounting:** Immersion
- **Diaphragm Material:** 316SS
- **Span Range Min/Max:** 0-23 ft
- **Diaphragm Material:** Polyurethane
- **Accuracy:** 0.5% Full scale
- **Diaphragm Material:** Polyurethane
- **Cable Jacket Material:** Polyurethane
- **Cable Length:** 40', see note 2
- **Press/Temp Rating:** 3x FSPR / 0 - 140°F
- **Power Supply:** 24VDC, loop-powered
- **Area Classification:** C1/D1, XP
- **Transmitter/Local Ind.:** N/A
- **Sealed/Vent Tube:** Vent Tube
- **Stilling Well:** N/A

**CALIBRATION**

- **Process (0% / 100%):** 0-23 ft
- **Output (4mA/20mA):** 0-23 ft

**PROCESS DATA**

- **Proc Fluid / State:** Sanitary Wastewater / Liquid
- **Specific Gravity:** Water-like
- **Density:** Water-like
- **Conductivity:** Water-like
- **Viscosity:** Water-like
- **Tank Material:** Concrete
- **Tank No.:** N/A
- **Level (Min/Oper/Max):** 0 / 6 / 23 ft
- **Pressure (Min/Oper/Max):** Amb
- **Temperature (Min/Oper/Max):** 40 / 72 / 120 °F

**ACCESSORIES**

- **Ind. Scale/Range:** N/A
- **Device Tag:** SS, engraved
- **Option-1:** Aneroid Bellows
- **Option-2:** Terminal box

**ACCEPTABLE LEVEL OF QUALITY EQUAL TO:**

- **Manufacturer:** KPSI 750 Series

**COMMENT**

1. Provide strain relief for cable & provide weight & chain assembly as shown on the Drawings
2. Cable length to be verified in the field prior to ordering.

**NOTES**
# Mechanical Tilt Float Switches – Instrument Data Sheet A-2

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<tr>
<td></td>
<td></td>
<td>BY</td>
<td>PS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DATE</td>
<td>April 2020</td>
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**SERVICE:** Sanitary Sewage Wet Well Low Low Level

**GENERAL**
- **Type:** Mechanical Tilt
- **Mounting Style:** Tether
- **Area Classification:** C1/D1, XP
- **Float/Disp. Material:** Polypropylene / ABS / EPDM
- **Float/Displacer Size:** 3.5" X 5"
- **Press/Temp Rating:** 32 - 170°F
- **Contact Type:** SPDT
- **Rating:** 10A @ 120VAC
- **Cable Length:** 40 feet, see note 2
- **Cable Jacket Mat'l:** Polyethylene / Neoprene / PVC

**CALIBRATION**
1st Switch Level: 
2nd Switch Level: 

**PROCESS DATA**
- **Proc Fluid / State:** Sodium Hypochlorite
- **Specific Gravity:** Water-like
- **Percent Solids:** Water-like
- **Conductivity:** Water-like
- **Di-Electric Const.:** Water-like
- **Viscosity:** Water-like
- **Tank Material.:** Plastic
- **Tank No.:** T-XX
- **Press/Temp Rating:** 32 - 170°F
- **Pressure (Min/Oper/Max):** Amb
- **Temperature (Min/Oper/Max):** 40, 72, 120
- **Pressure Units:** psig
- **Temperature Units:** °F

**ACCESSORIES**
- **Tether/Weight:** Yes, See note 1
- **Loc. Indicators/Style:** N/A
- **Instrument Tag:** SS-engraved
- **Option-1:** N/A
- **Option-2:** N/A
- **Option-3:** N/A

**NOTES**
1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
2. Confirm cable length required prior to ordering.
## MECHANICAL TILT FLOAT SWITCHES – INSTRUMENT DATA SHEET A-2

**TAG NO:** LSL-0101  
**PAGE:** 2 of 8  
**P&ID #:** -  
**PRINTED:** 3/31/2020  
**SPEC. NO:** 40 70 00

### PROJECT NUMBER: 0229766.05

### DESCRIPTION: Quincy The Strand Pump Station Improvements

### SERVICE: Sanitary Sewage Wet Well Low Level

### GENERAL

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<td>Float/Disp. Material</td>
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<tr>
<td>Float/Displacer Size</td>
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<td>Contact Type</td>
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<td>Contact Rating</td>
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<tr>
<td>Cable Length</td>
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<tr>
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### CALIBRATION

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### PROCESS DATA

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<td>Tank Agitated</td>
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### ACCESSORIES

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<td>Instrument Tag</td>
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### ACCEPTABLE LEVEL OF QUALITY EQUAL TO:

| Manufacturer | Conery B8 Series |

### COMMENTS

1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
2. Confirm cable length required prior to ordering.

### NOTES

**INSTRUMENTATION FOR PROCESS SYSTEMS**

WOODARD & CURRAN

40 70 00-11
# MECHANICAL TILT FLOAT SWITCHES – INSTRUMENT DATA SHEET A-2

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| PROJECT NUMBER: | 0229766.05 |
| DESCRIPTON:     | Quincy The Strand Pump Station Improvements |

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<td>April 2020</td>
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| SERVICE: | Sanitary Sewage Wet Well High Level |

## GENERAL

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<th>Type:</th>
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<td>Float/Displacer Size:</td>
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<tr>
<td>Press/Temp Rating:</td>
<td>32 - 170°F</td>
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<tr>
<td>Contact Type:</td>
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</tr>
<tr>
<td>Contact Rating:</td>
<td>10A @ 120VAC</td>
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<tr>
<td>Cable Length:</td>
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<tr>
<td>Cable Jacket Mat'l:</td>
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## CALIBRATION

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<td>Viscosity:</td>
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<td>Tank Material.:</td>
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<td>Tank No.:</td>
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<td>Tank Agitated:</td>
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## ACCESSORIES

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<th>Tether/Weight:</th>
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<td>Option-2:</td>
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## ACCEPTABLE LEVEL OF QUALITY EQUAL TO:

| Manufacturer: | Conery B8 Series |

## COMMENTS

1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
2. Confirm cable length required prior to ordering.

## NOTES

- 1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
- 2. Confirm cable length required prior to ordering.
# Mechanical Tilt Float Switches – Instrument Data Sheet A-2

**MECHANICAL TILT FLO T SWITCHES**

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**PROJECT NUMBER:** 0229766.05  
**DESCRIPTION:** Quincy The Strand Pump Station Improvements  
**REV**  
**REVISION DESCRIPTION**  
**DATE**  
**SERVICE:** Sanitary Sewage Wet Well High High Level  
**REV**  
**REVISION DESCRIPTION**  
**DATE**  
**DESCRIPTION:** Quincy The Strand Pump Station Improvements  
**SERVICE:** Sanitary Sewage Wet Well High High Level  
**REV**  
**REVISION DESCRIPTION**  
**DATE**

## General

<table>
<thead>
<tr>
<th>Type:</th>
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<td>Mounting Style:</td>
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<td>Float/Disp. Material:</td>
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<tr>
<td>Float/Displacer Size:</td>
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<td>Press/Temp Rating:</td>
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<tr>
<td>Contact Type:</td>
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<tr>
<td>Contact Rating:</td>
<td>10A @ 120VAC</td>
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<tr>
<td>Cable Length:</td>
<td>40 feet, see note 2</td>
</tr>
<tr>
<td>Cable Jacket Mat'l:</td>
<td>Polyethylene / Neoprene / PVC</td>
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## Calibration

1st Switch Level:  

2nd Switch Level:  

## Process Data

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<td>Tank Agitated:</td>
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<td>Level (Min/Oper/Max):</td>
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## Accessories

| Tether/Weight:     | Yes, See note 1 |
| Loc. Indicators/Style: | N/A       |
| Instrument Tag:    | SS-engraved   |
| Option-1:          | N/A           |
| Option-2:          | N/A           |
| Option-3:          | N/A           |

## Acceptable Level of Quality Equal To:

Manufacturer: Conery B8 Series

## Comments

1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.  
2. Confirm cable length required prior to ordering.

## Notes

40 70 00-13

**Woodard & Curran**
<table>
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<tr>
<td>DESCRIPTION:</td>
<td>Quincy The Strand Pump Station Improvements</td>
</tr>
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</table>

**SERVICE:** Stormwater Wet Well Low Low Level

### General
- **Type:** Mechanical Tilt
- **Tilt Angle:** Wide
- **Mounting Style:** Tether
- **Area Classification:** C1/D1, XP
- **Float/Disp. Material:** Polypropylene / ABS / EPDM
- **Float/Displacer Size:** 3.5” X 5”
- **Press/Temp Rating:** 32 - 170°F

### Calibration
- **1st Switch Level:**
- **2nd Switch Level:**

### Process Data
- **Proc Fluid / State:** Sodium Hypochlorite
- **Specific Gravity:** Water-like
- **Percent Solids:** Water-like
- **Conductivity:** Water-like
- **Di-Electric Const.:** Water-like
- **Viscosity:** Water-like
- **Tank Material.:** Plastic
- **Tank No.:** T-XX
- **Tank Agitated:** No

### Process Data
- **Pressure (Min/Oper/Max):** Amb
- **Temperature (Min/Oper/Max):** 40 72 120
- **Temperature Units:** °F

### Accessories
- **Tether/Weight:** Yes, See note 1
- **Loc. Indicators/Style:** N/A
- **Instrument Tag:** SS-engraved
- **Option-1:** N/A
- **Option-2:** N/A
- **Option-3:** N/A

### Acceptable Level of Quality Equal To:
- **Manufacturer:** Conery B8 Series

### Comments

1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
2. Confirm cable length required prior to ordering.

### Notes
# Mechanical Tilt Float Switches – Instrument Data Sheet A-2

## General

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<td>Contact Type</td>
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<td>Area Classification</td>
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<tr>
<td>Contact Rating</td>
<td>10A @ 120VAC</td>
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<tr>
<td>Float/Disp. Material</td>
<td>Polypropylene / ABS / EPDM</td>
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<td>Cable Length</td>
<td>40 feet, see note 2</td>
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<tr>
<td>Float/Displacer Size</td>
<td>3.5” x 5”</td>
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<tr>
<td>Cable Jacket Mat’l</td>
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<td>Press/Temp Rating</td>
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<td>Stilling Well</td>
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## Calibration

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<tr>
<td>Percent Solids</td>
<td>Water-like</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Water-like</td>
</tr>
<tr>
<td>Di-Electric Const.</td>
<td>Water-like</td>
</tr>
<tr>
<td>Viscosity</td>
<td>Water-like</td>
</tr>
<tr>
<td>Tank Material</td>
<td>Plastic</td>
</tr>
<tr>
<td>Tank No.</td>
<td>T-XX</td>
</tr>
<tr>
<td>Tank Agitated</td>
<td>No</td>
</tr>
<tr>
<td>Level (Min/Oper/Max):</td>
<td></td>
</tr>
<tr>
<td>Level Units</td>
<td>ft</td>
</tr>
<tr>
<td>Pressure (Min/Oper/Max):</td>
<td></td>
</tr>
<tr>
<td>Pressure Units</td>
<td>Amb</td>
</tr>
<tr>
<td>Temperature (Min/Oper/Max):</td>
<td></td>
</tr>
<tr>
<td>Temperature Units</td>
<td>°F</td>
</tr>
<tr>
<td>Viscosity (Max)</td>
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</table>

## Accessories

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tether/Weight</td>
<td>Yes, See note 1</td>
</tr>
<tr>
<td>Loc. Indicators/Style</td>
<td>N/A</td>
</tr>
<tr>
<td>Instrument Tag</td>
<td>SS-engraved</td>
</tr>
<tr>
<td>Option-1</td>
<td>N/A</td>
</tr>
<tr>
<td>Option-2</td>
<td>N/A</td>
</tr>
<tr>
<td>Option-3</td>
<td>N/A</td>
</tr>
</tbody>
</table>

## Acceptable Level of Quality Equal To:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Conery B8 Series</td>
</tr>
</tbody>
</table>

## Comments

1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
2. Confirm cable length required prior to ordering.

## Notes

- Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
- Confirm cable length required prior to ordering.
### MECHANICAL TILT FLOAT SWITCHES - INSTRUMENT DATA SHEET A-2

**TAG NO:** LSH-0201  
**P&ID #:** -  
**SPEC. NO:** 40 70 00  
**REV:** 0  
**REVISION DESCRIPTION:** Issue For Bid  
**BY:** PS  
**DATE:** April 2020

**PROJECT NUMBER:** 0229766.05  
**DESCRIPTION:** Quincy The Strand Pump Station Improvements

**SERVICE:** Stormwater Wet Well High Level

<table>
<thead>
<tr>
<th>GENERAL</th>
</tr>
</thead>
</table>
| Type: | Mechanical Tilt  
| Mounting Style: | Tether  
| Area Classification: | C1/D1, XP  
| Float/Disp. Material: | Polypropylene / ABS / EPDM  
| Float/Displacer Size: | 3.5" X 5"  
| Press/Temp Rating: | 32 - 170°F  
| Tilt Angle: | Wide  
| Contact Type: | SPDT  
| Contact Rating: | 10A @ 120VAC  
| Cable Length: | 40 feet, see note 2  
| Cable Jacket Mat'l: | Polyethylene / Neoprene / PVC  
| Float/Disp. Material: | Polypropylene / ABS / EPDM  
| Float/Displacer Size: | 3.5" X 5"  
| Press/Temp Rating: | 32 - 170°F  
| Stilling Well: | None

**CALIBRATION**

1. **1st Switch Level:**  
2. **2nd Switch Level:**

<table>
<thead>
<tr>
<th>PROCESS DATA</th>
</tr>
</thead>
</table>
| Proc Fluid / State: | Sodium Hypochlorite  
| Specific Gravity: | Water-like  
| Percent Solids: | Water-like  
| Conductivity: | Water-like  
| Di-Electric Const.: | Water-like  
| Viscosity: | Water-like  
| Tank Material.: | Plastic  
| Tank No.: | T-XX  
| Tank Agitated: | No  
| Level (Min/Oper/Max): | ft  
| Level Units: | Amb  
| Pressure (Min/Oper/Max): | psig  
| Temperature (Min/Oper/Max): | 40 72 120  
| Temperature Units: | °F

**ACCESSORIES**

| Tether/Weight: | Yes, See note 1  
| Loc. Indicators/Style: | N/A  
| Instrument Tag: | SS-engraved  
| Option-1: | N/A  
| Option-2: | N/A  
| Option-3: | N/A

**ACCEPTABLE LEVEL OF QUALITY EQUAL TO:**

Manufacturer: Conery B8 Series

**NOTES**

1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.  
2. Confirm cable length required prior to ordering.
| TAG NO: | LSHH-0201 | PAGE: | 8 of 8 |
| P&ID #: | - | PRINTED: | 3/31/2020 |

**MECHANICAL TILT FLOAT SWITCHES**

**DESCRIPTION:**
Quincy The Strand Pump Station Improvements

**SERVICE:**
Stormwater Wet Well High Level

### GENERAL

| Type: | Mechanical Tilt |
| Mounting Style: | Tether |
| Area Classification: | C1/D1, XP |
| Float/Disp. Material: | Polypropylene / ABS / EPDM |
| Float/Displacer Size: | 3.5" X 5" |
| Press/Temp Rating: | 32 - 170°F |

**Tilt Angle:** Wide

**Contact Type:** SPDT

**Contact Rating:** 10A @ 120VAC

**Cable Length:** 40 feet, see note 2

**Cable Jacket Mat'l:** Polyethylene / Neoprene / PVC

**Press/Temp Rating:**

| Proc Fluid / State: | Sodium Hypochlorite |
| Specific Gravity: | Water-like |
| Percent Solids: | Water-like |
| Conductivity: | Water-like |
| Di-Electric Const.: | Water-like |
| Viscosity: | Water-like |

**Level (Min/Oper/Max):**

| Level Units: | ft |
| Pressure (Min/Oper/Max): | Amb |
| Pressure Units: | psig |
| Temperature (Min/Oper/Max): | 40 72 120 |
| Temperature Units: | °F |

**Tank Material:** Plastic

**Tank No.:** T-XX

**Tank Agitated:** No

### ACCESSORIES

| Tether/Weight: | Yes, See note 1 |
| Loc. Indicators/Style: | N/A |
| Instrument Tag: | SS-engraved |

**Option-1:** N/A

**Option-2:** N/A

**Option-3:** N/A

### ACCEPTABLE LEVEL OF QUALITY EQUAL TO:

Manufacturer: Conery B8 Series

### COMMENTS

1. Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.

2. Confirm cable length required prior to ordering.

### NOTES

- Provide chain and weight mounting equipment for floats; confirm length of chain necessary prior to ordering.
- Confirm cable length required prior to ordering.
**MAGNETIC FLOWMETERS – INSTRUMENT DATA SHEET B-1**

<table>
<thead>
<tr>
<th>TAG NO:</th>
<th>FIT/FE-0101</th>
<th>PAGE: 1 of 2</th>
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<tbody>
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<td>SPEC. NO:</td>
<td>40 70 00</td>
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<table>
<thead>
<tr>
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<th>0229766.05</th>
<th>REV</th>
<th>REVISION DESCRIPTION</th>
<th>BY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>Quincy The Strand Pump Station Improvements</td>
<td>0</td>
<td>Issue For Bid</td>
<td>PS</td>
<td>April 2020</td>
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</tbody>
</table>

**SERVICE:** Sanitary Sewage Flow

**FLOWTUBE**
- **Meter Size:** 6-Inch
- **Electrode Material:** 316 SS
- **Flow Range:** 0 – 5,000 GPM
- **Ground Type:** Electrode/Grounding Ring
- **End Connections:** 150# RF Flanges
- **Ground Material:** 316 SS
- **Tube Material:** CS
- **Line Size:** 6-Inch
- **Liner Material:** PTFE / Hard Rubber
- **Electrode Type:** Standard
- **Enclosure Rating:** IP 68 – C1/D2, XP (See Note 2)

**TRANSMITTER**
- **Mounting:** Remote-Interior Wall Mount
- **Enclosure Material:** ABS / Aluminum
- **Cable Length:** See Note 1
- **Enclosure Rating:** NEMA 4X, Unclassified
- **Power Supply:** 120VAC
- **Accuracy:** 0.5%
- **Local Indicator/Style:** LCD
- **Alarm Relays/Rating:** 4-20mA HART
- **Totalizer:** Active Pulse, 24VDC

**CALIBRATION**
- **Process (0% / 100%):** 0 – 1000 GPM
- **Pulse Output / Value:** 1000 gals / pulse
- **Output (4mA / 20mA):** 0 – 1000 GPM

**PROCESS DATA**
- **Proc Fluid / State:** Sanitary Wastewater / Liquid
- **Flow (Min/Oper/Max):** 500, 750, 1000 gpm
- **Specific Gravity:** Water-like
- **Flow Units:**
- **Percent Solids:**
- **Pressure (Min/Oper/Max):** 0, 32 psig
- **Conductivity:** Water-like
- **Pressure Units:**
- **Viscosity:** Water-like
- **Temperature (Min/Oper/Max):** 40, 72, 100 °F
- **Line Size / Sched.:** 6” / Ductile Iron
- **Line No.:**

**ACCESSORIES**
- **Empty Tube Detection:** Yes
- **Option-1:** N/A
- **Instrument Tag:** SS-engraved
- **Option-2:** N/A
- **Calibration Standard:** Standard
- **Option-3:** N/A

**ACCEPTABLE LEVEL OF QUALITY EQUAL TO:**
- **Manufacturer:** Endress & Hauser W 400 Series

**NOTES**
1. Cable length to be verified in the field prior to ordering. Provide extra length of vendor cable to suit distance between tube and transmitter.
2. Provide Flow Tube with Continuous Immersion Service Rating – IP68 or equal. Provide necessary potting kits to achieve a submersion rating.
### MAGNETIC FLOWMETERS – INSTRUMENT DATA SHEET B-1

<table>
<thead>
<tr>
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<th>FIT/FE-0201</th>
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<td>Quincy The Strand Pump Station Improvements</td>
<td>REVISION DESCRIPTION</td>
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<tr>
<td>SERVICE:</td>
<td>Stormwater Flow</td>
<td>BY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DATE</td>
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<tr>
<td>FLOWTUBE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meter Size:</td>
<td>12-Inch</td>
<td>Electric Material:</td>
</tr>
<tr>
<td>Flow Range:</td>
<td>0 – 5,000 GPM</td>
<td>Ground Type:</td>
</tr>
<tr>
<td>End Connections:</td>
<td>150# RF Flanges</td>
<td>Ground Material:</td>
</tr>
<tr>
<td>Tube Material:</td>
<td>CS</td>
<td>Line Size:</td>
</tr>
<tr>
<td>Liner Material:</td>
<td>PTFE / Hard Rubber</td>
<td>Line Material:</td>
</tr>
<tr>
<td>Electrode Type:</td>
<td>Standard</td>
<td>Enclosure Rating:</td>
</tr>
<tr>
<td>TRANSMITTER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting:</td>
<td>Remote-Interior Wall Mount</td>
<td>Enclosure Material:</td>
</tr>
<tr>
<td>Cable Length:</td>
<td>See Note 1</td>
<td>Enclosure Rating:</td>
</tr>
<tr>
<td>Power Supply:</td>
<td>120VAC</td>
<td>Accuracy:</td>
</tr>
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<td>Local Indicator/Style:</td>
<td>LCD</td>
<td>Alarm Relays/Rating:</td>
</tr>
<tr>
<td>Totalizer:</td>
<td>Active Pulse, 24VDC</td>
<td>Comm. Protocol:</td>
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<tr>
<td>CALIBRATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process (0% / 100%):</td>
<td>0 – 1000 GPM</td>
<td>Pulse Output / Value:</td>
</tr>
<tr>
<td>Output (4mA / 20mA):</td>
<td>0 – 1000 GPM</td>
<td></td>
</tr>
<tr>
<td>PROCESSED DATA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proc Fluid / State:</td>
<td>Sanitary Wastewater / Liquid</td>
<td>Flow (Min/Oper/Max):</td>
</tr>
<tr>
<td>Specific Gravity:</td>
<td>Water-like</td>
<td>Pressure (Min/Oper/Max):</td>
</tr>
<tr>
<td>Percent Solids:</td>
<td></td>
<td>Temperature (Min/Oper/Max):</td>
</tr>
<tr>
<td>Conductivity:</td>
<td>Water-like</td>
<td>Temperature Units:</td>
</tr>
<tr>
<td>Viscosity:</td>
<td>Water-like</td>
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<tr>
<td>Line Size / Sched.:</td>
<td>12&quot; / Ductile Iron</td>
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</tr>
<tr>
<td>Line No.:</td>
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<td></td>
</tr>
<tr>
<td>ACCESSORIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Empty Tube Detection:</td>
<td>Yes</td>
<td>Option-1:</td>
</tr>
<tr>
<td>Instrument Tag:</td>
<td>SS-engraved</td>
<td>Option-2:</td>
</tr>
<tr>
<td>Calibration Standard:</td>
<td>Standard</td>
<td>Option-3:</td>
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<tr>
<td>ACCEPTABLE LEVEL OF QUALITY EQUAL TO:</td>
<td>Manufacturer:</td>
<td>Endress &amp; Hauser W 400 Series</td>
</tr>
<tr>
<td>NOTES</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Cable length to be verified in the field prior to ordering. Provide extra length of vendor cable to suit distance between tube and transmitter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Provide Flow Tube with Continuous Immersion Service Rating – IP68 or equal. Provide necessary potting kits to achieve a submersion rating.</td>
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</table>
# PRESSURE GAUGES – INSTRUMENT DATA SHEET C-1

<table>
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<tr>
<th>PRESSURE GAUGES</th>
<th>TAG NO: See Note 1</th>
<th>PAGE: 1 of 1</th>
<th>PRINTED: 3/31/2020</th>
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<tbody>
<tr>
<td>PROJECT NUMBER:</td>
<td>0229766.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DESCRIPTION:</td>
<td>Quincy The Strand Pump Station Improvements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVICE:</td>
<td>Pump Discharge Pressure (Various)</td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>ACCEPTABLE LEVEL OF QUALITY EQUAL TO:</th>
<th>Manufacturer: Ashcroft</th>
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<tbody>
<tr>
<td></td>
<td>Model Number: 1279 DURAGAUGE</td>
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## GENERAL

<table>
<thead>
<tr>
<th>Type:</th>
<th>Pressure</th>
</tr>
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<tbody>
<tr>
<td>Gauge Size:</td>
<td>4.5&quot;</td>
</tr>
<tr>
<td>color Face/Letter:</td>
<td>White/Black</td>
</tr>
<tr>
<td>Case Material:</td>
<td>Black Phenolic</td>
</tr>
<tr>
<td>Ring Material:</td>
<td>304 SS</td>
</tr>
<tr>
<td>Lens Material:</td>
<td>Glass</td>
</tr>
<tr>
<td>Blow Out Protect.:</td>
<td>N/A</td>
</tr>
<tr>
<td>Element Type:</td>
<td>Bourdon Tube</td>
</tr>
<tr>
<td>Element Material:</td>
<td>316L SS</td>
</tr>
</tbody>
</table>

| Socket Material:       | 316L SS  |
| Movement Material:     | 400 SS   |
| Conn. Size / Loc:      | 1/2" NPT/Lower |
| Gauge Range:           | 0-60 PSI |
| Accuracy:              | 1% Full Scale |
| Liquid Filled Gauge:   | Yes      |
| Liquid Fill Material:  | Glycerin |
| Throttle Screw:        | N/A      |
| Overload Stop:         | Yes      |

## DIAPHRAGM SEAL

| Diaphragm Seal (Yes/No): | Yes |
| Diaphragm Seal Type:     | Threaded |
| Diaphragm Material:      | 304 SS |
| Diaphragm Seal Fill:     | Glycerin |
| Diaphragm Proc. Conn.:   | 1/2" NPT |
| Housing Mat-Wet:         | 304 SS |
| Housing Mat-Non Wet:     | 304 SS |

## PROCESS DATA

| Proc Fluid / State:     | WasteWater/ Liquid |
| Specific Gravity:       |                     |
| Percent Solids:         |                     |
| Conductivity:           |                     |
| Viscosity:              |                     |
| Line Size / Sched.:     | Various             |
| Line No.:               |                     |
| Flow (Min/Oper/Max):    |                     |
| Flow Units:             | GPM                  |
| Pressure (Min/Oper/Max):| 0 30 psi             |
| Pressure Units:         |                     |
| Temperature (Min/Oper/Max):|             |
| Temperature Units:      |                     |
| Remote Capillary (Yes/No): | N/A            |
| Capillary Material:     | N/A                 |
| Capillary Length:       | N/A                 |

## NOTES

1. PI-0101, PI-0102, PI-0201, PI-0202
2. 
3. 
4. 
5.
## CARBON MONOXIDE DETECTOR – INSTRUMENT DATA SHEET D-1

### General Information
- **Tag No:** CO-301
- **Page:** 1 of 1
- **Printed:** 3/31/2020

### Project Information
- **Project Number:** 0229766.05
- **Description:** Quincy The Strand Pump Station Improvements
- **Revision:** 0
- **Revision Description:** Issue For Bid
- **By:** JR
- **Date:** April 2020

### Service
- **Service:** Carbon Monoxide Detector

### Device
- **Mounting:** Wall/Ceiling Mount
- **Current:** 0.05A
- **Power Supply:** 120VAC (w/ 9VDC back-up)
- **Case Material:** ABS
- **Module Type:** Closed Loop
- **Alarm Type:** 85dBA @ 10ft
- **Contact Type:** Normally Open Dry Contacts

### Accessories
- **Instrument Tag:** Yes
- **Option:** N/A
- **Calibration Standard:** N/A
- **Option:** N/A

### Acceptable Level of Quality Equal To
- **Manufacturer:** Gentex Model CO-1209

### Notes
1. Use mounting bracket and hardware provided with unit.
2. Use Duracell® MN 1604 9VDC alkaline battery for DC back-up power.
3. Perform self-test after installation to verify operation.
## TEMPERATURE TRANSMITTER – INSTRUMENT DATA SHEET E-1

<table>
<thead>
<tr>
<th>TEMPERATURE TRANSMITTER/SENSOR</th>
<th>P&amp;ID #:</th>
<th>TT-0301</th>
<th>P&amp;ID #:</th>
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</table>

### PROJECT NUMBER: 0229766.05

**DESCRIPTION:** Quincy The Strand Pump Station Improvements

**SERVICE:** Pump Station/Electrical Room Temperature

**Acceptable Level of Quality Equal To:** Manufacturer: DEVAR  
Model Number: RTTI

### TRANSMITTER

<table>
<thead>
<tr>
<th>Type:</th>
<th>RTD Transmitter</th>
</tr>
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<tr>
<td>Zero/Span (Non-Inter):</td>
<td>+0.02%/Span/ °F</td>
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<tr>
<td>Output Signal:</td>
<td>4 to 20mA</td>
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<tr>
<td>Power Supply:</td>
<td>13 to 40VDC</td>
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<tr>
<td>Element Burnout:</td>
<td>N/A</td>
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<tr>
<td>Input/Output Isolat’n:</td>
<td>N/A</td>
</tr>
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</table>

**Area Classification:** Unclassified

**Enclosure Class:** Unclassified

**Meter Span (Max/Min):** N/A

**Zero (Max/Min):** N/A

**Impedance Limitation:** N/A

**Accuracy:** +0.5 °F plus +0.2 of span

### CALIBRATION

**Input (0 / 100%):** -40 to 167 °F

**Output (0 / 100%):** -40 to 167 °F

**Process (0 / 100%):** -40 to 167 °F

### SENSOR

<table>
<thead>
<tr>
<th>Type:</th>
<th>100 Ohm Platinum</th>
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<tbody>
<tr>
<td>Temp Curve/Type:</td>
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</tr>
<tr>
<td>Sheath Length/Mat'l:</td>
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<tr>
<td>Insulation:</td>
<td>ABS Plastic</td>
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**Leads Configuration:** N/A

**Number of Elements:** N/A

**Leads Size/Color:** N/A

**Spring Loaded:** N/A

### THERMOWELL

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<tr>
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<tr>
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<tr>
<td>Bore:</td>
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**Process Fluid / State:** Air / Gas

**Flow (Min/Oper/Max):** N/A

**Flow Units:** gpm

**Pressure (Min/Oper/Max):** N/A

**Pressure Units:** psig

**Temperature (Min/Oper/Max):** Amb.

**Temperature Units:** °F

### PROCESS DATA

<table>
<thead>
<tr>
<th>Specific Gravity:</th>
<th>Gas Like</th>
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<tbody>
<tr>
<td>Percent Solids:</td>
<td>Gas Like</td>
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<tr>
<td>Conductivity:</td>
<td>Gas Like</td>
</tr>
<tr>
<td>Viscosity:</td>
<td>Gas Like</td>
</tr>
<tr>
<td>Line Size / Sched.:</td>
<td>Gas Like</td>
</tr>
</tbody>
</table>

### OPTIONS

**RTD/Thermowell:** N/A

**Indicator:** 3.5” LED Display

**Vent & Drain:** N/A

### NOTES

1.

2.
## WATER PRESSURE TRANSDUCER – INSTRUMENT DATA SHEET F-1

<table>
<thead>
<tr>
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<th>PT-0301</th>
<th>PAGE:</th>
<th>1 of 1</th>
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<td>PRINTED:</td>
<td>3/31/2020</td>
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<tr>
<td>SPEC. NO:</td>
<td>40 70 00</td>
<td></td>
<td></td>
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</tbody>
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### PROJECT NUMBER:
0229766.05

### DESCRIPTION:
Quincy The Strand Pump Station Improvements

### PROJECT NUMBER:
0229766.05

### DESCRIPTION:
Issuance For Bid

### SERVICE:
Municipal Water Pressure

### ACCEPTABLE LEVEL OF QUALITY EQUAL TO:
Manufacturer: TE Connectivity KPSI 27

### GENERAL
- **Span Range Min/Max:** 0 to 200 psi
- **XMTR Body Material:** Stainless Steel
- **XMTR Element Material:** 316 SS
- **Output Signal:** 4-20 mA
- **Surge Protection:** None
- **Power Supply:** 24 VDC Loop
- **Max. Press. Rating:** 200 psi
- **Electrical Connection:** Strain-Relieved Cable w/ flying leads
- **Reference Pressure Format:** Vented gage
- **Protection Rating:** IP 67
- **Cable Length:** 10ft
- **Label:** psi
- **Cable Type:** Polyurethane
- **Mounting:** Integral
- **Moisture Protection:** Vent Filter
- **Connection-Process:** 1/4” – 18 NPT

### CALIBRATION
- **Process (0% / 100%):** 0 – 200 psi
- **Output (4mA / 20mA):** 4 – 20 mA

### PROCESS DATA
- **Proc Fluid / State:** Municipal Water
- **Flow (Min/Oper/Max):** 0 | 25
- **Flow Units:** GPM
- **Specific Gravity:** -
- **Pressure (Min/Oper/Max):** 0 | 200
- **Percent Solids:** -
- **Pressure Units:** PSIG
- **Conductivity:** -
- **Temperature (Min/Oper/Max):** 40 | 100
- **Viscosity:** -
- **Temperature Units:** °F
- **Line Size / Sched.:** 1"
- **Line No.:**

### ACCESSORIES
- **Vent/Drain:** NA
- **Option-1:** N/A
- **Instrument Tag:** Yes- SS, Engraved
- **Option-2:** N/A

### NOTES
1. 
2. 
3. 
4. 
5. 

*WOODARD & CURRAN*  
**INSTRUMENTATION FOR PROCESS SYSTEMS**  
40 70 00-23
SECTION 43 21 40

SUBMERSIBLE PUMPS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide wet-pit submersible wastewater and stormwater pumps in accordance with this Section and applicable reference standards listed in Article 1.03.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and payment requirements: per Division 01 General Requirements.

1.03 REFERENCES

A. Reference Standards

1. American National Standards Institute (ANSI)
   a. ANSI/NEMA MG1 Motors and Generators

2. ASTM International (ASTM)
   b. ASTM A532 Standard Specification for Abrasion-Resistant Cast Irons

3. American Water Works Association (AWWA)

4. Institute of Electrical and Electronic Engineers (IEEE)

5. Hydraulic Institute (HI)


1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination, sequencing, and scheduling: per Division 01 General Requirements.
1.05 SUBMITTALS

A. Submit in accordance with Division 01 General Requirements.

B. Product data
   1. Manufacturer's product data, including parts listing, indicating compliance with requirements
   2. Certified dimension prints showing fabrication, assembly and installation, including anchorage details
   3. Characteristics and performance data for each pump including guaranteed performance curves based on actual test data of duplicate units demonstrating compliance with specified requirements. Variable speed units including capacity/head curves and best efficiency point (BEP) for minimum of 5 reduced speeds between minimum to maximum speed. Plot curves capacity versus head, net positive suction head (NPSH) required, pump efficiency, brake horsepower, and motor horsepower. Show BEP and all specified operating points. Tabulate data at all operating points.
   4. Weight of each major component and total weight of equipment
   5. List of manufacturer’s spare parts including gaskets, bearings, and seals
   6. Motor data including performance characteristics
   7. Wiring diagrams and control schematics

C. Design Data and Submittals

D. Manufacturer's recommended shipping, unloading, storage, installation and testing procedures

E. Source and field quality control submittals

F. Manufacturer reports
   1. Factory test report including test pump curves for supplied units following fabrication and prior to shipment, demonstrating compliance with requirements.

G. Qualification statements
   1. Installation lists with contact information demonstrating compliance with qualification requirements.

H. Closeout and maintenance material submittals: per Division 01 General Requirements.
1.06 QUALITY ASSURANCE
   A. Provide in accordance with Division 01 General Requirements.
   B. All equipment specified in this section shall be from a single manufacturer that has been regularly engaged in the design and manufacture of submersible wastewater pumps for a minimum of 20 years with a minimum of 5 other municipal installations of similar size wet-pit submersible wastewater pumps that have been in successful operation for a minimum of 10 years.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide in accordance with Division 01 General Requirements.

1.08 SITE CONDITIONS
   A. Existing conditions: per Division 01 General Requirements.
   B. Examine tight clearances in existing pump room and notify Engineer of any conflicts prior to placing order for equipment.

1.09 WARRANTY
   A. Special warranty for pump equipment: 6-year pro-rated warranty.

1.10 MAINTENANCE
   A. Furnish extra materials as specified below. Make interchangeable with and of same material and workmanship as corresponding original parts.
   B. Provide 1 set of the following spare parts for each pump.
      1. Mechanical seals
      2. Gaskets, O-rings, and lip seals
      3. Wearing rings
      4. Cable entry grommet and elastomer assembly
      5. Spares of any additional parts subject to wear, and as recommended by manufacturer.
   C. Provide 1 set of special tools required for normal operation and maintenance of pumps.
   D. Obtain required lubricants for initial operation, including startup and 6-months of operation. Provide grades and quantities of oil supplied as recommended by pump manufacturer.
PART 2 – PRODUCTS

2.01 GENERAL

A. Provide pumps, motors and bases as a single unit from the pump manufacturer.

B. Engineer and manufacture pumps under a written quality assurance program certified to ISO 9001:2000 Quality System Standard and conform to applicable requirements of ASTM, ANSI, AWWA, and HI.

C. Design and build equipment for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain.

D. Furnish complete pumping units. Design and proportion parts to have liberal strength, stability, and stiffness and adapted for the service to be performed.

E. Furnish working parts of pumps and motors, such as bearings, wearing rings, shaft, and sleeves of standard dimensions built to limit gauges or formed to templates so that parts are interchangeable between like units and that the Owner may obtain replacement and repair parts.

F. Do not exceed the nameplate ratings of motors. Do not allow design service factor to be reduced when the pump is operating at any point on its characteristic curve at maximum speed.

G. Noise level of motors: not to exceed 85 dBA measured 3 meters from the unit under free field conditions while operating on utility power.

H. Provide vertically-oriented, wet-pit submersible pumps capable of continuous operation in a submerged condition, permanently connected to outlet pipes as shown on Drawings.

   1. Pump motors: be cooled by process water and not require supplemental cooling over entire range of specified operating conditions.

   2. Pump operation: capable of normal, continuous operation when flooded in water to a depth of 65 feet or greater.

2.02 MANUFACTURERS

A. Xylem Inc. (Flygt)

B. Sulzer (ABS)

C. KSB Inc.

D. Or equal
2.03 PUMP SIZING AND PERFORMANCE

A. Wastewater pumps (P-0101, P-0102):

1. Discharge nominal pipe size, maximum: 4 inches
2. Motor horsepower, maximum: 10
3. Required Operating Conditions

<table>
<thead>
<tr>
<th>Flow (gpm)</th>
<th>Head (feet of water)</th>
<th>NPSHa (feet of water)</th>
<th>Minimum Overall Efficiency</th>
<th>Maximum Speed (rpm)</th>
<th>Pump Curve Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Flow</td>
<td>426</td>
<td>38</td>
<td>27</td>
<td>55%</td>
<td>1,800</td>
</tr>
</tbody>
</table>

   a. Each operating point must fall in the listed region on the pump curve as defined by HI Standards.
   b. NPSHa includes 5-foot factor of safety and assumes minimum wetwell operating level. NPSHr shall not exceed listed NPSHa for any operating condition.
   c. Maximum flow at full speed: as close to 426 gpm as possible still within the motor rated power.

B. Stormwater Pumps (P-0201, P-0202)

1. Discharge nominal pipe size, maximum: 12 inches
2. Maximum overall height of pump, motor, base, and suction elbow assembly: as shown on Drawings.
3. Motor horsepower maximum: 47
4. Required Operating Conditions

<table>
<thead>
<tr>
<th>Flow (gpm)</th>
<th>Head (feet of water)</th>
<th>NPSHa (feet of water)</th>
<th>Efficiency (Minimum Percent)</th>
<th>Maximum Speed (rpm)</th>
<th>Pump Curve Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Flow</td>
<td>2500</td>
<td>47</td>
<td>27</td>
<td>78</td>
<td>1,200</td>
</tr>
</tbody>
</table>

   a. Each operating point must fall in the listed region on the pump curve as defined by HI Standards.
b. NPSHa includes 5-foot factor of safety and assumes minimum wetwell operating level. NPSHr shall not exceed listed NPSHa for any operating condition.

c. Maximum flow at full speed: as close to 1,500 gpm as possible still within the motor rated power.

2.04 PUMP

A. Provide ASTM A48, class 30, 35 or 40 single piece gray cast iron volute, non-concentric design with smooth passages sized to pass any solids entering impeller. Provide minimum inlet and discharge size as specified. Provide ANSI B16.1 Class 125 discharge connection.

B. Provide volute and impeller equipped with replaceable stainless steel wear rings.

C. Provide ASTM A532 (Alloy III A) 25 percent chrome cast iron or Cast Duplex Stainless Steel ASTM A743 CD4MCu, statically and dynamically balanced single piece impellers designed for solids handling. Provide impellers with minimal number of vanes designed to handle wastewater containing suspended magnetite, keyed and held in place with a single stainless steel bolt.

D. Provide 416 stainless steel grade single piece motor/pump shaft. Shaft sleeves are not acceptable. Deflection at shaft seal within allowable operating range may not be more than 0.002-inch.

E. Provide 2 independent mechanical shaft seal sets not requiring maintenance or adjustment, with stationary and positively-driven parts. Contacting sliding surfaces: single-piece tungsten, silicon carbide, or carbon. Other parts: stainless steel. Seal springs may not contact pumped fluid.

F. Provide Buna-N O-rings for stationary parts.

G. Provide factory, pre-lubricated for life, radial and thrust bearings, 100,000 hours B10 life over allowable operating range.

H. Provide cable entry seal to ensure watertight, submersible seal up to depth specified, consisting of threaded gland, compressible grommets and positive stop. Glands to provide strain relief independent of sealing function.

I. Provide NEC severe service “S”, type SJTO single cable with neoprene jacket for power and instrument conductors. Length: sufficient to reach termination point as shown on Drawings.

J. Hardware: 316 stainless steel.

K. Provide intermediate chamber for leak detection between seals with conductive leak sensor indicating need for seal inspection.
2.05 MOTORS

A. Provide NEMA B motor, squirrel-cage induction motor.

1. Horsepower rating not less than maximum brake horsepower requirements of pumps over entire range of pump performance curve.

2. Service factor: 1.15 over 40 degrees C ambient.

3. Thermal overload protection with automatic reset

4. Class H insulation

5. ANSI/NEMA MG1 Part 31 continuous or intermittent, inverter-duty

6. Air filled, watertight design housing

7. Provide integral closed-loop cooling system. Stator housing enclosed by motor cooling jacket. Impeller integral to cooling system driven by pump shaft, providing necessary circulation of cooling liquid through jacket with 1 fill port and 1 drain port. Design system to maximize heat transfer from motor to cooling fluid and cooling fluid to pumped fluid. Provide cooling system for continuous pump operation in liquid or ambient temperatures up to 104 degrees F without operational restrictions over entire range of operating conditions, including near-zero speed. Pumps cooled by process fluid, fans, blowers or auxiliary cooling systems mounted external to pump motor are not acceptable.

8. Provide 1 thermal switch for each stator phase winding to detect motor over-temperature.

9. Provide NEMA report of test form for tests conducted according to AIEE Test Code as specified in the ANSI Standard MG1 for Motors and Generators.

2.06 CONTROLS

A. Furnish relays for each pump to detect seal failure and motor over-temperature. Provide separate dry contacts for seal failure and motor over temperature, Contact rating: 240 VAC 3A maximum. Indicators lights: power, seal failure, and motor over-temperature. Power: 24 VDC.

B. Provide separate relays for installation in control panel. Coordinate panel fabrication to accept relays provided by pump manufacturer.
2.07 LUBRICATION

A. Provide lubrication fittings readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.

2.08 SURFACE PREPARATION AND PAINTING

A. Prepare, prime and paint fabricated steel in accordance with Section 09 90 00. Provide touch-up paint as specified to restore integrity of coating system that may be damaged during construction.

2.09 NAMEPLATES

A. Furnish each pump and motor with a stainless-steel nameplate with embossed data securely mounted to the body of the equipment. Include as a minimum, manufacturer's name and model number, serial number, rated flow capacity, head and speed. Include a minimum, for motor nameplates, manufacturer's name and model number, serial number, horsepower, speed, input voltage, amps, number of cycles, power and service factors.

2.10 SOURCE QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

1. Test pump tests in accordance with the HI Standard at manufacturer’s facility prior to shipment.

2. Performance test each pump at all specified duty points, plus 5 additional points spanning the full range of allowable operating conditions. Develop pump test curves to illustrate conformance with the Specifications. Record capacity, head, motor speed, pump speed, efficiency, input horsepower, and vibration shall be recorded for each test point. For variable speed units, test each pump at full speed plus 3 equally spaced speeds between maximum and minimum design conditions.

B. Hydrostatically test each pump to 1.5 times shutoff head.

C. Test motors in accordance with IEEE standards and at no load running current, high potential, and winding resistance.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Install each pump and motor in accordance with the written instructions of the manufacturer and under direct supervision of manufacturer's representative. Install and assemble pumps and other equipment in accordance with the Drawings and with the manufacturers' installation instruction manual. Furnish bolts, shims, tools, and other devices necessary for installing the pumping units. The manufacturer's representative familiar with equipment being installed shall supervise the handling, installation, start-up, and testing of the equipment.

B. Obtain certificate from pump manufacturer stating installation of the pumping equipment is satisfactory, equipment is ready for operation, and operating personnel have been suitably instructed in the operation, lubrication and care of each type unit provided.

3.02 FIELD PAINTING

A. In accordance with Section 09 90 00.

B. Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

C. Clean factory painted items requiring touching up in the field of all foreign material. Prime and top-coat with manufacturer's standard factory finish.

D. Paint exposed ferrous surfaces with 2 coats of enamel paint conforming to SSPC Paint 21. Clean factory primed surfaces with solvent before painting. Surfaces that have not been factory primed shall be prepared and primed with 1 coat of SSPC Paint 25, or in accordance with enamel paint manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

A. Provide in accordance with Division 01 General Requirements.

B. Site/Field Tests and Inspections

1. After installation of the pumping units and appurtenances is complete, test pumping equipment for proper operation. Ensure manufacturer's representatives are present during each test. Notify Engineer 1 week prior to test and confirm with Engineer 24 hours prior to test.

2. Conduct a running field test on each pumping unit in the presence of the Engineer and manufacturer’s representative for a minimum of 2 hours. Operate each pumping unit at its rated capacity and the design points specified.
a. Throttle discharge valves or run multiple pumps simultaneously to achieve specified heads. Utilize an accurate method of measuring the discharge flow and suction and discharge heads. Use of new, calibrated, and tested station flow meter and pressure gauges is acceptable.

b. Test to confirm units and appurtenances have been installed correctly, that the assembly is free from undue stress imposed by the piping or mounting bolts, that there is no objectionable heating, vibration, or noise from any parts, and that manual and automatic controls function properly. If any deficiencies are revealed during any tests, correct such deficiencies and repeat testing.

3. Provide vibration testing by a qualified and independent testing company. Test each complete system (base, pump, and motor) at each test condition. Conduct vibration testing in the presence of the manufacturer’s representatives in accordance with procedures outlined in the applicable sections of the HI Standards and these Specifications.

   a. In the event vibration exceeds specified limits and cause of vibration is attributable to the pumping equipment, ensure manufacturer makes necessary balancing or alignment adjustments to bring equipment to within specified limits.

4. Provide field test booklets for each unit showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of installed system. Indicate the final position of controls and data gathered during testing in field test booklets and ensure test booklets are signed by the manufacturer’s representative, Contractor, and Engineer.

C. Manufacturer Field Services

   1. Provide factory trained service representative to assist in installation, start-up, and equipment testing in addition to startup, checkout and travel time and witness field testing. Manufacturer to provide a minimum of 8 on-Site hours of personnel training in operation and maintenance of equipment.

3.04 STARTUP & COMMISSIONING

   A. Provide in accordance with Division 01 General Requirements.

3.05 CLOSEOUT ACTIVITIES

   A. Provide in accordance with Division 01 General Requirements.

END OF SECTION