TECHNICAL SPECIFICATIONS

FOR

NORTH AND SOUTH TREATMENT FACILITY

MAY 2024

VOLUME 2 OF 3

CONTRACT DOCUMENTS

FOR

CONSTRUCTION OF

NORTH AND SOUTH TREATMENT FACILITY

FOR

CITY OF HARRISBURG

MAY 2024

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FOR
NORTH AND SOUTH TREATMENT FACILITY
FOR
CITY OF HARRISBURG

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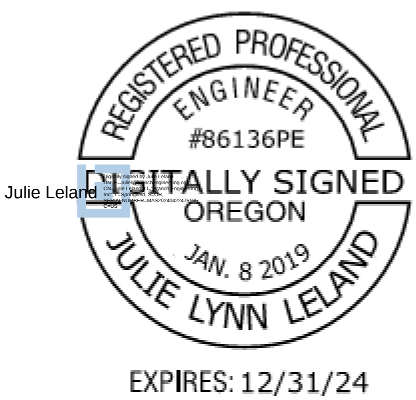

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TABLE OF CONTENTS
FOR
NORTH AND SOUTH TREATMENT FACILITY
FOR
CITY OF HARRISBURG

Division 43 - Special Construction

Division 46 - Water and Wastewater Equipment

DRAWINGS

SUPPLEMENTARY INFORMATION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete formwork.
B. Cast-in-place concrete - Interior and exterior.
C. Joint devices associated with concrete work.
D. Concrete curing.

1.2 RELATED REQUIREMENTS

A. Structural Drawings Notes: Concrete properties and special inspection requirements.
B. Section 07 90 05 - Joint Sealers: Sealants for saw cut joints and isolation joints in slabs.

1.3 REFERENCE STANDARDS

A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International.

B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International.

C. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International.

D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International.

E. ACI 305R - Hot Weather Concreting; American Concrete Institute International.

F. ACI 306R - Cold Weather Concreting; American Concrete Institute International.

G. ACI 308R - Guide to Curing Concrete; American Concrete Institute International.

H. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International.

I. ASTM C33 - Standard Specification for Concrete Aggregates.

J. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

K. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.

L. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens).

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

N. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

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

P. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2010.

Q. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.

R. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

C. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.

D. Shop drawings with detailed placing, including but not limited to plans and elevations at footings and slabs, and bending details.

E. Slab jointing plan.

F. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.5 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301 and ACI 318.
B. Follow recommendations of ACI 305R when concreting during hot weather.
C. Follow recommendations of ACI 306R when concreting during cold weather.
D. Coordinate with Agency's testing agency.

PART 2 PRODUCTS

2.1 FORMWORK

A. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.

1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.

2. Earth Cuts: Do not use earth cuts as forms for vertical surfaces. Natural rock formations that maintain a stable vertical edge may be used as side forms.

3. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.

4. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

5. Chamfer: Provide 3/4 inch by 3/4 inch (19 mm x 19 mm) 45 degree fillet on all exposed 90 degree horizontal or vertical outside facing edges, unless noted otherwise.

   a. Do not chamfer slab edges.

2.2 REINFORCEMENT

A. See structural notes on drawings for grade and size of reinforcing steel. All reinforcing shall be grade 60 deformed steel bars conforming to ASTM A 615/A 615M.

B. Reinforcement Accessories:

1. Tie Wire: Annealed, minimum 16 gage.

2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

C. Steel bending processes shall conform to the requirements of ACI 318.

D. Bending or straightening shall be accomplished so that the steel will not be damaged.

E. Kinked bars shall not be used.

2.3 CONCRETE MATERIALS

A. See drawings structural notes.

B. Cement: ASTM C150, Type I - Normal Portland type.

C. Fine and Coarse Aggregates: ASTM C 33.

D. Fly Ash: ASTM C618, Class C or F.

E. Color Additives: Pure, concentrated mineral pigments specifically intended for mixing into concrete and complying with ASTM C979.

1. Applicable to concrete lintels only.

2. Color(s): As indicated on drawings.

3. Products:

   a. Butterfield Color: www.butterfieldcolor.com.
   b. Davis Colors: www.daviscolors.com.
   c. Lambert Corporation: www.lambertusa.com.
   d. Substitutions: See General Conditions (Volume 1)

F. Water: Clean and not detrimental to concrete.

2.4 CHEMICAL ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

B. Air Entrainment Admixture: ASTM C260.

C. Water Reducing Admixture: See drawings structural notes.

2.5 ACCESSORY MATERIALS

A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.

1. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.

B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.

1. Minimum Compressive Strength at 48 Hours: 2,400 psi.
2. Minimum Compressive Strength at 28 Days: 7,000 psi.

C. Liquid Curing Compound: ASTM C 309, Type 1, clear or translucent.

2.6 BONDING AND JOINTING PRODUCTS

A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059 Type II.

B. Epoxy Bonding System: Complying with ASTM C881/C881M and of Type required for specific application.

C. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.

D. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with minimum 1 inch diameter holes for conduit or rebars to pass through at 6 inches on center; ribbed steel stakes for setting.

2.7 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.

C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

D. Normal Weight Concrete:

1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.

2. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.

3. Water-Cement Ratio: As indicated on drawings.

4. Total Air Content for Exterior Slabs and Flat Work Only: 5 to 7 percent, determined in accordance with ASTM C 173/C 173M for exterior flat work.

5. Maximum Slump: As indicated, unless otherwise noted.

6. Maximum Aggregate Size: 3/4 inch.

2.8 MIXING

A. Transit Mixers: Comply with ASTM C94/C94M.

B. Do not add water to concrete mixture unless concrete supplier has indicated in writing amount of mixing water that was withheld for addition at the project site.

2.9 SUPPORTS

Bar supports shall conform to ACI 315.

A. Bar supports shall consist of approved high density "adobes", stainless steel chairs, plastic spacers or plastic shim plates.

1. Brick, broken concrete masonry units, spalls, rocks or similar materials shall not be used for support of reinforcing steel.

2. Steel chairs shall be furnished with plastic tips when incorporated into concrete exposed to view.

3. Plastic spacers shall be PRECO BARSPAN WHEELS, as manufactured by the PRECO CORPORATION or approved alternate.

4. Plastic shim plates may be used to support the plastic spacers and shall be used to support the vertical reinforcing in the corewall, unless shown otherwise on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.2 PREPARATION

A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.

B. Verify that forms are clean and free of rust before applying release agent.

C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.

2. Use latex bonding agent only for non-load-bearing applications.

E. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.3 REINFORCING BARS

Comply with the specified codes and standards and Concrete Reinforcing Steel Institutes recommended practice for "placing reinforcing bars," for details and methods of reinforcement placement and supports, and as herein specified.

A. General

1. Mild steel reinforcing bars shall be furnished, cut, bent and placed as indicated on the Drawings.

2. At the time of placing concrete, all reinforcement shall be free from loose mill scale, rust, grease or other coating which might destroy or reduce its bond with concrete.

3. Steel reinforcement which is to be placed in the work shall be stored under cover to prevent rusting, and shall be placed on blocking such that no steel touches any ground surface.

4. All reinforcing steel placed in the work shall be tied together and supported in such a manner that displacement during placing of concrete and shotcrete will not occur.

5. When there is a delay in depositing concrete, reinforcement shall be reinspected and cleaned when necessary.

B. Cutting and Bending

1. Steel reinforcement shall be cut and bent in accordance with ACI 318 and with approved practices and machine methods, either at the shop or in the field.

2. Reinforcement shall be accurately formed to the dimensions indicated on the Drawings and on the bending schedule.

3. Bends for hooks on bars shall be made around a pin having a diameter not less than six times the minimum thickness of the bar.

4. All bars shall be bent cold.

C. Minimum Bar Spacing

The clear distance between parallel bars shall not be less than one and one-half times the diameter of the bars and, unless specifically authorized, shall in no case be less than one inch, nor less than the maximum size of coarse aggregate specified.

D. Concrete Cover (Minimum)

1. On all formed surfaces which will be exposed to water, ground or the elements, there shall be a nominal cover over the steel of 2 inches for bars number 6 through number 18 and 1.5 inches for bars number 5 and smaller, with an installation tolerance of + 1/4 inch. When different diameter bars cross in one face, base the cover requirement on the bar size and location that will provide the largest cover over the nearest steel to the outside surface.

2. 3 inch minimum coverage for rebar off ground or aggregate base.

3. The minimum cover over reinforcing steel for concrete construction of other facilities shall be as shown on the Drawings.

4. No "bury" or "carrier" bars will be allowed unless specifically approved by the ENGINEER.

E. Splicing

1. Except as shown or specified on the Drawings, reinforcing steel shall not be spliced at any location without specific approval by the ENGINEER. Splices in adjacent bars shall be staggered.

2. Where permitted or required, splices in reinforcing steel shall have sufficient lap to transfer full strength of the bar by bond and shear. Unless specified or shown otherwise on the Drawings, the bars at a lap splice shall be in contact with each other. In no event shall the lap length be less than indicated on the Drawings.

3. Unless specified or shown otherwise on the Drawings, bars shall be lap spliced in accordance with ACI 318 and shall be fastened together with steel tie wire.

4. Unless shown otherwise on the Drawings, where bars are to be lapped spliced at joints in the concrete, all bars shall project from the concrete first placed, a minimum length equal to the lap splice length indicated on the Drawings. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sandblasting before the bars are embedded in a subsequent concrete placement.

F. Supports

1. All reinforcement shall be retained in place, true to indicated lines and grades, by the use of approved bar supports.

2. The supports shall be of sufficient quantity, strength and stability to maintain the reinforcement in place throughout the concreting operations. Bar supports shall be placed no further than 4 feet apart in each direction. Supports must be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete. The CONTRACTOR shall be held responsible for providing the appropriate quantity and type of bar supports.

3. Do not place reinforcing bars more than two inches beyond the last leg on continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

G. Bar Tying

1. Bars shall be tied sufficiently often to prevent shifting. Bar ties shall be placed at a minimum of 50 percent of all bar intersections.

3.4 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Place concrete for floor slabs in accordance with ACI 302.1R.

C. Notify Agency Project Manager not less than 24 hours prior to commencement of placement operations.

D. Ensure reinforcement, inserts, and embedded parts will not be disturbed during concrete placement.

E. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.5 SLAB JOINTING

A. Contractor to submit slab joint plan to engineer for review and approval at least 2 weeks prior to slab pour.

B. Anchor joint fillers and devices to prevent movement during concrete placement.

C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.

D. Repair underslab vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.

E. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface. Conform to Section 07 90 05 for finish joint sealer requirements.

F. Install joint devices in accordance with manufacturer's instructions.

G. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

H. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

I. Place concrete continuously between predetermined expansion, control, and construction joints.

J. Do not interrupt successive placement; do not permit cold joints to occur.

K. Saw cut joints within 1 hour after placing. Use 3/16 inch (5 mm) thick blade, cut into 1/4 depth of slab thickness.

L. Screed floors level at perimeter and slope to drains as indicated. Surface flatness maximum 1/4 inch in 10 ft (6mm/3m).

3.6 FLOOR FLATNESS AND LEVELNESS TOLERANCES

A. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.7 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.

C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:

1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.

D. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:

1. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI 301.1R; thin floor coverings include Fluid Applied Flooring.

2. Other Surfaces to Be Left Exposed: "Steel trowel" as described in ACI 302.1R, minimizing burnish marks and other appearance defects. Light broom finish matching existing, where indicated, otherwise steel trowel finish.

3. Exterior Slabs:

   a. Broom finish to match existing where there is an abutting existing slab.
   b. Light broom finish slabs where there is not an abutting existing slab.

E. Tooled Edge: Provide 1/4 inch (6 mm) radius tooled edge without shiner.

1. Provide 1/4 inch (6 mm) radius tooled edge at all exposed outward facing 90 degree slab edges and where indicated.

3.8 CURING AND PROTECTION

A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

1. Normal concrete: Not less than 7 days.

C. Surfaces Not in Contact with Forms:

1. Slabs and Floors to Receive Finishes: Ensure that curing compounds and other surface coatings are compatible with specified finish material.

2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.

3. Final Curing: Begin after initial curing but before surface is dry.

   a. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.9 NOT USED

3.10 FIELD QUALITY CONTROL

A. See structural drawings for special inspection requirements.

B. Agency will provide material and quality control testing. Coordinate and cooperate with Agency as necessary.

C. Provide free access to concrete operations at project site and cooperate with appointed firm.

D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.

E. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

3.11 DEFECTIVE CONCRETE

A. Test Results: The testing agency shall report test results in writing to Agency Project Manager and Contractor within 24 hours of test.

B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

C. Repair or replacement of defective concrete will be determined by the Agency Project Manager. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Agency Project Manager for each individual area.

END OF SECTION

SECTION 04 20 00 - UNIT MASONRY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete Block.
B. Mortar.
C. Reinforcement and Anchorage.
D. Lintels.
E. Accessories.

1.2 RELATED REQUIREMENTS

A. Not Used.
B. Not Used.
C. Section 07 90 05 - Joint Sealers: Backing rod and sealant at control and expansion joints.
D. Section 09 90 00 - Painting and Coating: Polyaspartic coating for CMU.

1.3 REFERENCE STANDARDS

A. TMS 402 - Building Code Requirements for Masonry Structures; The Masonry Society; 2016.

B. TMS 602 - Specification For Masonry Structures; The Masonry Society; 2016.

C. ASTM C476 - Standard Specification for Grout for Masonry; 2010.

D. IMIAWC (CW) - Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.

E. IMIAWC (HW) - Recommended Practices & Guide Specifications for Hot Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Provide data for masonry units, mortar, and grout.

C. Samples: Submit 2 samples of each finish and color type of units to illustrate color, texture, and extremes of color range.

D. Samples: Submit 1 sample each of mortar manufacturer's full color palette for selection. Submit 3 samples of selected color for confirmation.

E. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

F. Mock Up: Construct minimum of 6 feet long by 4 feet high section of wall for approval by Agency Project Manager prior to proceeding with remainder of wall. If appearance does not match that indicated in the Contract Documents to the satisfaction of the Agency, then rebuild until a match is approved. Completed structure shall incorporate mock-up section.

G. Control Joint Plan for review and approval by engineer at least 2 weeks prior to construction of masonry walls.

1.5 QUALITY ASSURANCE

A. Preconstruction Meeting: See General Conditions (Volume 1)

B. See structural drawings for special inspection requirements.

C. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.

1. Maintain one copy of each document on project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

B. Protect masonry units from moisture and as recommended by masonry units manufacturer.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:

1. Sizes: Standard 8 inch (200 mm) deep units.

B. Concrete Block Weight: Medium.

C. Moisture-Resistant Admixture:

1. "Dry Block" block admixture by Grace Construction Products.
2. Substitutions: See General Conditions (Volume 1).

D. Concrete Block Texture: Split face at exterior surfaces, standard texture at interior surfaces.

E. Concrete Block Color: Standard gray.

F. Manufacturers:

1. Mutual Materials.
2. Willamette Graystone.
3. Approved Alternate.

2.2 MORTAR MATERIALS

A. Mortar: See drawings structural notes.

B. Water: Clean and potable.

C. Moisture-Resistant Admixture:

1. "Dry Block admixture by Grace Construction Products.
2. Substitutions: See General Conditions (Volume 1).

2.3 REINFORCEMENT AND ANCHORAGE

A. Reinforcing: See drawings structural notes.

2.4 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.

1. Manufacturers;

a. Dur-O-Wal: www.dur-o-wal.com.
b. Substitutions: See General Conditions (Volume 1).

B. Cleaning Solution:

1. Eaco-chem MMD 80.
2. Substitutions: See General Conditions (Volume 1).

2.5 LINTELS

A. Lintels: As indicated on drawings.

2.6 GROUT MIXES

A. Grout Mixes: See drawings structural notes.

B. Grout: ASTM C476. Consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

C. Mixing: Use mechanical batch mixer and comply with referenced standards.

2.7 ANTI-GRAFFITI MASONRY SEALER

A. Sealer: Fabrishield PR-63 paint repellent by Fabrikem, www.fabrikem.com.
B. Substitutions: No substitutions.

PART 3 EXECUTION

3.1 COLD AND HOT WEATHER REQUIREMENTS

A. Comply with requirements of International Masonry Industry All Weather Council (IMIAWC).

3.2 WET WEATHER REQUIREMENTS

A. Protect masonry from wet weather during construction. Prevent rain from entering open cells or contacting face of the masonry units. Wet weather protection includes, but is not limited to:

1. Cover top of incomplete work subject to falling moisture with coverings extending 24 inches (600 mm) or more down all sides of work at end of day. Leave cover in place until resuming work.

B. Do not construct wall during wet weather, unless under cover and keeping work out of wet for 5 days from day of installation.

3.3 COURSING

A. Establish lines and levels indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Mortar Joints: Concave.

1. Double strike all joints.

3.4 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

C. Remove excess mortar and mortar smears as work progresses.

D. Interlock intersections and external corners.

E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

F. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.5 REINFORCEMENT AND ANCHORAGE - GENERAL

A. See drawings structural notes.

3.6 LINTELS

A. Align with faces of masonry.
B. Maintain minimum 8 inch bearing on each side of opening.

3.7 CONTROL AND EXPANSION JOINTS

A. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.

B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

C. Form expansion joint as detailed.

3.8 BUILT-IN WORK

A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.

B. Install built-in items plumb, level, and true to line.

C. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with grout.

1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

D. Do not build into masonry construction organic materials that are subject to deterioration.

3.9 TOLERANCES

A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

E. Maximum Variation of Joint Thickness: 1/16 inch in 3 ft.

F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.10 CUTTING AND FITTING

A. Cut and fit for items as required. Coordinate with other sections of work to provide correct size, shape, and location.

3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in General Conditions (Volume 1).

   1. Also see structural drawings for special inspection requirements.

3.12 CLEANING

A. Remove excess mortar and mortar droppings.

   1. Continuously process through course of work, but no more than 4 hours from placement.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution. Follow manufacturer's written instructions.

D. Use non-metallic tools in cleaning operations.

E. Use cleaning procedures that do not alter the appearance of, or damage the masonry units.

END OF SECTION

SECTION 05 50 00 – METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Shop fabricated steel items.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

A. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.

B. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2009a.

C. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2009.

D. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2018.

E. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).

1.4 SUBMITTALS

A. See General Conditions (Volume1) for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

C. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL

A. Plates: ASTM A36.
B. Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1.
C. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

2.2 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds, unless noted otherwise.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.3 FINISHES - STEEL

A. Prepare surfaces to be primed in accordance with SSPC-SP2.
B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
C. Prime Painting: One coat.

2.4 FABRICATION TOLERANCES

A. Squareness: 1/8 inch maximum difference in diagonal measurements.
B. Maximum Offset Between Faces: 1/16 inch.
C. Maximum Misalignment of Adjacent Members: 1/16 inch.
D. Maximum Bow: 1/8 inch in 48 inches.
E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Obtain approval prior to site cutting or making adjustments not scheduled.

D. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.2 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
B. Maximum Offset From True Alignment: 1/4 inch.
C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

1.2 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010

C. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood Protection Association; 2010.

D. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 2005.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.

1. Species: Douglas Fir-Larch, unless otherwise indicated.

2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.2 CONSTRUCTION PANELS

A. Roof Sheathing: APA PRP-108, Rated Sheathing, Exterior Exposure Class, and as follows:

1. Span Rating: 24/0.
2. Thickness: As indicated.
3. Face Plys: C-D

2.3 ACCESSORIES

A. Fasteners and Anchors:

1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

B. Die-Stamped Connectors: Hot dipped galvanized steel, unless noted otherwise on drawings, sized to suit framing conditions.

1. For contact with preservative treated wood in exposed locations, provide minimum G185 galvanizing per ASTM A653/A653M, unless noted otherwise.
2. See structural drawing notes for type and manufacturer. No substitutions.

C. Water-Resistive Barrier: 60 minute water-resistive Kraft building paper.

2.4 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

1. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

PART 3 EXECUTION

3.1 INSTALLATION – GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.2 FRAMING INSTALLATION

A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.

B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.

C. Install structural members full length without splices unless otherwise specifically detailed.

D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes.

3.3 ROOF-RELATED CARPENTRY

A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.

3.4 CLEANING

A. Waste Disposal: Comply with applicable regulations. Haul debris off site to legal disposal facility appropriate for the material. Burning not allowed.

B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

END OF SECTION

SECTION 06 17 53 - SHOP-FABRICATED WOOD TRUSSES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood roof trusses.
2. Wood truss bracing.
3. Metal truss accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For metal-plate connectors, metal truss accessories, and fasteners.

B. Shop Drawings: Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
2. Indicate sizes, stress grades, and species of lumber.
3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
6. Show splice details and bearing details.

C. Delegated-Design Submittal: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Evaluation Reports: For the following, from ICC-ES:

1. Metal-plate connectors.

2. Metal truss accessories.

1.4 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.

2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Engineer and authorities having jurisdiction and is certified for chain of custody by an FSC-accredited certification body.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in TPI BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design metal-plate-connected wood trusses.

B. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

2.2 DIMENSION LUMBER

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Provide dry lumber with 19 percent maximum moisture content at time of dressing.

B. Permanent Bracing: Provide wood bracing as indicated in drawings or by truss manufacturer.

2.3 METAL CONNECTOR PLATES

A. General: Fabricate connector plates to comply with TPI 1.

B. Hot-Dip Galvanized-Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 (Z180) coating designation; and not less than 0.036 inch (0.9 mm) thick.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.

B. Nails, Brads, and Staples: ASTM F 1667.

2.5 METAL FRAMING ANCHORS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.

2.6 FABRICATION

A. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

B. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.

F. Securely connect each truss ply required for forming built-up girder trusses.

G. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

H. Install wood trusses within installation tolerances in TPI 1.

I. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.

J. Replace wood trusses that are damaged or do not meet requirements.

END OF SECTION

SECTION 07 21 00 - THERMAL INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Batt insulation.

1.2 RELATED REQUIREMENTS

A. None.

1.3 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

PART 2 PRODUCTS

2.1 BATT INSULATION MATERIALS

A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.

1. Thermal resistance as indicated.

2. Facing: Manufacturer's standard on one side. Vapor permeability of one perm or less.

3. Manufacturers:

    a. CertainTeed Corporation: www.certainteed.com.
    b. Johns Manville Corporation: www.jm.com.
    c. Owens Corning Corp: www.owenscorning.com.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

3.2 NOT USED

3.3 BATT INSTALLATION

A. Install insulation in accordance with manufacturer's instructions.

B. Install in exterior ceiling spaces without gaps or voids. Do not compress insulation.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

E. Install with factory applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.

F. Staple or nail facing flanges in place at maximum 6 inches on center.

3.4 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

SECTION 07 31 13 - ASPHALT SHINGLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt shingles.
2. Underlayment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed product and for each color and blend specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Research/evaluation reports.

C. Warranties: Sample of special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.6 WARRANTY

A. Special Warranty: Standard form in which manufacturer agrees to repair or replace asphalt shingles that fail in materials or workmanship within specified warranty period.

1. Material Warranty Period: 30 years from date of Substantial Completion, prorated, with first three years nonprorated.

2. Algae-Discoloration Warranty Period: Asphalt shingles will not discolor five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GLASS-FIBER-REINFORCED ASPHALT SHINGLES

A. Multitab-Strip Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.

1. 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:

a. Atlas Roofing Corporation.
b. CertainTeed Corporation.
c. GAF Materials Corporation.
d. IKO.
e. Malarkey Roofing Products.
f. Owens Corning.
g. PABCO Roofing Products.
h. TAMKO Roofing Products, Inc.
i. <Insert manufacturer's name>.

2. Tab Arrangement: Three tabs, regularly spaced.

3. Cutout Shape: Square.

4. Butt Edge: Straight cut.

5. Strip Size: Manufacturer's standard.

6. Algae Resistance: Granules treated to resist algae discoloration.

7. Color and Blends: As selected by Owner from manufacturer's full range.

B. Hip and Ridge Shingles: Site-fabricated units cut from asphalt shingle strips. Trim each side of lapped portion of unit to taper approximately 1 inch (25 mm).

2.2 UNDERLAYMENT MATERIALS

A. Hybrid underlayment: “Safeguard30” underlayment, www.safeguard30.com, or approved alternate.

2.3 RIDGE VENTS

A. Rigid Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent with nonwoven geotextile filter strips and external deflector baffles; for use under ridge shingles.

1. 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:

    a. Air Vent, Inc.; a Gibraltar Industries company.
    b. Cor-A-Vent, Inc.
    c. GAF Materials Corporation.
    d. Lomanco, Inc.
    e. Mid-America Building Products.
    f. Obdyke, Benjamin Incorporated.
    g. Owens Corning.
    h. RGM Products, Inc.
    i. Trimline Building Products.

2. Minimum Net Free Area: 11 square inches per lineal foot.

3. Width: 9” minimum.

4. Thickness: 5/8”.

2.4 ACCESSORIES

A. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.

B. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- (3-mm-) diameter, smooth shank, sharp-pointed, with a minimum 3/8-inch- (9.5-mm-) diameter flat head and of sufficient length to penetrate 3/4 inch (19 mm) into solid wood decking or extend at least 1/8 inch (3 mm) through OSB or plywood sheathing.

    1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

C. Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.

2.5 METAL FLASHING AND TRIM

A. General: Comply with requirements in Section 07 6200 "Sheet Metal Flashing and Trim."

B. Sheet Metal: Zinc-tin alloy-coated steel.

C. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item.

PART 3 EXECUTION

3.1 UNDERLAYMENT INSTALLATION

A. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

B. Cover underlayment within seven days.

3.2 METAL FLASHING INSTALLATION

A. General: Install metal flashings and other sheet metal to comply with requirements in Section 07 6200 "Sheet Metal Flashing and Trim."

1. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and requirements in current adopted version of building code, and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."

3.3 ASPHALT SHINGLE INSTALLATION

A. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."

B. Install starter strip along lowest roof edge, consisting of an asphalt shingle strip with tabs removed at least 7 inches (175 mm) wide with self-sealing strip face up at roof edge.

1. Extend asphalt shingles 3/4 inch (19 mm) over fasciae at eaves and rakes.

2. Install starter strip along rake edge.

C. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.

D. Fasten asphalt shingle strips with a minimum of four roofing nails located according to manufacturer's written instructions.

1. When ambient temperature during installation is below 50 deg F (10 deg C), seal asphalt shingles with asphalt roofing cement spots.

E. Ridge Vents: Install continuous ridge vents over asphalt shingles according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.

F. Ridge Cap Shingles: Maintain same exposure of cap shingles as roofing shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds. Fasten with roofing nails of sufficient length to penetrate sheathing.

1. Fasten ridge cap asphalt shingles to cover ridge vent without obstructing airflow.

END OF SECTION

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formed roof-drainage sheet metal fabrications.
2. Formed steep-slope roof sheet metal fabrications.
3. Formed wall sheet metal fabrications.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.
B. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.7 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual", SMACNA's "Architectural Sheet Metal Manual", and current adopted building code requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As calculated from wind design parameters indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation or aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275); prepainted by coil-coating process to comply with ASTM A 755/A 755M.

1. Surface: Manufacturer's standard clear acrylic coating on both sides.

2. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As selected by Owner from manufacturer's full range.

2.3 UNDERLAYMENT MATERIALS

A. Refer to Section 07 3113 Asphalt Shingles.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.

    b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.

    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

C. Solder:

1. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

A. General: Fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.

2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.

3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.

C. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

F. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder. Alternately, form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter brackets and gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.

B. Downspouts: Fabricate rectangular downspouts to standard dimensions, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.

1. Hanger Style: Strap.

2. Fabricate from the following materials:

    a. Galvanized Steel: 0.022 inch (0.56 mm) thick.

2.7 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

A. Drip Edges: Provide at eaves and rake edges. Fabricate from the following materials:
B. Galvanized Steel: 0.022 inch (0.56 mm) thick.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.

2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.

4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.

5. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements in Section 07 9005 "Joint Sealers."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not solder metallic-coated steel sheet.

2. Do not use torches for soldering.

3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.2 ROOF-DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated.

Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters: Join sections with joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.

1. Install gutter with expansion joints at locations not exceeding 50 feet (15.24 m) apart. Install expansion-joint caps.

C. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c.

3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, requirements of current adopted building code, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate.

C. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.4 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION

SECTION 07 90 05 - JOINT SEALERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sealants and joint backing.

1.2 REFERENCE ST ANDARDS

A. ASTM C834 - Standard Specification for Latex Sealants; current adopted edition.

B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; current adopted edition.

C. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Poly(Vinyl Chloride)Foam (Closed-Cell); current adopted edition.

1.3 SUBMITT ALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Provide data indicating sealant chemical characteristics.

C. Samples: Submit two samples, 1/4 x 2 inch in size illustrating sealant colors for selection.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Company specializing in performing the work of this section with minimum two years experience.

1.5 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.6 WARRANTY

A. See General Conditions (Volume 1) for additional warranty requirements.

B. Correct defective work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 SEALANTS

A. General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25, Uses M, G, and A; single component.

1. Applications: Use for:

    a. Control, expansion, and soft joints in masonry.
    b. Joints between concrete and other materials.
    c. Joints between metal frames and other materials.
    d. Other exterior joints for which no other sealant is indicated.

B. Exterior Metal Lap Joint Sealant: Butyl or polyisobutylene, nondrying, nonskinning, noncuring.

1. Applications: Use for:

    a. Concealed sealant bead in sheet metal work.
    b. Under thresholds.

C. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.

1. Color: Standard colors matching finished surfaces.

2. Applications: Use for:

    a. Interior wall and ceiling control joints.
    b. Joints between door and window frames and wall surfaces.
    c. Other interior joints for which no other type of sealant is indicated.

D. Bathtub/Tile Sealant: Clear silicone; ASTM C 920, Uses I, M and A; single component, mildew resistant.

E. Concrete Paving Joint Sealant: Polyurethane, self-leveling; ASTM C920, Class 25, Uses T, I, M and A; single component.

1. Color: Gray.

2. Product: Vulkem 45 manufactured by Tremco.

    a. Applications:

        1) Insulation Joint between building wall and sidewalk at building perimeter.

3. Substitutions: See General Conditions (Volume 1).

2.2 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

C. Verify that joint type, materials and sealants compatible and as recommended by sealant manufacturer. Notify Agency Project Manager if sealant, other than those specified, is required. Provide product data justifying use of the sealant.

3.2 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.
B. Clean and prime joints in accordance with manufacturer's instructions.
C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
D. Protect elements surrounding the work of this section from damage or disfigurement.

3.3 INSTALLATION

A. Apply sealants where indicated and were necessary for weathertightness and waterproofness on both exterior and interior surfaces.

B. Apply sealants where indicated and where appropriate to enhance sanitary maintenance.

C. Use sealants recommended by the manufacturer for the specific application.

D. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

E. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer.

F. Install bond breaker where joint backing is not used.

G. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

I. Tool joints concave.

J. Apply masonry sand to sealant at expansion/movement joints in masonry to simulate mortar joint.

3.4 CLEANING

A. Clean adjacent soiled surfaces.

3.5 PROTECTION

A. Protect sealants until cured.

END OF SECTION

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 DESCRIPTION

Work includes providing metal doors and door frames of the described size, type and thickness specified herein and shown on plans.

1.2 SUBMITTALS

A. Shop drawings in accordance with Section 400.

B. Product Data: Submit manufacturer's technical product data substantiating that products comply with requirements.

C. Shop Drawings: Submit for fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

D. Provide schedule of doors and frames, using the door numbers as they appear in the Door Schedule on the Drawings.

1.3 QUALITY ASSURANCE

A. Materials

1. All material used in the fabricating of steel doors and frames shall be free from defects impairing strength, durability, and appearance. Doors shall conform to Commercial Standard CS 242-62 and PS4-66.

2. Doors and frames in accordance with Standard Steel Door Institute (SDI) recommendations -- SDI 100-78, extra heavy duty, Type III, 16 gage, galvanized steel.

3. Doors and frames to be from a single manufacturer.

4. All frames are fully welded with bituminous coating.

B. Hardware

1. Reinforce, drill and tap doors and frames to receive mortised hinges, locks, latches, flush bolts and concealed closer as required.

2. Hardware preparation in accordance with SDI 107. CONTRACTOR to drill and tap for surface applied hardware in accordance with SDI 107.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Steel Doors and Frames:

1. Assa Abloy Ceco, Curries, or Fleming: www.assaabloydss.com.

2. Republic Doors: www.republicdoor.com.

3. Steelcraft; Product B14: www.steelcraft.com.

   a. Steelcraft product is the standard of quality to be matched by any other manufacturer.

4. Substitutions: See General Conditions (Volume 1).

2.2 DOORS AND FRAMES

A. Requirements for All Doors and Frames:

1. Door Top Closures: Flush with top of faces and edges.

2. Door Texture: Smooth faces.

3. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.

4. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed), manufacturer's standard coating thickness.

5. Finish: Factory primed, for field finishing.

2.3 STEEL DOORS

A. Exterior Doors:

1. Grade: ANSI A250.8 Level 4, physical performance Level A, Model 2, seamless.

2. Core: Steel stiffeners and insulation.

   a. Manufacturer's standard insulation.

3. Top Closures: Flush with top of faces and edges.

4. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness.

5. Insulating Value: U-value of 0.437, when tested in accordance with ASTM C1363.

6. Weatherstripping: Separate, see Section 08 71 00.

7. Fabricate doors to resist excessive thermal bow which would otherwise result in the doors operating improperly when exposed to direct sunlight.

B. Interior Doors:

1. Same as exterior doors except provisions for thermal bow not applicable.

2.4 STEEL FRAMES

A. General:

1. Comply with the requirements of grade specified for corresponding door, except:

   a. ANSI A250.8 Level 4 Doors: 12 gage frames.

2. Reinforcing: Add reinforcing as indicated in the drawings.

3. Finish: Same as for door.

4. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

5. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.

B. Exterior Door Frames: Fully welded.

1. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness.

2. Finish: Factory primed, for field finishing.

3. Weatherstripping: Separate, see Section 08 71 00.

C. Interior Door Frames: Fully welded type.

1. Same as exterior door frames.

2.5 ACCESSORY MATERIALS

A. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.

B. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.

2.6 FINISH MATERIALS

A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 08 33 23 - OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulated service doors.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.

2. Show locations of controls, locking devices, and other accessories.

3. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: As indicated on Drawings.
2. Testing: According to ASTM E 330.

B. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 DOOR ASSEMBLY

A. Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. 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:

    a. ACME Rolling Doors.
    b. Alpine Overhead Doors, Inc.
    c. Alumatec Pacific Products.
    d. Amarr Garage Doors.
    e. ASTA Door Corporation.
    f. C.H.I. Overhead Doors.
    g. City-Gates.
    h. Clopay Building Products.
    i. Cookson Company.
    j. Cornell Iron Works, Inc.
    k. Janus International Corporation.
    l. Lawrence Roll-Up Doors, Inc.
    m. McKeon Rolling Steel Door Company, Inc.
    n. Metro Door.
    o. Overhead Door Corporation.
    p. QMI Security Solutions.
    q. Raynor.
    r. Southwestern Rolling Steel Door Co.
    s. Wayne-Dalton Corp.
    t. Approved alternate.

B. Operation Cycles: Door components and operators capable of operating for not less than 10,000.

C. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W).

D. Door Curtain Material: Galvanized steel.

E. Door Curtain Slats: Flat profile slats of 2-5/8-inch (67-mm) center-to-center height.

1. Insulated-Slat Interior Facing: Galvanized steel.

F. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from hot-dip galvanized steel and finished to match door.

G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

H. Hood: Match curtain material and finish.

1. Mounting: Face of wall.

I. Locking Devices: Equip door with locking device assembly and chain lock keeper.

1. Locking Device Assembly: both jamb sides locking bars, operable from inside with thumb turn, outside with cylinder.

J. Manual Door Operator: Chain-hoist operator.

K. Curtain Accessories: Equip door with weatherseals.

L. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Color as selected by Owner from manufacturer's full range.

2. Interior Curtain-Slat Facing: Finish as selected by Owner from manufacturer's full range.

2.3 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

2.4 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: standard with manufacturer and keyed to building keying system.
2. Keys: Three for each cylinder.

C. Chain Lock Keeper: Suitable for padlock.

2.5 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.6 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 30-lbf (133-N) force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Lubricate bearings and sliding parts as recommended by manufacturer. Adjust seals to provide tight fit around entire perimeter.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

SECTION 08 71 00 - DOOR HARDWARE

PART 1 GENERAL

1.1 DESCRIPTION

Work includes furnishing and installing finish hardware on doors throughout the project as specified herein and as needed for a complete and proper installation.

1.2 SUBMITTALS

A. Submit copies of a complete schedule of hardware, listing each opening, door size, hand, frame material, and door label. State keying, material finish, and manufacturer's number for each item. Obtain ENGINEER's review before proceeding. Review does not relieve CONTRACTOR of responsibility for items that may not be included on the schedule.

B. Schematic Keying Diagram.

C. One copy of transmittal notice sent to door and frame fabricator by hardware supplier.

PART 2 PRODUCTS

2.1 MATERIALS:

For each of the required items of finish hardware, provide from the Hardware Schedule in the Drawings, or alternates approved in advance by the OWNER, and as follows.

A. Fasteners

1. Furnish necessary screws, bolts, and other fasteners of suitable size and type to anchor the hardware in position for long life under hard use.

2. Where necessary, furnish fasteners with expansion shields, toggle bolts, hex bolts, and other anchors, according to the material to which hardware is to be applied and according to the recommendations of the hardware manufacturer.

2.2 KEYING

A. Coordinate with OWNER.

B. Provide temporary keying throughout construction with temporary construction cores. Replace temporary cores with permanent cores at OWNER's direction at Final Completion.

2.3 FIRE DEPARTMENT KEY ACCESS BOXES

A. If required by authority having jurisdiction, provide fire department "Knox-Box" access key lock boxes. Apply for and order boxes through the local Fire Department having jurisdiction.

B. Boxes: Knox-box Series 3200 for recessed mount, 1/4-inch steel case, fully welded.

1. Size: 7" h x 7" w x 3-1/4" d with 7" square face plate.

2. Finish: Zinc phosphate with black polyester powder coating or dark bronze or aluminum, as selected by Owner.

3. Provide recessed mounting kit and all other required mounting accessories.

4. Coordinate and provide keying and type per fire/police department, and other jurisdictional agency requirements.

C. Where boxes are to be located within concrete or masonry walls, furnish Knox recess mounting kits for casting in place. Install box near the door indicated on the Drawings, approximately one foot from the door jamb and approximately five to six feet above finished grade.

2.4 OTHER MATERIALS

Provide other materials, not specifically described but required for a complete and proper installation, as selected by the CONTRACTOR and subject the approval of the OWNER.

PART 3 EXECUTION

3.1 PREPARATION

A. Deliver products complete with necessary parts for fitting and installing. Wrap each in a separate package, distinctly labeled and numbered for each opening for which it intended. Check merchandise ordered from the factory before sending to the job site.

B. Have an experienced person to receive, take charge of, and distribute hardware at the job site.

3.2 INSTALLATION

A. Install mortised items, then remove and place in their original package until painters have completed their work, then fit permanently in place.

B. Wrap hardware subject to hand usage during construction for protection. Keep finish free from blemishes or defects.

C. Mount hardware in location and height as recommended by SDI.

D. Adjust door closers for moderate swing in the sweep position and unless automatic flush bolts are used, adjust latch position for as slow a closing as practical.

E. Install door stops as directed by OWNER. Place door stops at point of contact. In certain locations, it may be advantageous to place stop on the door.

F. Ensure watertight joints at exterior doors.

3.3 CORRECTIONS AND CLEANUP

A. Replace scratched or damaged hardware with new hardware.

B. Remove protective maskings, clean surfaces.

C. Upon completion of this work, remove all disused implements, rubbish, and debris, and leave premises neat and clean.

3.4 HARDWARE GROUPS – SEE DRAWINGS

END OF SECTION

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Gypsum wallboard.
B. Joint treatment and accessories.

1.2 REFERENCE STANDARDS

A. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; current adopted edition.

B. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; current adopted edition.

C. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; current adopted edition.

D. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; current adopted edition.

E. ASTM C1396/C1396M - Standard Specification for Gypsum Board; current adopted edition.

F. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; current adopted edition.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 5 years of experience.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.

2.2 BOARD MATERIALS

A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.

1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. Thickness: as indicated on Drawings.

B. Moisture Resistant Gypsum Wallboard: Use within 4 feet of floor in restrooms. Field treat any cut edges with water repellant sealant as recommended by manufacturer.

2.3 ACCESSORIES

A. Finishing Accessories: ASTM C1047, rolled zinc or rigid plastic, unless otherwise indicated.

1. Types: As detailed or required for finished appearance.

B. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.

1. Ready-mixed vinyl-based joint compound.

C. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.2 INSTALLATION OF TRIM AND ACCESSORIES

A. Corner Beads: Install at external corners, using longest practical lengths.

B. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

1. Exception: Where gypsum board edge is concealed by other trim.

3.3 JOINT TREATMENT

A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:

1. As indicated on Drawings.

2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.

B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.

1. Feather coats of joint compound so that camber is maximum 1/32 inch.

C. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.4 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09 90 00 - PAINTING AND COATING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface preparation.
B. Field application of paints and stains.
C. Surfaces to be finished are indicated in this section and on the Drawings.

1.2 RELATED REQUIREMENTS

A. Section 04 20 00 Unit Masonry: Anti-graffiti sealer.
B. Section 09 21 16 Gypsum Board Assemblies

1.3 REFERENCE STANDARDS

A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; current adopted edition, www.paintinfo.com.

B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Master Painters and Decorators Association; current adopted edition.

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Provide complete list of all products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").

2. MPI product number (e.g. MPI #47).

3. Cross-reference to specified paint system(s) product is to be used in; include description of each system (copy of relevant MPI Manual page is acceptable).

C. Samples for Selection:

1. Submit two sets of stain manufacturer's standard color samples on wood substrate for selection.

D. Samples: Submit three paper "drop" samples, 6 x 8 inches in size, illustrating range of colors available for each finishing product specified.

1. Where sheen is specified, submit samples in only that sheen.

1.5 QUALITY ASSURANCE

A. Material Safety Data Sheets: At project site maintain file of MSDS sheets for each product used; become familiar with and follow manufacturer's stated application and safety requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.7 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

1.8 EXTRA MATERIALS

A. See General Conditions (Volume 1) for additional provisions.
B. Supply 1 gallon of each color; store where directed.
C. Label each container with color in addition to the manufacturer's label.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Paints and Coatings: Any manufacturer listed in MPI Approved Products List (at www.paintinfo.com) under applicable MPI product reference number, unless otherwise indicated.

B. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.

C. Where a paint is not specified for a specific material, provide the paint system appropriate for the material.

2.2 MATERIALS - GENERAL

A. Paints and Coatings: Provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI Categories, except as otherwise indicated.

1. Provide ready mixed paints and coatings.

2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.3 PAINT SYSTEMS

A. Concrete Masonry Units:

1. Sealer: Fabrishield PR-63 paint repellent by Fabrikem, www.fabrikem.com:

   a. Apply to exterior surface of all exterior walls and to interior surfaces of walls at publicly accessible restrooms.

B. Structural Steel and Metal Fabrications:

1. Applications include doors, frames, and louvers, window frames, gates, structural and miscellaneous steel.

2. Alkyd Metal Primer MPI #79, Alkyd MPI #9 (2 coats). Premium Grade.

C. Lumber, Sheathing, and Wood Trim – Exterior exposed to view:

1. Latex (over alkyd / oil primer): Alkyd / Oil Primer MPI #5, Latex MPI #10 (2 coats). Premium Grade.

D. Gypsum Board:

1. Epoxy High Build (over latex sealer): Latex Primer Sealer MPI #50, Epoxy High Build MPI #108 (2 coats). Premium Grade.

2.4 Steel, Iron, Galvanized and Non-Ferrous Metal; PVC For Structural, Tanks, Pipes, Conduits, Electrical Boxes, and Equipment

1. Exterior, Non–immersion: System 1075 Endura-Shield DFT / MILS

    a. Surface Prep: SSPC SP-6 for ferrous metal
    SSPC SP-7 for non-ferrous
    PVC hand sand to scarify
    NAPF 500-03-04 for Cast Iron

    b. 1st coat: Series 66-1255 Beige Hi-Build Epoxoline 3.0 - 5.0

    c. 2nd coat: Series 66-color Hi-Build Epoxoline 4.0 - 6.0

    d. 3rd coat: Series 1075-color Endura-Shield 2.0 - 3.0

2. Interior, Non-immersion: System 66 Hi-Build Epoxoline

    a. Surface Prep: SSPC SP-6 for ferrous metal
    SSPC SP-7 for non-ferrous
    PVC hand sand to scarify
    NAPF 500-03-04 for Cast Iron

    b. 1st coat: Series 66-1255 Beige Hi-Build Epoxoline 3.0 - 5.0

    c. 2nd coat: Series 66-color Hi-Build Epoxoline 4.0 - 6.0

    d. 3rd coat: Series 66-color Hi-Build Epoxoline 4.0 - 6.0

3. Immersion / splash potable water: Series 20 Pota-Pox

    a. Surface Prep: SSPC SP-10 for ferrous metal
    b. 1st coat: Series 20-15BL Tank White Pota-Pox 3.0 - 5.0
    c. 2nd coat: Series 20-44BR Beige Pota-Pox 3.0 - 5.0
    d. 3rd coat: Series 20-15BLTank White Pota-Pox 3.0 - 5.0

    All coatings in contact with potable water shall meet NSF/ANSI/CAN Std. 600 (NSF 600) extraction limitations.

4. Immersion / splash non-potable

    a. Surface Prep: SSPC SP-10 for ferrous metal: Series 66 Hi-Build Epoxoline
    b. 1st coat: Series 66-1255 Beige Hi-Build Epoxoline 3.0 - 5.0
    c. 2nd coat: Series 66-color Hi-Build Epoxoline 4.0 - 6.0
    d. 3rd coat: Series 66-color Hi-Build Epoxoline 4.0 - 6.0

5. High temperature surfaces

    a. Surface Prep: SSPC SP-10 for ferrous metal: Series 39 Silicone Aluminum
    b. 1st coat: Series 39-1261 — 1.0 - 1.5
    c. 2nd coat: Series 39-1261 — 1.0 - 1.5

B. Concrete

1. Interior Walls, Ceiling, Precast Ceiling Panels, exposed except floor: Series 66 Hi-Build Epoxoline

    a. Surface prep: SSPC SP-13
    b. 1st coat: Series 54-660 masonry filler — 80 – 100 sq. ft / gal.
    c. 2nd coat: Series 66-color Hi-Build Epoxoline — 3.0 - 4.0
    d. 3rd coat: Series 66-color Hi-Build Epoxoline — 3.0 - 4.0

2. Interior floors, Dustproof: NOT USED

3. Interior floors, Epoxy Clear Sealed, Skid Resistant

    a. Surface prep: Acid etch

    b. 1st coat: Series 66-L6207 Clear HB Epoxoline — 2.0 - 3.0

    c. Broadcast Series 287-300C as directed by engineer while prime coat is wet, sweep off excess when dry.

    d. 2nd coat: Series 66-L6207 Clear HB Epoxoline — 2.0 - 3.0

4. Interior floors, Laminate: NOT USED

5. Interior floors, Decorative: NOT USED

6. Interior floors, Chemical & Chlorine Room Series 221 Lami-Tread

    a. Surface prep: Shot Blast or Mechanically abrade
    b. 1st coat: Series 201 Epoxoprime — 6.0 - 8.0
    c. 2nd & 3rd coats: Series 221 Lami-Tread — 1/16” per lift
    d. 4th coat: Series 282 Tneme-Glaze — 8.0 – 10.0

PART 3 EXECUTION

3.1 SCOPE -- SURFACES TO BE FINISHED

A. Paint all exposed surfaces except where indicated not to be painted or to remain natural; the term "exposed" includes areas visible through permanent and built-in fixtures when they are in place.

B. Paint the surfaces described in PART 2, indicated on the Drawings, and as follows:

1. If a surface, material, or item is not specifically mentioned, paint in the same manner as similar surfaces, materials, or items, regardless of whether colors are indicated or not.

2. Paint surfaces behind movable equipment and furnishings the same as similar exposed surfaces.

3. Paint surfaces to be concealed behind permanently installed fixtures, equipment, and furnishings, using primer only, prior to installation of the permanent item.

4. Finish top, bottom, and side edges of exterior doors the same as exposed faces.

5. Paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment occurring in finished areas to match background surfaces, unless otherwise indicated.

    a. "Finished areas" are the restroom areas.

6. Paint all mechanical and electrical equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.

7. Paint shop-primed mechanical and electrical items occurring in finished areas.

8. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

C. Do Not Paint or Finish the Following Items:

1. Items fully factory-finished unless specifically noted; factory-primed items are not considered factory-finished.

2. Items indicated to receive other finish.

3. Items indicated to remain naturally finished.

4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.

5. Concealed piping, ductwork, and conduit.

3.2 EXAMINATION

A. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials; report incompatible primer conditions and submit recommended changes for Owner Project Manager's approval.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:

1. Concrete, and Concrete Unit Masonry: As directed by coating manufacturer.
2. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.

E. Measure the ph factor of concrete, masonry, and mortar before starting any finishing process, using the method specified in MPI Architectural Painting Manual.

1. Report results in writing to Owner Project Manager before starting work.

2. If results of test indicates need for remedial action, provide written description of remedial action. If a different primer or paint systems is required, state the total cost of the change. Do not proceed with remedial action or change without receiving written authorization from Owner Project Manager.

3.3 PREPARATION

A. Prepare surfaces as specified in MPI Architectural Painting Specification Manual and as follows for the applicable surface and coating; if multiple preparation treatments are specified, use as many as necessary for best results; where the Manual references external standards for preparation (e.g. SSPC standards), prepare as specified in those standards; comply with coating manufacturer's specific preparation methods or treatments, if any.

B. Coordinate painting work with cleaning and preparation work so that dust and other contaminants do not fall on newly painted, wet surfaces.

C. Surface Appurtenances: Prior to preparing surfaces or finishing, remove electrical plates, hardware, light fixtures, light fixture trim, escutcheons, machined surfaces, fittings, and similar items already installed that are not to be painted.

1. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before preparation and finishing.

2. After completing painting in each space or area, reinstall items removed using workers skilled in the trades involved.

D. Surfaces: Correct defects and clean surfaces which affect work of this section.

E. Concrete, Cement Plaster and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

F. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

G. Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

H. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

3.4 APPLICATION

A. Apply products in accordance with manufacturer's instructions and as specified or recommended by MPI Manual, using the preparation, products, sheens, textures, and colors as indicated.

1. Remove, refinish, or repaint work not complying with requirements.

B. Do not apply finishes over dirt, rust, scale, grease, moisture, scuffed surfaces, or other conditions detrimental to formation of a durable coating film; do not apply finishes to surfaces that are not dry.

C. Use applicators and methods best suited for substrate and type of material being applied and according to manufacturer's instructions.

1. Brush Application: Use brushes best suited for the type of material applied; use brush of appropriate size for the surface or item being painted; produce results free of visible brush marks.
    a. Not for use on doors and door frames.
2. Roller Application: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
    a. Not for use on doors and door frames.
3. Spray Application: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
4. Where application method is listed in the MPI Manual for the paint system that application method is required; otherwise any application method recommended by manufacturer for material used and objects to be painted is acceptable.
    a. Exception: Doors and door frames.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate; provide total dry film thickness of entire system as recommended by manufacturer.
1. Number of coats and film thickness required are the same regardless of application method.
    a. Minimum Coats: One coat of primer; two coats of finish paint.
2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance.
3. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive dry film thickness equivalent to that of flat surfaces.

E. Apply finish to completely cover surfaces with uniform appearance without brush marks, runs, sags, laps, ropiness, holidays, spotting, cloudiness, or other surface imperfections.
1. Before applying finish coats, apply a prime coat of material recommended by manufacturer, unless the surface has been prime coated by others; where evidence of suction spots or unsealed areas in first coat appear, recoat primed and sealed surfaces to ensure finish coat with no burn through or other defects due to insufficient sealing.

2. Apply first coat to surface that has been cleaned, pretreated, or otherwise prepared as soon as practical after preparation and before subsequent surface deterioration.

3. Do not apply succeeding coats until the previous coat has cured as recommended by manufacturer.

4. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat will not cause the undercoat to lift or lose adhesion.

5. If manufacturer's instructions recommend sanding to produce a smooth, even surface, sand between coats.

6. Before applying next coat vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

3.5 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Finish paint shop primed equipment to color selected.

B. Remove louvers, grilles, covers, access panels on mechanical and electrical components and paint separately.

C. Prime and paint insulted and exposed pipes, conduit, boxes, insulted and exposed ducts, hangers, brackets, collars, and supports except where items are prefinished.

D. Replace identification markings on mechanical and electrical equipment when painted accidentally.

E. Paint interior surfaces of air ducts and convector and baseboard heating cabinets visible through grilles and louvers with one coat of flat black paint, to limit sight lines.

1. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.

F. Paint exposed conduit and electrical equipment occurring in prefinished areas with color to match adjacent surfaces.

G. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

H. Color Coding

1. Color code equipment, piping, and conduit in accordance with specifications.

2. Color banding and identification (flow arrows, naming, numbering) in accordance with following schedule in accordance with the Recommended Standard for Water Works, published by the Great Lakes – Upper Mississippi River Board State Public Health and Environment Managers.

a.	Raw Water	110GN Clover
b.	Settled or Clarified Water	10GN Aqua Sky
c.	Finished or Potable Water	11SF Safety Blue
d.	Sewage Plant Effluent	07RD Terra Cotta
e.	Backwash Waste	68BR Twine
f.	Sludge	84BR Weathered Bark
g.	Sewer	GR28 Fossil
h.	Alum or Primary Coagulant	04SF Safety Orange
i.	Ammonia	11WH White
j.	Carbon Slurry	35GR Black
k.	Caustic	02SF Safety Yellow w/09SF Safety Green Band
l.	Chlorine (gas & solution)	02SF Safety Yellow
m.	Fluoride	25BL Fountain Blue w/ 06SF Safety Red band
n.	Lime Slurry	PA30 Daiquiri Ice
o.	Ozone	02SF Safety Yellow w/ 04SF Safety Orange band
p.	Phosphate Compounds	PA30 Daiquiri Ice w/ 06SF Safety Red band
q.	Polymers or Coagulant Aids	04SF Safety Orange w/ 09SF Safety Green Band
r.	Potassium/ Permanganate Sodium	14SF Safety Purple
s.	Soda Ash	PA30 Daiquiri Ice w/ 04SF Safety Orange
t.	Phosphoric/Sulfuric Acid	02SF Safety Yellow w/06SF Safety Red band
u.	Sulfur Dioxide	PA30 Daiquiri Ice w/ 02SF Safety Yellow band
v.	Compressed Air	91GN Balsam
w.	Gas	28RD Monterrey Tile
x.	Other Lines	32GR Light Gray
y.	Hoists / Trolleys	02SF Safety Yellow
z.	Fire Protection	06SF Safety Red

I. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.

3.6 CLEANING AND PROTECTION

A. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

B. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from site.

C. Protect other work, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting as approved by Owner Project Manager.

D. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in MPI Manual.

END OF SECTION

SECTION 09 97 13.24 - STEEL WATER STORAGE TANK PAINTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. High-performance coatings and special preparation of tank surfaces.

2. Painting and Coating: Preparing, priming, painting, and staining of surfaces.

B. Related Requirements:

1. Section 09 90 00 - Painting and Coating: Preparing, priming, painting, and staining of surfaces.

1.2 REFERENCE STANDARDS

A. Federal Specification Unit:

1. FS A-A-3054 - Paint, Heat Resisting (204 Degrees C).

B. Master Painters Institute:

1. MPI - Approved Products List.

2. MPI - Architectural Painting Manual.

C. Military Standardization Documents:

1. MIL C-22750D - Coatings: Epoxy Polyamide.

D. SSPC: The Society for Protective Coatings:

1. SSPC - Painting Manual, Volume 2: Systems and Specifications.

2. SSPC-Paint 16 - Coal Tar Epoxy-Polyamide Black (or Dark Red).

3. SSPC-SP 2 - Hand Tool Cleaning.

4. SSPC-SP 3 - Power Tool Cleaning.

5. SSPC-SP 5 - White Metal Blast Cleaning.

6. SSPC-SP 6 - Commercial Blast Cleaning.

7. SSPC-SP 7 - Brush-Off Blast Cleaning.

8. SSPC-SP 10 - Near-White Metal Blast Cleaning.

9. SSPC-SP 11 - Power Tool Cleaning to Bare Metal.

1.3 PREINSTALLATION MEETINGS

A. Convene a meeting a minimum one week prior to commencing Work of this Section. Meeting shall be attended by Contractor, Owner's representative, Engineer, Coating Applicators, and Manufacturer's representative.

B. Topics to be discussed at meeting shall include:

1. A review of Contract Documents shall be made and deviations or differences shall be resolved.

2. Review items such as environmental conditions, surface conditions, surface preparation, application procedures, and protection following application.

3. Establish which areas on-site will be available for use as storage areas and working area.

C. Inspection Services:

1. The Contractor shall designate a person to fulfill the requirements of the Inspector as described in the FIELD QUALITY CONTROL section. The COATING MANUFACTURER REPRESENTATIVE (Section 3.9) can fulfill these responsibilities.

1.4 SUBMITTALS

A. Volume 1 – Section 400 General Conditions – 103.9.00 Shop Drawings and Sample Submittals Shop Drawings: Submit product information related to surface preparation materials that meet specification requirements shown in Part 2, Products.

B. Product Data:

1. Submit manufacturer information indicating coating materials, performance ratings and application information.

2. Include MPI - Approved Products Lists with proposed products highlighted.

C. Samples: Submit two color samples, illustrating available colors for selection.

1. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Materials Resources Certificates:

a. Certify source for regional materials and distance from Project Site.

2. Indoor Air Quality Certificates:

a. Certify VOC content for each interior paint and coating.

D. Manufacturer Instructions: Submit special procedures, perimeter conditions requiring special attention and any other instructions or procedures.

E. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.

2. Submit manufacturer's approval of applicator.

1.5 CLOSEOUT SUBMITTALS

A. Volume 1 – Section 400 General Conditions – 103.9.00 Shop Drawings and Sample Submittals Provide Operation and Maintenance Data: Submit maintenance and cleaning requirements for coatings, repair and patching techniques and touch up recommendations.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Volume 1 – Section 400 General Conditions – 103.9.00 Shop Drawings and Sample Submittals Extra Stock Materials:

1. Furnish 1 gal. of each color of each type of coating specified, for Owner's maintenance use.

2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.7 QUALITY ASSURANCE

A. MPI Standards:

1. Comply with indicated MPI standards.

2. Products: Listed in MPI - Approved Products List.

B. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

B. Applicator: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer. Submit listing of not less than 3 of applicator's most recent applications representing similar scope and complexity to Project requirements. List shall include information as follows:

1. Project name and address
2. Name and phone number of OWNER
3. Name and phone number of CONTRACTOR
4. Name and phone number of ENGINEER
5. Date of completion

1.9 DELIVERY, STORAGE, AND HANDLING

A. Container Labeling: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

B. Inspection:

1. Accept materials on Site in manufacturer's sealed and labeled containers.
2. Inspect for damage and to verify acceptability.

C. Store materials in ventilated area and otherwise according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Minimum Conditions: Install in accordance with manufacturers recommendations.

B. Subsequent Conditions: Maintain above temperature range, 24 hours before, during, and 72 hours after installation of coating.

C. Provide lighting level of necessary to complete the project.

D. Restrict traffic from area where coating is being applied or is curing.

1.11 WARRANTY

A. Volume 1 – Section 400 General Conditions – 109.7.00 Warranties Include coverage for bond to substrate, degradation of chemical resistance and delamination.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Interior Coating

1. Coating manufacturer shall submit certified documentation that interior coating in contact with potable water has been certified in accordance with the National Sanitation Foundation Standard No. 600. Meets zinc-rich primer requirements of AWWA D102-03 Standards.

2. Galvanic Protection:

    a. Method: Primer applied to SSPC SP10 Near White Blast Clean hot rolled carbon steel.

    b. Requirement: The average measured potential of primer is -878 millivolts.

3. Adhesion:

    a. Method: ASTM D 4541(TTM-34) Type V Positester

    b. Requirement: Not less than 2,083 psi (14.36 MPa) adhesion, average of three trials.

4. Prohiesion:

    a. Method: TTM-80 Prohiesion Cabinet Testing.

    b. Requirement: No blistering, cracking, rusting or delamination of film. No more than 1/64” creepage at scribe after 15,000 hours.

5. Moisture Vapor Transmission:

    a. Method: ASTM D 1653

    b. Requirement: No more than .31 US perms water vapor permeability.

B. Exterior Coating:

1. Primer

a. Same as interior performance for primer

2. Finish

a. Abrasion:

1) Method: ASTM D 4060, CS-17 Wheel, 1000 grams load

2) Requirement: No more than 96 milligrams loss after 1000 cycles.

3. Adhesion:

a. Method: ASTM D 3359 Method B (Crosshatch Adhesion) Coating system applied to sandblasted steel panels and cured 30 days at 77 degrees F.

b. Requirement: Not less than a rating of 5, average of three tests.

4. Graffiti Resistance

a. Method: The following graffiti materials applied to coating and allowed to dry for seven days: acrylic, epoxy-ester and alkyd spray paints, ballpoint ink, crayon, Markett marker, black shoe polish and lipstick. Removal first attempted with xylene, if graffiti remained then Methyl Ethyl Ketone was used.

b. Requirements: Complete and easy removal without loss of shine.

2.2 COMPONENTS

A. Surface preparation

1. All welded and abraded areas shall receive a blast cleaning in accordance with SSPC SP10 Near White Blast Cleaning.

2. Fabrication Defects:

a. Correct steel and fabrication defects revealed by surface preparation.

b. Remove weld spatter and slag.

c. Round sharp edges and corners of welds to a smooth contour

d. Smooth weld undercuts and recesses.

e. Grind down porous welds to pinhole-free metal.

f. Remove weld flux from surface.

3. Ensure surfaces are dry.

4. Interior, Wet Substrate: Remove visible oil, grease, dirt, dust, mill scale, rust, pain, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2.

5. Exterior: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2.

6. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.

7. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions.

B. Coatings:

1. Description:

   a. Complete multicoat systems formulated and recommended by manufacturer for intended applications and in indicated thicknesses.

   b. Specified number of coats does not include primer or filler coat.

2. Lead content: None.

3. Chromium Content as Zinc Chromate or Strontium Chromate: None.

4. Maximum VOC Content: As required by applicable regulations.

5. Colors: As selected from manufacturer's standard colors.

6. Primer: As recommended by painting system manufacturer.

C. Interior Treatment

1. Interior Shop:

   a. Prime all prepared surfaces with one coat of Tnemec Series 94H2O at 2.5 to 3.5 mils dry film thickness.

2. Interior Field:

   a. Primer: All blasted areas shall receive one coat of Tnemec Series 94H2O at 2.5 to 3.5 mils dry film thickness.

3. Stripe Coat: Tnemec Series N140 @ 4.0 mils DFT

a. Intermediate Coat: Tnemec Series 21 at 6.0-8.0 mils dry film thickness.

b. Finish: Tnemec Series 21 at 6.0-8.0 mils dry film thickness.

D. Exterior Treatment – Zinc/Epoxy/Acrylic Polyurethane

1. Exterior Shop, Including Anchor Chairs and Bolts, Piping and Platforms:

   a. Prime all prepared surfaces with one coat Tnemec Series 94H20 at 2.5 to 3.5 mils dry film thickness.

2. Exterior Field

   a. Primer: All blasted areas shall receive one coat of Tnemec Series 94H20 at 2.5 to 3.5 mils dry film thickness.

3. Full Coat:

   a. Intermediate Coat: Tnemec Series 27FC Typoxy at 4.0 to 6.0 mils dry film thickness.

   b. Finish Coat: Tnemec Series 1095 Endurashield at 3.0 to 5.0 mils dry film thickness

   c. NOTE: Minimum dry film thickness shall be 9.5 mils

2.3 SURFACE PREPARATION MATERIALS

A. Abrasives

1. Abrasives used in blast cleaning operations shall be clean, well graded, non- metallic, and free of contaminants which would interfere with adhesion of the coatings to the substrate material.

2. Selection of abrasive size and type shall be based upon the type, grade, and surface condition of the steel to be cleaned and on the finished surface to be produced for the subsequent paint system.

3. Blast cleaning abrasives shall meet or exceed the following minimum criteria:

Description	Criteria
Shape	Angular
Hardness (Mohr Scale)	8
Specific Gravity	3.3
Bulk Density (1lbs/cu. ft.)	110
Free Silica (% by wt.)	0

4. Blast cleaning abrasive particle size shall be that which will produce a 2.0-mil (.002-inch) anchor profile on the substrate metal or in accordance with recommendations of the manufacturers of the specified coating system to be applied, subject to approval by the ENGINEER.

5. Blast cleaning abrasive manufacturer: Blast cleaning abrasives shall be Kleen Blast Abrasive as manufactured by Kleen Blast, Green Diamond Abrasive as manufactured by Green Diamond Sand Products or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 30 - Contract Closeout: Requirements for application examination.

B. Substrates:

1. Verify that substrate surfaces are ready to receive Work of this Section as indicated by coating manufacturer.

2. Obtain and follow manufacturer instructions for examination and testing of substrates.

3.2 PREPARATION

A. Provide a minimum of two days' notice to Owner in advance of spray painting to notify public and private property owners.

B. Contractor will be responsible and pay for all damage to public and private property which is a result of falling particles of metal, paint, or other materials which may fall during painting operations.

C. Clean surfaces of loose foreign matter.

D. Remove substances that would bleed through finished coatings; if removal is not possible, seal surface with shellac.

E. Remove finish hardware, fixture covers, and accessories and store.

F. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent.

G. Ferrous Metal:

1. Solvent clean.

2. Remove loose rust, loose mill scale, and other foreign substances.

3. Hand Tools: Comply with SSPC-SP 2.

4. Power Tools: Comply with SSPC-SP 3.

5. Blasting: Comply with SSPC-SP 10.

3.3 APPLICATION

A. Comply with MPI - Architectural Painting Manual.

B. Apply primer to each surface, unless specifically not required by coating manufacturer.

C. Apply coatings to specified thicknesses.

D. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish.

E. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.4 FIELD QUALITY CONTROL

A. Volume 1 – Section 400 General Conditions – 108.2.00 Samples, Testing and Inspection CLEANING

B. Collect waste material that may constitute fire hazard, place in closed metal containers, and remove daily from Site.

C. Clean surfaces immediately of overspray, splatter, and excess material.

D. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.5 PROTECTION

A. Protect adjacent surfaces and materials not receiving coating from overspray.

B. Mask when necessary to provide adequate protection and repair damage.

3.6 BRUSH COATS AND NON-SKID SURFACING

A. Specifications pertaining to brush coats and non-skid surfacing are as follows:

1. Brush Coats:

a. All welds, laps, edges, inside angles, and irregular surfaces shall receive a brush coat of the specified product prior to application of each complete coat.

b. Paint may be applied as a spray stripe coat and back brushed by hand.

c. Coatings shall be brushed in multiple directions to ensure penetration and coverage, as directed by the ENGINEER.

2. Non-Skid Surfaces:

a. Applied after the full prime coat has cured.

b. Where shown on the Drawings or specified elsewhere in this Section, a non-skid surface shall be applied to a portion of the reservoir roof surface.

3. Application:

a. Broadcast over a wet coat of the finish topcoat specified herein.

b. Following curing of coating/sand mixture, non-skid surface area shall be top coated with the same finish coating.

4. Locations:

a. On a 3-foot-wide strip extending from the roof access hatch to the vent at the center of tank roof.

b. On a 3-foot-wide strip around the roof vent at the tank center.

c. On a 3-foot-wide strip around the roof's access hatch.

3.7 ATMOSPHERIC CONDITIONS

A. No coatings shall be applied under the following limitations:

1. Temperature: If temperatures are anticipated to be as noted below within eight hours after application of the coating.

2. Epoxy Coatings: Surface to be coated is below 55 degrees Fahrenheit (F). Exceptions may be approved by ENGINEER with concurrence from manufacturer if material is "low temperature" type.

3. Inorganic Zinc or Urethane Finishes: Surface to be coated is below 40 degrees F.

4. When the temperature is less than 5 degrees F above the dew point.

a. The dew point shall be measured by use of an instrument such as a sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychometric Tables or other instrument acceptable to the ENGINEER.

5. When the temperature of the surface to be coated is above 125 degrees F for all coating types.

B. Surfaces: When the surfaces to be coated are wet or damp or there is the presence of rain, snow, fog, or mist coatings shall not be applied.

C. If any of the above adverse conditions are present, the coating or paint application shall be postponed until conditions are favorable. The day's coating or paint application shall be completed in time to permit the film.

3.8 COATING MANUFACTURER’S REPRESENTATIVE PARTICIPATION-COATING INSPECTOR

A. Painting/Coating Manufacturer’s Representative:

1. Services of the paint/coating manufacturer's representative shall be provided at no additional expense to the OWNER.

2. Reporting from the paint manufacturer's representative shall not preclude the ENGINEER from making independent assessments of the quality of Work. The ENGINEER will make the final decision as to the acceptability of the paint/coating systems.

3. Responsibilities:

a. Make periodic site visits throughout the course of the surface preparation and the painting/coating application.

b. Schedule all site visits with the ENGINEER.

c. Minimum Site Visits:

1) Inspect typical shop and field steel preparation prior to primer applications.

2) Inspect finished primer applications prior to application of intermediate coats.

3) Inspect each intermediate coat prior to application of subsequent finish coats.

4) Inspect final coats and report to the ENGINEER the representative’s assessment of the paint system's suitability and acceptability for the intended service.

d. Prepare and submit written reports directly to the ENGINEER immediately following each site visit.

1) Reports shall identify the representative's observations relative to the quality of the surface preparation and painting/coating work.

2) Reports shall address any conditions observed which have the potential to adversely impact the finished painting/coating system's integrity and performance.

3) Any such findings shall be immediately remedied by the CONTRACTOR.

3.9 COLLECTION, MONITORING AND DISPOSAL OF REGULATED WASTES

A. Unless otherwise indicated on the Plans or in the Specifications, all abrasive blasting material and byproducts, paints, solvents and containers, and any other discarded materials or equipment shall remain the property of the CONTRACTOR and shall be disposed of in a manner compliant with applicable Federal, State, and local laws and regulations governing disposal of all wastes generated by the CONTRACTOR in the prosecution of this work.

3.10 PAINTING REQUIREMENTS

A. Paint top surfaces of all purlins, rafters, beams and all other roof structural members prior to the roof plate installation.

B. Paint lower side of roof plates prior to installation.

C. Caulk all unwelded roof plate and structural member laps, prior to painting.

D. Caulking material; polyurethane sealant; PRC Permapad RC-270, Vulkem 921, or equal - Apply in accordance with the manufacturer's instructions.

E. Paint the underside of floor plates prior to laying down on the base material.

F. At columns, paint the top side of floor plates and the underside of column base plates prior to column erection.

3.11 PAINTING

A. Perform interior and exterior cleaning, preparation, and painting in accordance with AWWA D102 and Section 09 90 00.

B. Provide a first anniversary inspection of the tank painting, including testing and any required repair work, at no additional cost to the Owner.

END OF SECTION

SECTION 10 05 00 - BUILDING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire Extinguishers.
2. Rubber Switchboard Mats.

1.2 SUBMITTALS

A. Submit the following for Product Review.
B. Submit manufacturer's product literature and mounting details.
C. Submit shop drawings for identifying devices.

PART 2 PRODUCTS

2.1 FIRE EXTINGUISHERS

A. WARRANTY

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

2. Warranty Period: Six years from date of Substantial Completion.

B. PRODUCTS

1. PERFORMANCE REQUIREMENTS

a. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

b. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2. PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

   a. Fire Extinguishers: Type, size, and capacity for each location as indicated.

      1) 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:

         a) Amerex Corporation.
         b) Ansul Incorporated.
         c) Badger Fire Protection.
         d) Buckeye Fire Equipment Company.
         e) Fire End & Croker Corporation.
         f) Guardian Fire Equipment, Inc.
         g) JL Industries, Inc.; a division of the Activar Construction Products Group.
         h) Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
         i) Larsens Manufacturing Company.
         j) Moon American.
         k) Nystrom Building Products.
         l) Pem All Fire Extinguisher Corp.
         m) Potter Roemer LLC.
         n) Pyro-Chem; Tyco Safety Products.
         o) Strike First Corporation of America.

3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

C. Multipurpose Dry-Chemical Type 2A10BC: UL-rated, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

D. MOUNTING BRACKETS

1. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

   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) Amerex Corporation.
      2) Ansul Incorporated.
      3) Badger Fire Protection.
      4) Buckeye Fire Equipment Company.
      5) Fire End & Croker Corporation.

6) Guardian Fire Equipment, Inc.
7) JL Industries, Inc.; a division of the Activar Construction Products Group.
8) Larsens Manufacturing Company.
9) Nystrom Building Products.
10) Potter Roemer LLC.
11) Strike First Corporation of America.

E. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated on Drawings.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Vertical.

2.2 RUBBER SWITCHBOARD MATS

A. Provide corrugated rubber mats which conform to ASTM D178 Type II, oil resistant. Mats for low voltage (below 1 kV) switchboards and switchgear and motor control centers shall be rated for protection for 1,000 volts minimum to ground. Mats for medium voltage (1 kV to 15 kV) switchgear shall be rated 17,000 volts.

B. Mat shall be a minimum of ¼-inch thick and black in color with beveled edges. Mats shall cover the areas noted in the schedule and as a minimum shall extend the full width of the equipment with a minim width of 30 inches. Mats shall be as noted in the schedule and be a minimum 4 feet deep in front of low voltage equipment and 6 feet deep in front of medium voltage equipment.

C. Installation: Install at locations shown in the following schedule.

PART 3 EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: height as indicated on Drawings above finished floor to top of fire extinguisher.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

D. Rubber Mat Schedule:

Location	Area Coverage Required
Treatment Building	In front of all electrical, instrumentation, and telemetry panels

END OF SECTION

SECTION 10 14 00 - SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Restroom identification signs.

1.2 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities; Final Rule; current adopted edition; (ADA Standards for Accessible Design).

B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; current adopted edition.

C. ATBCB ADAAG - Americans with Disabilities Act Accessibility Guidelines; current adopted edition.

1.3 1.03 SUBMITTALS

A. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.

B. Design: Submit design of each sign type with all color and copy shown, for approval.

C. Verification Samples: Submit full size samples in proposed materials, colors and copy exactly as proposed for each sign type.

D. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

PART 2 PRODUCTS

2.1 SIGNAGE APPLICATIONS

A. Accessibility Compliance: All signs are required to comply with ADA Standards for Accessible Design and ANSI/ICC A 117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

2.2 SIGN TYPES

A. Flat Signs: Signage media without frame.

1. Edges: Square.

2. Corners: Square.

3. Materials:

   a. Vandal-resistant and UV-resistant two layered laminated plastic.
   b. 1 inch (25 mm) high letters.
   c. 1/32 inch (.75 mm) raised copy and boarder.
   d. Grade 2 braille under the lettering.

4. Wall Mounting of One-Sided Signs: As recommended by sign manufacturer for vandal-resistant permanent exterior mounting without exposed fasteners.

B. Color and Font: Unless otherwise indicated:

1. Character Font: Helvetica, Arial, or other sans serif font.
2. Character Case: Upper case only.
3. Background Color: Dark Blue.
4. Character Color: White color.

C. Sign quantity and copy:

1. Sign Type 1: "UNISEX" with unisex pictogram and braille – (5) at North site and (1) at South site.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions for vandal-resistant permanent exterior mounting without exposed fasteners.

B. Install neatly, with horizontal edges level.

C. Locate signs where indicated:

1. If no location is indicated obtain Owner's instructions.

D. Protect from damage until Substantial Completion; repair or replace damage items.

END OF SECTION

SECTION 10 20 00 - LOUVERS

PART 1 GENERAL

1.1 SECTION INCLUDES

Extruded aluminum automatic intake and exhaust dual combination louver dampers with stationary J-style louver blades, bird and insect screening, security bars, and automatic backdraft damper blades.

1.2 REFERENCES

A. AAMA 605.2 - High Performance Organic Coatings on Architectural Extrusions and Panels.

B. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

1.3 SUBMITTALS

A. Comply with requirements of General Conditions (Volume 1).

B. Product Data: Submit manufacturer's product data including performance data.

C. Shop Drawings: Submit shop drawings indicating materials, construction, dimensions, accessories, and installation details.

D. Samples: Submit sample of louver to show frame, blades, bird screen, seals, accessories, finish, and color.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.

C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURER

Ruskin Manufacturing, 3900 Dr. Greaves Road, Kansas City, Missouri 64030. Phone (816) 761-7476. Fax (816) 765-8955, Greenheck, or equal.

2.2 EXTRUDED ALUMINUM COMBINATION LOUVERS

A. Fabrication:

1. Model: See drawings for louver schedule. Typical: ELBD812 (for filter room), ELB0813 (for storage room).

2. Frame:

a. Material: Extruded aluminum, Alloy 6063-T5.
b. Wall Thickness: 0.081 inch (2.1 mm), nominal.
c. Depth: 4 inches (102 mm).
d. Construction: Masonry Wall Mount
e. Caulking surfaces.

3. Louver Blades:

a. Style: Stationary, J-style.
b. Material: Extruded aluminum, Alloy 6063-T5.
c. Wall Thickness: 0.081 inch (2.1 mm), nominal.
d. Angle: 45 degrees.
e. Centers: 5 inches (127 mm), nominal.

4. Backdraft Damper Blades:

a. Style: Gravity.
b. Material: Roll formed aluminum.
c. Wall Thickness: 0.031 inch (0.8 mm), nominal.

5. Bird Screen:

a. Material: Aluminum 1/2 inch mesh x 0.063 inch (13 mm mesh x 1.6 mm), intercrimp.

b. Frame: Removable, rewireable.

6. Seals: Synthetic seals mounted on louver blade edges to provide quiet operation.

7. Assembly: Factory assemble louver components.

B. Performance Data:

1. Based on testing 48 inch x 48 inch (1,219 mm x 1,219 mm) size unit in accordance with AMCA 500.

2. Free Area: 39 percent, nominal.

3. Free Area Size: 6.3 square feet (0.60 m2).

4. Maximum Recommended Air Flow Thru Free Area: 1,000 feet per minute (305 m/min).

5. Air Flow: 6,300 cubic feet per minute (178 m3/min).

6. Maximum Pressure Drop: 0.2 inches w.g. (0.05 kPa).

2.3 ACCESSORIES

A. Blank-Off Panels: 0.040 inch (1 mm) aluminum sheet, 1 inch (25 mm), aluminum skin, or insulated core, factory installed with removable screws and neoprene gaskets.

B. Hinged Frame: Continuous piano hinge attached to angle or channel subframe.

C. Security Bars on stationary louver blades side: Galvanized steel, 1/2 inch x 1/2 inch (13 mm x 13 mm) attached to louver with tamper-proof screws.

D. Bird Screens: Interwoven wire mesh of aluminum, 0.063 inch diameter wire, ½ inch open weave, square design.

E. Insect Screens: Aluminum mesh, set in aluminum frame.

2.4 FACTORY FINISH

A. Kynar 500 Fluoropolymer Coating:

1. Conform to AAMA 605.2.
2. Apply coating following cleaning and pretreatment.
3. Cleaning: AA-C12C42R1X.
4. Dry louvers before final finish application.
5. Total Dry Film Thickness: Approximately 1.2 mils (0.03 mm), when baked at 450 degrees F (232 degrees C) for 10 minutes.

B. Clear Anodize Finish:

1. Comply with Aluminum Association AA-C22A41. Clear anodize finish 215-R1.
2. Apply finish following chemical etching and pretreatment.
3. Minimum Thickness: 0.7 mils (0.018 mm), 60 minute anodizing process.

C. Prime Coat:

1. Apply alkyd prime coat following chemical cleaning and pretreatment.
2. Primer preparation for field painting.

D. Color for Fluoropolymer Coating: Color as selected by Architect from manufacturer's standard colors.

E. Color for Anodize Finish: Provide the following color samples for owner approval: Black, Clear Anodize, Dark Bronze, Medium Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

Inspect areas to receive louvers. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.

B. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

C. Install joint sealants as specified in by manufacturer.

D. Apply field topcoat within 6 months of application of shop prime coat. Apply field topcoat as specified in Section 09 90 00.

3.3 CLEANING

A. Clean louver surfaces in accordance with manufacturer's instructions.
B. Repair minor damaged surfaces as directed by Engineer.

END OF SECTION

SECTION 10 21 00 - EXHAUST FANS

PART 1 GENERAL

1.1 SECTION INCLUDES

Exhaust Fans.

1.2 REFERENCES

A. ASTM B209/B209M – Aluminum-Alloy Sheet and Plate
B. ASTM B211/B221M – Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

1.3 PERFORMANCE REQUIREMENTS

A. See drawing schedules.

1.4 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

Verify that field measurements are as instructed by the manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS

Aluminum: ASTM B221 alloy, temper; extruded shape; ASTM B209 alloy, temper, sheet; prefinished with shop applied siliconized polyester finish.

2.2 ACCESSORIES - NOT USED.

2.3 FABRICATION - NOT USED.

2.4 FINISHES

Aluminum Surfaces, Screen and Blank-Out Sheeting: Mill finish. Color as specified by Owner.

PART 3 EXECUTION

3.1 EXAMINATION

Verify that prepared opening is ready to receive work and opening dimensions are as instructed by the fan manufacturer.

3.2 INSTALLATION

A. Install fan assembly in accordance with manufacturer’s instructions.

B. Install fan level and plumb.

END OF SECTION

SECTION 10 21 10 - WALL MOUNT HEATERS

PART 1 GENERAL

1.1 SECTION INCLUDES

Wall mount heaters.

1.2 REFERENCES

A. UL-E21609
B. ASTM B209/B209M – Aluminum-Alloy Sheet and Plate
C. ASTM B211/B221M – Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

1.3 PERFORMANCE REQUIREMENTS

A. See drawing schedules.

1.4 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

Verify that field measurements are as instructed by the manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Q Mark
B. Dayton
C. Broan

2.2 MATERIALS

Aluminum: ASTM B221 alloy, temper; extruded shape; ASTM B209 alloy, temper, sheet; prefinished with shop applied siliconized polyester finish.

2.3 ACCESSORIES

A. Fasteners and Anchors: Steel mounting bracket adjustable.
B. Thermostat: Built-in SPST temperatures range 40-85 degrees F.
C. Flashings: aluminum.

2.4 FABRICATION - NOT USED.

2.5 FINISHES

Aluminum Surfaces, Screen and Blank-Out Sheeting: Mill finish. Color as specified by Owner.

PART 3 EXECUTION

3.1 EXAMINATION

Verify that prepared opening and heating coils are ready to receive work and opening dimensions are as instructed by the heater manufacturer.

3.2 INSTALLATION

A. Install heater assembly in accordance with manufacturer's instructions.
B. Install heater level and plumb.

3.3 ADJUSTING

Adjust operable louvers for freedom of movement of control mechanism. Lubricate operating joints.

END OF SECTION

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Accessories for toilet rooms.

1.2 RELATED REQUIREMENTS

A. Electrical Drawings: Air hand dryer.

1.3 REFERENCE STANDARDS

1.4 WORK BY AGENCY

A. Agency will provide and install accessories not listed in this section including, but not limited to: toilet seat cover dispensers, shelves, waste receptacles.

1.5 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Toilet Accessories:

1. American Specialties, Inc: www.americanspecialties.com.
    a. Standard of quality for soap dispenser only. Soap dispenser listed by American Specialties product number.
2. Bradley Corporation: www.bradleycorp.com.
3. Bobrick Washroom Equipment, Inc.: www.bobrick.com.
    a. Standard of quality. Accessories are listed by Bobrick product number.
4. Substitutions: General Conditions (Volume 1)

2.2 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

   1. Grind welded joints smooth.

B. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof, security type.

C. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.3 FINISHES

A. Stainless Steel: No. 4 satin brushed finish.

2.4 TOILET ROOM ACCESSORIES

A. Soap Dispenser: Liquid soap dispenser, integral with lavatory, reservoir in pipe chase.

   1. Tank: American Specialties 0378 2 1/2 gallon (9.5 L) surface mounted reservoir.

   2. Soap Valve - Companion Toilet: American Specialties 0353 standard liquid soap valve.

   3. Soap Valve - Main Toilet: Soap valves provided with wash fountain.

B. Grab Bars:

   1. Bobrick B-6806 Series, 18 inch, 36 inch, and 42 inch as indicated in Drawings.

C. Toilet Paper Dispensers:

   1. Surface-mounted, keyed dispenser for double nine inch diameter roll – 2 dispensers per stall, Bobrick B-2892.

D. Mirrors:

   1. 24” x 36” with stainless steel frame and replaceable acrylic glass cover pane. Use concealed wall hanger with theft-resistant locking device.

E. Hand Driers:

   1. ADA compliant World Dryer VERDEdri Q-974A, 110V White
   2. Approved alternate.

F. Sanitary Napkin Disposal Receptacles:

1. Stainless Steel, surface mounted, inner liner: Bobrick B-254.

PART 3 EXECUTION

3.1 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Provide all piping and connections for fully operational soap dispenser system. Install tank at elevation required for gravity flow to soap valve.

D. Mounting Heights and Locations: As required by accessibility regulations and as indicated on drawings

E. Connect to wash fountain soap valves.

END OF SECTION

SECTION 10 40 00 - IDENTIFYING DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

This section describes the signs, decals, tags, pipe markers, and other such devices which are to be incorporated into the project.

1.2 QUALITY ASSURANCE

A. Comply with the following reference standards:

1. Federal Occupational Safety and Health Act (OSHA): referenced sections, specifications for accident prevention signs and tags and exist signs, and comparable Sections in State OSHA.

2. American National Standard Specifications, ANSI A13.1, "Scheme for the Identification of Piping Systems."

3. National Fire Protection Association (NFPA) No. 704, System for the identification of the fire hazards of materials.

B. Comply with manufacturer's published recommendation for installation of materials used.

1.3 SUBMITTALS

A. Product Information. Submit a single complete package.

1. Submit scaled drawings or Photostats of every custom made sign proposed for use, showing size of lettering and colors.

2. Submit manufacturer's standard color palette for selection where requested herein.

3. Submit product literature on items proposed to be furnished.

PART 2 PRODUCTS

2.1 SIGNS

A. Provide signs by W.H. Brady Co., Seton Name Plate Co., or equal.

B. Sign No. 1: EXIT SIGN

1. Size: 14-inches wide by 10 inches high.

2. Material: Fiberglass, 0.100 inch thickness, Brady B-120.

3. Text:

   a. Conforming to OSHA 1910.1S(d)(5) and 1910.37(q)
   b. White text and symbols on red field as scheduled below.
   c. Exist signs: 6-inch high letters, ¾-inch wide principle strokes.

4. Provide eyelet holes at each corner for mounting.

Sign No.	Quantity	Text/Symbol
1	4	EXIT

C. Sign No. 2: FIRE EQUIPMENT LOCATION MARKERS

1. Size: 3-1/2 inches wide by 14 inches (approximate size)

2. Material: Fiberglass, 0.100-inch thickness, Brady B-120.

3. Text: Bright, fade resistant red on white downward facing directional arrow on red field. Text as shown on schedule below.

4. Provide eyelet holes at each corner for mounting.

Sign No.	Quantity	Text/Symbol	Seton	Brady or Equal
2	1/extinguisher	FIRE EXTINGUISHER	FSM33	47039

D. Sign No. 3: CHEMICAL SAFETY WARNING SIGNS

1. Provide chemical safety signs on exterior door and at each chemical tank as directed by owner.

2. Signs shall conform to OSHA 1910.1200.

2.2 TAGS

A. Accident Prevention Tags:

1. Seton Nameplate Co., W.H. Brady Co., or equal.

2. Size: Approximately 3-inches by 6-inches.

3. Material: Write-on matte finish plastic laminate, metal reinforced eyelet. Provide nylon or wire-tie fasteners.

4. Conform to OSHA 1910.145(F), Specifications for Accident Prevention Tags.

5. Text as scheduled below.

Quantity	Text
6	DANGER – DO NOT OPEN
6	DANGER – DO NOT CLOSE
6	EMPTY (red colored tag)
6	FULL (green colored tag)
6	CAUTION – IN USE (yellow colored tag)
6	DANGER – DO NOT OPERATE
6	OUT OF ORDER
6	DANGER – DO NOT START
6	SHUT-OFF VALVE

2.3 PIPE MARKERS

A. Seton Nameplate Co., SetMark, W.H. Brady, Pipe Marker System 1, or equal.

B. Pipe Markers conforming to ANSI A13.1

C. Material: Acrylic plastic snap –around type or pressure sensitive vinyl, temperature tolerance range of –40 degrees F to 250 degrees F, non-fade, colored fields, lengths as shown below.

D. Text: Pipe code name per Part 3. Non-fade ink, lettering size, as shown below:

Outside Diameter of Pipe (inches)	Length of Color Field (inches)	Size of Letters (inches)
¾ to 1- ¼	8	½
1- ½ to 2	8	¾
2- ½ to 6	12	1- ¼
8 to 10	24	2- ½
Over 10	32	3- ½

2.4 PROCESS EQUIPMENT NAMEPLATES

A. Nameplates shall be used to identify all process equipment including but not limited to pumps, chlorinators, control panels, and any other equipment requiring identification as directed by the Engineer.

B. Fabricated from 1/16-inch thick satin-surfaced Setonply, all edges beveled neatly.

C. Furnish with drilled holes for mounting to the appropriate equipment or nearest adjacent surface. As an alternative, acceptable adhesive attachment methods may be used if approved by the Engineer.

D. Nameplate background color, lettering color, and wording shall be as directed by the Engineer and approved by the Owner.

E. Minimum Size: 4-inch x 1-1/2-inch.

F. Manufacturer: Seton Nameplate Company, New Haven, CT, Style 2060-40 or approved equal.

2.5 CONFINED SPACE WARNING SIGNS

A. Painted aluminum with a yellow background and black lettering.

B. Each sign shall contain the following wording:

“DANGER
PERMIT-REQUIRED CONFINED SPACE
DO NOT ENTER”

PART 3 EXECUTION

3.1 SIGN INSTALLATION

A. Install signs for all equipment in a visible, accessible location.

B. Install signs after painting surfaces to receive signs. Follow manufacturer’s written installation instructions.

C. Use fasteners as follows:

1. To concrete and masonry materials: 4- ¼-inch diameter stainless steel expansion anchors and bolts.
2. To sheet metal (gauges 6 to 28) #10 stainless steel sheet metal screws.
3. To gypsum board: Adhesive backing tape.
4. To wood doors and hollow metal doors: Adhesive backing tape.
5. To chain link fencing: Wire ties at each corner.
6. To plywood backing boards: #10 wood screws.
7. To machinery: Stainless steel fasteners as suitable.

3.2 PIPE MARKERS

A. Install markers as indicated in the following schedule.

B. Apply pipe markers where exposed piping enters or leaves the wall or floor of a structure, adjacent to tanks or other hydraulic containments, at each valve, at each piping change in direction, and along piping runs not exceeding 20 feet on center.

C. Directional arrows: Point in the direction of the flow.

D. Locate pipe markers for easy reading. Where pipes are located above normal line of vision, the lettering and directional arrows shall be placed below the horizontal centerline of the pipe. Where pipes are below normal line of vision, lettering and directional arrows shall be above the horizontal centerline of the pipe.

3.3 SIGN LOCATION SCHEDULE

Install signs as indicated in the following schedule (quantity is total):

Sign No.	Quantity	Location Description
1	2	Entrance Door at each building (inside)
1	2	Rollup Door at each building
2	1/extinguisher	At each fire extinguisher
3	2	Entrance Door to chemical room at each building (outside)
3	6	On or beside each chemical tank, as directed by Owner

3.4 PIPE MARKER SCHEDULE

Pipe Abbreviation	Pipe Name	Pipe Label Letter	Pipe Label Field
SA	Sample	White	Green
PW	Plant Water	White	Green
BK	Backwash Water	Black	Yellow
UFW	Unfiltered Water	White	Red
FW	Filtered Water	White	Blue

3.5 PIPE COLOR SCHEDULE

Type of Pipe	Use of Pipe	Color of Pipe
Water	Raw Water Settled or Clarified Water Finished Water	Olive Green Aqua Dark Blue
Chemical Lines	Chlorine Solutions	Yellow
Waste Lines	Backwash Waste	Light brown
Other Lines	Compressed Air Gas Other Pipes	Dark Green Red Light Gray

END OF SECTION

SECTION 22 40 00 – PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

Section includes: labor, materials, equipment, services, and incidentals required to install a complete, operable, and tested, plumbing system as specified herein and as shown on the Drawings. All materials and equipment shall be new and of the best quality. Work shall include, but not necessarily be limited to:

A. Domestic water systems.
B. Plumbing fixtures and trim.
C. Laboratory piping.
D. Testing.

1.2 SUBMITTALS

A. Provide shop drawings and technical literature covering details of equipment, fixtures, and accessories furnished under this section.

B. Provide list of recommended spare parts.

1.3 QUALITY ASSURANCE

A. Codes:

1. Comply with the rules and regulations of Authorities having jurisdiction over the work specified herein, including the 1991 Uniform Plumbing Code with local amendments.

2. Where specifically indicated, fixtures shall be provided and installed in accordance with ANSI A117.1: "Specifications for Making Buildings and Facilities Accessible to, and usable by, the Physically Handicapped."

B. Obtain Permits and inspections as required by the various codes.

C. The Drawings shall be taken in a sense as diagrammatic. Size of pipes and general method of running them are shown, but it is not intended to show every offset and fitting nor every structural difficulty that may be encountered.

1.4 PLUMBING FIXTURES

A. General: Provide factory fabricated fixtures of type, style and material indicated on the plumbing fixture connection schedule. For each type fixture, provide manufacturer's standard trim, carrier, seats and valves as scheduled or as recommended by manufacturer as required for complete installation.

1. Fixtures: Complete with fittings, supports, fastening devices, faucets, valves, traps, stops and additional devices required.
2. Exposed IPS Piping and Tubing: Brass, chrome plated.
3. Escutcheons: Brass, chrome plated.
4. Fixtures Locations: As shown on Architectural Drawings.
5. Stops: Stops installed on each supply pipe at each fixture accessibly located with wall escutcheons.
6. Showers, Public lavatories, Interior Faucets: Provide with flow control device per code.

1.5 DEGASS SEPERATORS

A. The System consists of the following components:

1. North WTP: One (1) Gas Separators to remove entrained gas in the 8" raw water line. Up to 800 gpm.
2. South WTP: One (1) Gas Separators to remove entrained gas in the 8" raw water line. Up to 400 gpm.
3. Fittings, pipes, valves, instruments, and any other accessories and appurtenances required for a full operation system.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

PART 2 PRODUCTS

2.1 GENERAL

Equipment and materials shall conform to the standards and manufacturer’s serial numbers shown, or equal.

2.2 LABORATORY SINKS (EPOXY RESIN)

A. Chemical and corrosion resistant epoxy resin material heat-formed into one-piece construction, having rounded corners and 1-1/2 inch drain outlet. Same marker as work surfaces.

B. Inside dimensions: 30 inches long x 24 inches wide x 12 inches deep.

C. Acceptable manufacturers and products are:

1. Hamilton Modified Epoxy 20L202
2. Kewaunee Kemresin No. 1000 series
3. Or equal.

2.3 SINK DRAIN ASSEMBLIES

Durcon Model No. So-3 outlet with No. AD-1 adapter, No. DT-3 trap and BH-6 overflow; R&G Sloane Manufacturing Company Model No. 7841 A outlet with No. 7218 adapter, No. 7225 P-trap and No. 7842 overflow; or equal.

2.4 INTERIOR PLUMBING MATERIALS

A. Cleanouts:

1. Manufacturer: J.R. Smith, Jonespec, Zurn, Wade, or accepted substitute.

2. Types:

a. Tile Floor Cleanouts: Smith 4053-U with square heavy-duty nickel bronze top, taper thread, bronze plug, and vandalproof screws.

b. Carpeted Floor Cleanout: Smith 4023-U-X with round heavy-duty nickel bronze top, taper thread, bronze plug, carpet clamping device and vandalproof screws.

c. Concrete Floor Cleanout: Smith 4023-U with round heavy-duty nickel bronze top, stainless steel shallow cover and vandalproof screws.

d. Wall Cleanouts: Smith 4472-U, bronze ferrule with raised head bronze plug, stainless steel shallow cover and vandalproof screws.

e. Outside Area Walks and Drives: Smith 4253-U-G with galvanized cast iron body, top secured with vandalproof screws, taper thread and bronze plug. Install in 18" x 18" x 6" deep concrete pad flush with grade.

B. Flashing: Minimum 4# sheet lead; to extend horizontally 10" from edge of vent penetrations or rain drain body and vertically 12" minimum up from roof turned over and down into hub of vent or finished with bronze cap providing counterflashing for screwed pipe.

C. Shock Arrester: Precharged bellows or sealed piston type manufactured to meet PDI WH-201 and ASSE 1010 Standards. Size in accordance with PDI procedures. Jonespec, J.R. Smith, PPP, Wade, Zurn, or accepted substitute.

D. Traps: Provide traps on all fixtures except fixtures with integral traps. Exposed traps chromium plated cast brass or 17 gauge chrome plated brass tubing. American Standard, Kohler, Chicago, Brasskraft, Eastman, Speedway, McGuire or approved substitute.

E. Supplies and Stops: First quality, chrome plated with brass stems. Stops: loose key type. American Standard, Kohler, Chicago, Brasskraft, Eastman, Speedway, McGuire or approved substitute.

F. Thermometers: 3-inch diameter bi-metal dial thermometer with stainless steel case, white dial, black numbers with 4-inch stainless steel stem and brass separable socket. Provide back or bottom connections as required. 0°F to 200°F range. Weiss, Palmer, Ashcroft, Trerice, Marshalltown, Weksler or approved substitute.

G. Pressure Gauges: Single arm guide gauge with 0 to 160 range, 20 PSI intervals and 2 PSI incremental graduations. Aluminum dial with 1 percent accuracy and low bottom connections for wall mounting. Weiss, Palmer, Ashcroft, Trerice, Marshaltown, Weksler or approved substitute.

2.5 2.03 PRIMING VALVES:

A. Smith 2699, Wade, Zurn, PPP or accepted substitute. Locate in closets, under counters or in walls behind Milcor or access panels as specified in Section 15050. Use copper specified in Section 15060 for all underground priming lines.

2.6 DEGAS SEPERATORS

A. Mazzei Injector Company or accepted substitute:

1. North WTP: One (1) system unit, Mazzei DS600-A (DSF06030AAA00A-SUB) or equivalent

   a. Body and flanges: Type 316L stainless steel
   b. Gaskets: TFE or PTFE

2. South WTP: one (1) system unit, Mazzei DS400-A (DSF04030AAA00A-SUB) or equivalent

   a. Body and flanges: Type 316L stainless steel
   b. Gaskets: TFE or PTFE

B. All equipment, valves, valve seats, analyzers, seals, gaskets, welds and all associated appurtenances to be used with oxygen, must be resistant to degradation and gas losses due to the use of this gas.

1. Greases and lubricants shall be oxidation resistant, Dupont "Krytox," or equal.

C. COMPONENTS

1. Designed to effectively remove entrained gas from the ozonated sidestream while maintaining the required mass transfer efficiency.

2. Centrifugal vortex type.

3. Designed to effectively process flow rates produced from the Mass Transfer Skids (one Gas Separator per Mass Transfer Skid).

4. Inlet and outlet water connections: 8-IN flanged

   a. DS400-A: 4-IN flanged
   b. DS600-A: 6-IN flanged

5. Entrained off-gas outlet connection via air relief valve

   a. Inlet to air relief valve: 3IN

   b. Outlet from air relief valve: 1IN

   c. Manifold all off-gas outlets to a common header pipe to convey gas to the ozone destruct units.

6. Provide a manual backpressure valve (high performance butterfly valve meeting Section 40 05 64) on the discharge of each Gas Separator.

D. SOURCE QUALITY CONTROL

1. Conduct factory hydrostatic leak test.

   a. Pressurize to 110% of normal operating pressure.
   b. Hold for 2 hours
   c. Demonstrate no leaks by pressure decay - no pressure loss.
   d. Submit results to owners engineer.

2.7 PLUMBING FIXTURES

A. Stops: Furnish stop valves for all fixtures. In-line non-adjustable, located in pipe chase (pattern to fit installation). Kohler, Speedway, Chicago, Eastman, Brasskraft, or accepted substitute.

B. Water Closet

1. Install each wall hung water closet with code approved electric flush meter, quiet acting, chrome plated, screwdriver stop and vacuum breaker as recommended by water closet manufacturer.

2. Provided with concealed wall hangers for stainless steel water closet fixtures.

3. Bases of design, Manufacturers Model: Plumbing Supply #4110-HS Back Supply and 3" minimum waste outlet.

C. Urinal

1. Wall mounted waterless urinal with periodic auto-cleaning system, quiet acting, chrome plated, and vacuum breaker as recommended by urinal manufacturer.

2. Provide with concealed wall hangers for urinal fixture.

3. Bases of design, Manufacturers Model: Falcon HYP-4000.

D. Lavatories

1. Provide with wall backing plate for lavatory assembly and assemble lavatory with faucet as required.

2. Bases of design, Manufacturers Model: Acorn Wash-Ware ADA compliant, wall mounted with infrared control, accommodating 1-2 users at a time, with soap integral to wash fountain, model 3401-1-SO-BDM (soap dispenser – 9965-250-002).

E. Water Closet Seats

1. Solid black reinforced plastic, hinge with insert integrally in seat. Church 9500C, Olsonite, Beneke, Bemis or accepted substitute.

F. Floor Drains

1. FD-1 Cast iron body, double drainage flange with weep holes, priming connection, nickel bronze strainer finish, flashing clamp device, adjustable or insert type strainer. Comply with ANSI. Smith Model 2005-A, Josam, Zurn or accepted substitute.

G. Floor Drains integral cleanout

1. FD-2 Cast iron body, double drainage flange with weep holes, priming connection, nickel bronze strainer finish, flashing clamp device, adjustable or insert type strainer. Comply with ANSI.

2. Bases of design, Manufacture Model, Smith Model 2040.

H. Wash Fountains

1. Fountain shall accommodate 1-4 users at a time. The pre-assembled spray modules shall be equipped with four independent streamformers, each controlled by a

separate infrared sensor module. ADA 54” Sentry Semi-Circular Shallow Bowl Wash Fountain, wall mounted with soap integral to the wash fountain and backsplash

2. Bases of design, Manufacturer Model, Bradley SN2024.

I. Floor Sink

1. Bases of design, Manufacturer Model, Gamut #968Z178

J. Auto-flush valve

1. Quiet, diaphragm type, chrome plated closet flushometer, infrared sensor with indicator light, chrome plated wall cover plates with vandal resistant screws.

2. Bases of design, Manufacturer Model: Royal 152-1.6 ES-S.

2.8 HOSE BIBBS

A. Freezeless

B. For hot, cold, or hot and cold water as indicated.

C. Bases of design, Manufacturer Model, Woodford V22CP-4-MH for hot and cold water and similar for hot or cold water only.

2.9 PIPE SLEEVES

A. Interior Wall Sleeves: 12 gage galvanized steel, flush with wall on both sides.

B. Interior Floor Sleeves: 12 gage galvanized steel and extend 2-inches above finished floor.

C. Exterior Wall Sleeves: Cast iron, flush with wall on both sides.

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

2.10 ESCUTCHEONS

A. Brass material, chrome plated finish. Size sufficient to cover all pipe openings through wall, floor or ceiling. Set screw or spring to secure to pipe.

2.11 UNIONS

A. Steel pipe union shall be 150-pound malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe.

B. Copper pipe union shall be 200 psig working pressure. Bronze body. Solder ends.

C. Insulating unions shall be 250 psig working pressure. Pipe ends and material to match piping. Electric current below 1% of galvanic current. Gasket material as recommended by manufacturer. Epco or approved.

2.12 EMERGENCY EYEWASH AND SHOWER COMBINATION UNIT

Eyewash station assemblies shall be Honeywell Pure Flow 1000 Eyesaline Eyewash Station or equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Confirm location and size of fixtures and openings before rough- in and installation.

B. Verify adjacent construction is ready to receive rough-in work of this Section.

C. Review rough-in locations of potable water and waste piping systems to verify actual locations prior to installing fixtures.

D. The Supplier is responsible for all equipment being adequately and effectively protected against the damage from handling, or other cause, during transport from Supplier’s premises to the place of delivery.

E. The Contractor is responsible for proper storage and protection of the equipment from the time of delivery until Final Acceptance.

3.2 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Install components level and plumb.

C. Install and secure fixtures in place with wall carriers and bolts. Install fixtures as shown on drawings.

1. Support all wall hung water closets and urinals on heavy duty, concealed, chair carriers mounted to floor structure.

2. Support wall hung lavatories mounted on stud partitions on heavy concealed wall brackets bolted to a steel plate anchored firmly to studs with bolts. Plate to extend one stud each way beyond fixture mounting point width. Floor mounted concealed arm carriers approved.

D. Cleanouts

1. Where required by code, at each change of sewer direction 45 degrees or greater and more than 10' long, at end of each branch or main and spaced not greater than 100' apart, as required by code and/or as shown on Drawings.

E. Install all devices in accordance with manufacturer's written instructions and recommendations.

F. Provide waste piping to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by code.

G. Mechanical Equipment Connections: Connect piping system to mechanical equipment as indicated. Comply with equipment manufacturer's instructions. Provide shutoff valve and union for each connection. Provide drain valve on drain connection.

H. Water Hammer Arrestors: Install in upright position, in locations and of sizes per PDI WH-201.

I. Arrange locations of valves, unions, drains and other components to provide for ease of maintenance, repair or service. Size access panels and locate to provide working spaces for all devices served by access.

J. Provide valves and shock arrestors where required by code and where otherwise indicated in Specifications and on Drawings.

K. Degas Separator

1. System shall be installed in accordance with the Supplier's written recommendations and instructions. Anchor bolts and templates shall be provided to the Contractor by the Supplier.

L. Fixtures:

1. Install plumbing fixtures where shown and at appropriate heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings and industry standards.

2. Set and connect to soil, waste, vent and water piping in neat, uniform manner. Connections to be plumb and set at right angles to floor and wall unless otherwise required.

3. Seal fixtures mounted on floors and walls with sealant compounds as directed by architect.

4. Set mixing valves of lavatories to limit temperature to 110°F.

M. Stops: Screwdriver or loose key stops to be installed in hot and cold supply pipe to each fixture accessibly located.

N. Floor Drains:

1. Install drains in accordance with manufacturer's written instructions. See Drawings for locations.

2. Install floor drains at low points of areas to be drained or as indicated. Grate to be flush with finished floor. Set floor sinks as required by local codes.

3. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Prime all drains. Refer to Drawings. Contractor to prime all drain traps at close of construction. Do not utilize trap primers for fill. Coordinate with local authorities for exact requirements.

O. Hose Bibbs:

1. Install where shown, in accordance with manufacturer's installation instructions.

3.3 ADJUSTING AND CLEANING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow

B. At completion clean plumbing fixtures and equipment.

C. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.4 INSPECTION

A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Engineer. Remove cracked or dented units and replace with new units.

END OF SECTION

SECTION 26 05 00 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

The Harrisburg Water Improvements project includes electrical work at existing North and South Facilities. Work includes replacement of electrical systems, new added electrical equipment as well as a new well 9 at the North facility. The following Electrical, Instrumentation and Controls scope of work includes (but is not limited to) the following:

A. General Electric Utility Information and coordination

1. The Electric Utility servicing both City of Harrisburg locations is:

   a. Pacific Corp
   b. Builder Support phone number is: 800-469-3981
   c. North Site Meter reference number: 77 293 629 (WO# 6969111)
   d. South Site Meter reference number: 74 264 282 (WO# 6969110)

2. Refer to Pacific Corp “Electric Service Requirements Manual” for electric utility requirements for all utility transformer to meter and client incoming service entrance. Located on Pacific Corp website at: https://www.pacificpower.net/working-with-us/builders-contractors/electric-service-requirements.html.

3. The Contractor shall provide permitting and submittals to utility and will coordinate with the utility for any required outages during construction. Any utility forms needing City’s representative signature and information shall be coordinated with the City Project Manager/Engineer.

4. Utility required outages during construction shall be coordinated with City operations personnel in order to maintain water distribution system supply and pressure.

B. Hardware System Integrator (HSI) and Software System Integrator (SSI):

1. The Hardware System Integrator (HSI) under this contract shall install, configure and test the base set of SCADA/PLC software and configure all network equipment including the cellular systems. The communications systems shall be configured and tested to confirm communication between two devices at all locations on the network. Upon completion and verification of the testing documents by the Owner’s Construction Representative, the HSI shall notify the Owner/Engineer/SSI that the system is ready for Process Control Software Download.

2. The Software System Integrator (SSI) (under a separate contract) shall design, configure and commission the SCADA and PLC process control software. After notifications from the HSI that the network systems are tested and operational, the SSI shall download the process control programs to the HSI configured systems and verify systems are communicating across the preconfigured networks.

C. The Telemetry and SCADA work for both facilities:

1. The Telemetry systems shall consist of Cellular Modems based on the FirstNet cellular network utilizing Cradle Point modems. The system will be setup as a first responder type network for resilience and dependability. The Contractor shall install, setup, configure, commission and test the cellular network. The system will be Ethernet based and provide the backbone for the SCADA communication systems.

2. The SCADA system shall be native compatible Rockwell Ethernet/IP communications with the Rockwell PLC systems. The contractor shall provide a network and component system capable of supporting the pre-purchased Rockwell FactoryTalk and Logix5000 software and based on the drawing SCADA Systems architecture.

3. PC equipment will be provided under this contract. The systems will be configured and installed utilizing NIST SP 800-82, Rev. 2, Guide to Industrial Control Systems as a Cyber Security resource.

4. Contractor to purchase all computer equipment as identified on the network diagram.

D. Work at North Facility:

1. Addition of a new North Reservoir with electrical, control/signal, lightning protection and grounding.

2. Addition of a new building to house the pressure filter, chemical systems, electrical infrastructure, booster pumps and fire pump. The building will also include five bathrooms for the neighboring Fair Grounds for various activities.

3. Addition of Well 9 building and all equipment to make a functional operating well. The well will supply water to a new reservoir located near the existing Well 8 facility.

4. Well 8 incoming electrical will be decommissioned and a new power feed from the new MCC will be installed. The well 8 ATS shall be replaced with a disconnect switch and all associated hardware will be modified to accommodate the new power feed. Refer to electrical drawings.

5. The existing well 8 utility meter and the utility wiring will remain intact for possible future metered connection to the fairgrounds area. A conduit will be installed to the new manhole (with a pull string) as shown on the drawings and only conduit will be installed for future use.

6. The electrical will require the following:

    a. A new utility electrical service and secondary conductor conduit/wire from the utility pole to the meter box at the new building to meet the new loads. NOTE" Currently the transformer is mounted on the pole which may change to a pad mounted transformer should the utility require it during construction.

    b. A new utility meter box, incoming equipment, backup generator, ATS, MTS (with portable generator connection) and MCC as shown on the drawings.

    c. New Power, Instrumentation and Control wiring for all equipment as identified in these specifications and the drawings.

    d. New Power, Instrumentation and Control conduit and wiring to/from the new Well 9.

    e. Set the Well 8 VFD to constant speed as it is no longer feeding directly into the distribution system. The contractor shall examine the pump curve of the existing pump and estimate the proper speed for pumping to operate at its most efficient point.

    f. Modification of the electrical control scheme for Well 8 to meet the new wiring and control schematic requirements as shown on the drawings. Refer to the FVNR electrical schematics in the drawings and adjust to interface with the existing VFD (to be operated at constant speed).

    g. A Process Automated Control (PAC) system including a PLC, instrumentation and control functions required by these specifications and the drawings.

    h. Facility and area lighting.

    i. Proper grounding per the NEC, IEEE Green Book, these specifications and drawings.

E. Work at South Facility:

1. Addition of a new South Reservoir with electrical, control/signal and grounding.

2. Addition of a new building to house the pressure filter, chemical systems, electrical infrastructure, booster pumps and fire pump.

3. The electrical will require the following:

    a. Replace the existing utility electrical service and feeder conduit/wire to the existing MCC building with new service feeder conductors from the existing transformer.

    b. Install a new Allen Bradley MCC. Utilize the existing feeder boxes, conduit and wire from Wells 4, 6 & 7 and reconnect to new MCC.

    c. A new utility meter box for larger service, incoming equipment, backup generator, ATS, MTS (with portable generator connection) and MCC as shown on the drawings.

    d. Rewire existing circuits from existing distribution panel to the new distribution panel.

    e. Rewire existing Maintenance Building wiring to new MCC.

    f. A power sub feeder to the new Filter and Pump Station building MCC from the new MCC in the existing building.

    g. Power, Instrumentation and Control wiring for all equipment as identified in these specifications and the drawings. Note the conduits to the new instruments on the existing reservoir and the new reservoir.

    h. Modification of the electrical control scheme for Wells 4, 6, and 7 to meet the new wiring and control schematic requirements as shown on the drawings. Refer to the FVNR electrical schematics in the drawings.

    i. A Process Automated Control (PAC) system including a PLC, instrumentation and control functions required by these specifications and the drawings.

    j. Facility and area lighting per drawings.

    k. Proper grounding per the NEC, IEEE Green Book, these specification and drawings.

F. Work in General:

1. Provide all required labor, project equipment and materials, tools, construction equipment, safety equipment, transportation, and test equipment, and satisfactorily complete all electrical work shown on the Drawings, included in these Specifications, or required for a complete and fully operating facility. In addition, provide wiring for the equipment that will be provided under other Divisions of these Specifications.

2. Provide all conduit for the Instrumentation and Controls specified in Division 40. Provide all Instrumentation and Control wire that is specified in Division 26.

3. Auxiliary Devices: Provide conduit and wire for power and control for all auxiliary devices such as solenoid valves, pressure switches, and instruments that are included as part of a manufacturer's packaged system (i.e., all systems specified in divisions covering packaged systems). Contractor shall be responsible for conduit and wire to these auxiliary devices even if not specifically shown on the Drawings or specified herein. Coordinate with contractor providing pressure filters, chemical systems and any other package equipment supplied for the project.

4. Coordination with local utility to clarify boundaries for connection purposes.

G. Work Specified in Other Divisions:

1. Division 40: Providing instruments and other electrical equipment specified in Division 40.

H. Work to be done by Others outside this contract and coordinated by the contractor under this contract:

1. Provide and connect Utility Power Company meters and main incoming wire as coordinated with the local utility. Refer to utility’s boundaries of responsibility.

2. Coordinate with the SSI (Software System Integrator) regarding scheduling for SCADA and PLC I/O testing, startup, installation, functional testing and startup/commissioning.

3. Provide telephone company instruments, relays, terminals, and cables. (if required by field modifications).

I. Safety:

1. Conduct operations in accordance with NFPA 70E, Standard for Electrical Safety Requirements for Employee Workspaces.

1.2 SUBMITTALS

A. Shop Drawings:

1. General: Submit Product Review or Product information shop drawings for materials and equipment as required under the General Conditions (Volume 1).

2. For Product Review submittals, submit a single, complete submittal package for all items specified in a particular Specification section. Submittal packages shall be

organized by equipment type. Include separators and tabs or other means of identifying each Specification paragraph (e.g., 2.01, 2.02, etc.) of the submittal.

3. For substituted (or equal) equipment in submittals, provide product data sheets and warranty information for first named and the substituted equipment. Identify any differences between the first named and the substitution. Provide technical benefits of the substitution over the first named.

B. As-Built Shop Drawings: Revise manufacturer's shop drawings to show any construction changes. Prior to final acceptance, deliver one complete set to the Engineer for favorable review. After such review, provide copies of all CAD produced drawings on magnetic media satisfactory to the Engineer in AutoCAD DWG format.

C. Manuals:

1. Furnish manuals for equipment where Manuals are specified in the equipment Specifications. Submit manuals in accordance with the requirements of the General Conditions (Volume 1).

2. In each manual, include equipment descriptions, record shop drawings, operation and maintenance instructions, parts ordering data and ratings for the equipment furnished for this project.

D. Spare Parts:

1. For each piece of equipment, submit a list of recommended spare parts (Preferably in MS Excel format). Include part numbers and the name, address, and telephone number of the supplier.

1.3 QUALITY ASSURANCE

A. Codes: All electrical equipment and materials, including installation and testing, shall conform to the following applicable codes and publications.

1. National Electrical Code (NEC), applicable edition

2. State of Oregon Electrical Code

3. National Electrical Safety Code (NESC), recent edition

4. Occupational Safety and Health Act (OSHA) standards

5. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, International Electrical Testing Association (NETA), recent edition.

6. Practices identified in the NECA 1-2006 Good Workmanship in Electrical Construction publication shall be adhered to.

B. Variances: In instances where two or more codes are at variance, the most restrictive requirements shall apply.

C. Standards: Equipment shall conform to applicable standards of American National Standards Institute (ANSI), Electronics Industries Association (EIA), Institute of Electrical and Electronics Engineers (IEEE), and National Electrical Manufacturers Association (NEMA). The revisions of these standards in effect on the date of issuance of the Contract Documents shall apply.

D. Underwriters Laboratories (UL) listing is required for all equipment and materials where such listing is offered by the Underwriters Laboratories. Safety labeling and listing by other organizations, such as ETL Testing Laboratories, may be substituted for UL labeling and listing if acceptable to the authority having code enforcement jurisdiction. Should the authority having code enforcement require UL certification after the equipment is installed, the UL field certification costs shall be the contractor’s responsibility at no expense to the Owner or Engineer. Provide service entrance labels for all equipment required by the NEC to have such labels.

E. Contractor's Expense: Obtain and pay for all required bonds, insurance, licenses, permits and inspections, and pay all taxes, and fees that will be required for the electrical construction work.

1. Exception: Fees from the electrical utility company will be paid by the owner.

F. Series short circuit ratings for protective devices are not allowed.

1.4 DRAWINGS

A. The Electrical Drawings are diagrammatic; exact locations of electrical products shall be verified in the field with the Owner’s Construction Representative except where special details are used to illustrate the method of installation of a particular piece or type of equipment or material, the requirements or descriptions in this Specification shall take precedence in the event of conflict.

1. Locations of equipment, inserts, anchors, motors, panels, pull boxes, manholes, conduits, stub-ups, fittings, lighting fixtures, power and convenience outlets, exterior lighting units and ground wells are approximate unless dimensioned; verify locations with the Engineer prior to installation.

2. Field verify scaled dimensions on Drawings.

3. Review the Drawings and Specification Divisions of other trades and perform the electrical work that will be required for the installations.

4. Should there be a need to deviate from the Electrical Drawings and Specifications, submit written details and reasons for all changes to the Engineer for favorable review.

5. Resolution of conflicting interpretations of the Contract Documents shall conform to the General Conditions (Volume 1).

B. As-Built Drawings:

1. Maintain a complete full-size and accurate red-lined Record Set of Drawings for the electrical construction work. This set shall remain in the main construction facility, not used in the field and shall be updated on a weekly basis. The Owner or Engineer shall have access to these drawings at any time during construction.

2. Record all work that is installed differently than shown on the Drawings. Identify with cloud lines, initials and date the change was incorporated into the drawing set.

3. During construction, markups on all field sets of drawings shall be transferred to the clean set of full-size Drawings (item #1 above) with red ink. Mark the Drawings "AS-CONSTRUCTED DRAWINGS" and submit them to the Engineer when the electrical work is completed.

4. Locate all underground conduits by accurate field-measured dimensions from walls and corners, etc., of surrounding structures. Identify these conduits on the Record Set of Drawings prior to pouring concrete. Have the redlines verified by the Owner's Construction Representative prior to pouring concrete.

1.5 FACTORY TESTS

A. Submit reports of factory tests and adjustments performed by equipment manufacturers to the Engineer prior to field testing and adjustment of the equipment. These reports shall identify the equipment and show dates, results of tests, measured values and final adjustment settings. Provide factory tests and adjustments for equipment where factory tests are specified in the equipment Specifications.

1.6 INSPECTIONS

A. The Engineer/Owner or Owner representative may inspect the fabricated equipment at the factory before shipment to job site. Provide the Engineer with sufficient prior notice (minimum of 14 calendar days) so that an inspection can be arranged at the factory.

B. Inspection of the equipment at the factory by the Engineer/Owner or Owner's Construction Representative will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.

C. Favorable review of the equipment at the factory only allows the manufacturer to ship the equipment to the project site. The Contractor shall be responsible for the proper installation and satisfactory startup operation of the equipment to the satisfaction of the manufacturer and the Engineer.

1.7 COORDINATION

A. Coordinate the electrical work with the other trades, code authorities, utilities, and the Owner.

B. Where connections must be made to existing installations, properly schedule all the required work, including the power shutdown periods. Schedule and carry out shutdowns so as to cause the least disruption to operation of the plant and privately owned facilities. Temporary lighting and power are to be provided by the contractor to facilitate construction work by all trades while facility electrical is not available.

C. When two trades join together in an area, make certain that no electrical work is omitted.

1.8 JOB CONDITIONS

A. Operations:

1. Keep all power shutdown periods to a minimum.

2. Carry out shutdowns only after the schedule has been favorably reviewed by the Engineer.

B. Construction Power:

1. Make all arrangements for the required construction power.

2. When required, provide all equipment, materials and wiring in accordance with the applicable codes and regulations.

3. Upon completion of the project, remove all temporary construction power equipment, material and wiring from the site as the property of the Contractor.

C. Storage:

1. Provide adequate storage for all equipment and materials which will become part of the completed facility so that it is protected from weather, dust, water, or construction operations.

1.9 ELECTRICAL AND TELEPHONE SERVICES

A. Provide all the equipment and materials not provided by the utility companies for permanent electrical and telephone services at the locations shown on the Drawings and described hereinafter. All work shall meet the requirements of the serving utility companies.

B. Coordinate all work with the serving utilities, obtain the required inspections, and notify the respective utility when service is required.

1.10 DAMAGED PRODUCTS

A. Notify the Engineer in writing in the event that any equipment or material is damaged.

B. Obtain prior favorable review by the Engineer before making repairs to damaged products.

1.11 OPTIONAL EQUIPMENT

A. For optional or substituted equipment, refer to Division 1, General Conditions.

1.12 LOCATIONS

A. General: Use equipment, materials and wiring methods suitable for the types of locations in which they are located, as defined in Paragraph B. herein.

B. Definitions of Types of Locations:

1. Dry Locations: All those indoor areas which do not fall within the definitions below for Wet, Damp, Hazardous, or Corrosive Locations and which are not otherwise designated on the Drawings.

2. Wet Locations: All locations exposed to the weather, whether under a roof or not, unless otherwise designated on the Drawings.

3. Damp Locations: All spaces wholly or partially underground or having a wall or ceiling forming part of a channel or tank, unless otherwise designated on the Drawings.

4. Hazardous Locations: All areas in which fire or explosion hazards may exist, normally or accidentally, due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or filings. These areas are shown on the Drawings, together with the Class and Division designations as defined in the NEC, determining the enclosure types and wiring methods required.

5. Corrosive Locations: Areas where chemical is stored or processed including chlorine or sulfur dioxide gas under pressure.

PART 2 PRODUCTS

2.1 STANDARD OF QUALITY

A. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Engineer prior to installation.

B. It is the intent of these Specifications and Drawings to secure high quality in all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses, which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.

C. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble-free service. Light-duty, fragile and competitive grade devices of doubtful durability shall not be used.

2.2 NAMEPLATES

A. For each piece of electrical equipment, provide a manufacturer's nameplate showing his name, location, the pertinent ratings and the model designation.

B. Identify each piece of equipment and related controls with a rigid laminated engraved phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with the equipment name. Securely fasten nameplates in place using two stainless steel screws or, where favorably reviewed by the Engineer, with epoxy cement. Where no inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription furnished by the Engineer upon prior request by the Contractor.

C. Each control device, including pushbuttons, control switches, and indicating lights, shall have an integral legend plate or nameplate indicating the device function. These shall be inscribed as indicated on the Drawings or as favorably reviewed by the Engineer.

2.3 FASTENERS

A. Fasteners for securing equipment to walls, floors and the like shall be either hot-dip galvanized after fabrication or stainless steel. Provide stainless steel fasteners in Corrosive Locations. When fastening to existing walls, floors, and the like, provide capsule anchors, not expansion shields. Size capsule anchors to meet load requirements. Minimum size capsule anchor bolt is 3/8 inch.

2.4 PAINTING

A. Equipment: Refer to each electrical equipment section of these Specifications for painting requirements of equipment enclosures. Repair any final paint finish, which has been damaged or is otherwise unsatisfactory, to the satisfaction of the Engineer.

B. Wiring System: Paint all exposed conduits, boxes and fittings to match the color of the surface to which they are affixed. Paint finishes shall include proper surface preparation, prime coat and a final finish coat, and shall conform to Section 09 90 00.

2.5 ENCLOSURES

A. Unless otherwise noted, provide enclosures as follows:

1. Dry Locations: NEMA Type 12
2. Wet Locations: NEMA Type 3R or 4X based on water dynamics
3. Damp Locations: NEMA Type 12 gasketed or better
4. Hazardous Locations (gases): NEMA Type 7
5. Hazardous Locations (dusts): NEMA Type 9
6. Corrosive Locations: NEMA Type 4X
7. See additional requirements below in Paragraph 3.08, Metal Panels

PART 3 EXECUTION

3.1 REQUIREMENTS

A. All electrical installations shall conform to the codes and standards outlined in this Section.

3.2 WORKMANSHIP

A. Assign a qualified representative who shall supervise the electrical construction work from beginning to completion and final acceptance.

B. Perform all labor using qualified craftsmen, who have had experience on similar projects. Provide first-class workmanship for all installations.

C. Ensure that all equipment and materials fit properly in their installations.

D. Perform any required work to correct improperly fit installations at no additional expense to the Owner.

E. Follow practices identified in NECA 1-2006 Good Workmanship in Electrical Construction.

3.3 EXCAVATION AND BACKFILL

A. Provide the excavations for electrical equipment foundations and trenches for conduits as shown on the Drawings.

B. Exercise caution during all excavation work and avoid damage to existing underground pipes. Exercise extreme caution when working near existing electrical conduits and facilities. Field verify the location of all electrical facilities before proceeding with any nearby work.

C. Refer to Division 31 23 00, Excavation and Fill, of these Specifications for all excavation and backfilling work.

3.4 CONCRETE

A. Where shown on the Drawings or specified, provide the required concrete installations for conduit encasement and equipment foundations.

B. Refer to Division 03 00 00, Concrete, of these Specifications for all concrete work.

3.5 CONDUCTOR IDENTIFICATION

A. Identify all wires and cables in conformance with the requirements of Sections 26 05 53. This requirement applies to all equipment provided under this contract, regardless of Division, as well as to all conductors provided or worked on during this contract.

3.6 INSTALLING EQUIPMENT

A. Provide the required inserts, bolts and anchors, and securely attach all equipment and materials to their supports.

B. Install all floor-mounted equipment on 4-inch-high reinforced concrete pads. The Contractor, suppliers, and fabricators shall take this requirement into consideration when designing, fabricating, and installing panels, motor control centers, and other enclosures so that height above the floor of the operating handles of electrical devices meets the requirements of these Specifications and applicable codes.

C. Seismic Anchoring: Refer to Manufacturer's documentation for anchorage design.

3.7 CUTTING, DRILLING, AND WELDING

A. Provide any cutting, drilling, and welding that is required for the electrical construction work.

B. Structural members shall not be cut or drilled, except when favorably reviewed by the Engineer. Use a core drill wherever it is necessary to drill through concrete or masonry.

C. Provide the required welding for equipment supports. Conduits and fittings shall not be welded to structural steel.

D. Perform patch work with the same materials as the surrounding area and finish to match, as specified in Division 03 of these specifications.

3.8 METAL PANELS

A. Mount all metal panels which are mounted on or abutting concrete walls in damp locations or any outside walls 1/4 inch from the wall and paint the back sides of the panels with a high build epoxy primer. Film thickness shall be 10 mils minimum.

3.9 PROTECTIVE DEVICE COORDINATION

A. Provide the services of a recognized independent testing laboratory or coordination analysis consultant for the proper system coordination of the protective devices furnished on this project. Submit the name and the qualifications of the laboratory or consultant for review by the Engineer; qualifications must include professional registration of proposed personnel as electrical engineers.

B. Short Circuit Calculations: Provide short circuit calculations for the electrical system shown on the drawings. The calculations shall include symmetrical fault currents and ground fault currents. Obtain required utility data to perform calculations in addition to any information not indicated on the Drawings but required to perform these calculations.

C. The protective device on the line side closest to the fault or abnormal conditions shall isolate the problem portion of the system and minimize damage in that portion. The rest of the system shall be maintained in normal service. The coordination shall be in conformance with the recommendations of latest IEEE Standard 242.

D. Submit the analysis that shall include impedance and short circuit calculations, list of any assumptions made in the analysis, the recommended settings of the protective devices, and the system time/current characteristic curves. The submittal shall be made so as to allow time for review and resubmittal, if necessary, before the implementation of final settings and adjustments by the testing laboratory.

3.10 HARMONIC ANALYSIS: NONE REQUIRED

3.11 FIELD TESTS

A. Perform power wiring tests in accordance with applicable procedures as described in NETA Acceptance Testing Specifications.

B. Give sufficient notice to the Engineer prior to any test to permit witnessing the test.

C. Provide the services of a recognized independent testing laboratory and pay all costs of performing the inspections and tests as specified herein.

D. The testing laboratory shall provide all materials, equipment, labor and technical supervision to perform such tests and inspections. It is the intent of these tests to ensure that all electrical equipment is operational within industry and manufacturer's tolerances and is installed in accordance with the Contract Documents and manufacturer's instructions. The tests and inspections shall determine the suitability for energization.

E. The testing laboratory shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907. Membership in the International Electrical Testing Association (NETA) constitutes proof of meeting such criteria. The testing laboratory shall submit proof of these qualifications to the Engineer for review. Testing laboratory shall be Electrical Testing and Controls, Electro-Test, Power Systems, or equal.

F. The testing laboratory shall have a calibration program, which maintains all applicable test instrumentation within, rated accuracy. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain. Instruments shall be calibrated in accordance with the following frequency schedule:

1. Field instruments: 6 months maximum
2. Laboratory instruments: 12 months
3. Leased specialty equipment: 12 months

G. Where testing pursuant to NETA requirements is required in these specifications, submit a test report which includes the following:

1. Name of project, name of person performing test, and date of test

2. Description of equipment tested

3. Description of test

4. List of test equipment used and calibration date

5. Test results

6. Conclusions and recommendations

7. Appendix, including appropriate test forms:

    a. The test report shall be bound, and its contents certified.

    b. Submit the completed report directly to the Engineer no later than thirty (30) days after completion of the test unless directed otherwise.

    c. Number of reports to be submitted for review shall be the same as the number required for shop drawing submittals.

H. Safety practices shall include, but are not limited to, the following requirements:

1. Occupational Safety and Health Act (OSHA).

2. Accident Prevention Manual for Industrial Operations, Seventh Edition, National Safety Council, Chapter 4.

3. Applicable state and local safety operating procedures.

I. All field tests shall be performed with apparatus de-energized except where otherwise specifically required by the latest Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems published by NETA. The testing laboratory shall have a designated safety representative who shall be present on the project and supervise operations with respect to safety. Circuits operating in excess of 600 volts between conductors shall have conductors shorted to ground by a hot-line grounded device approved for the purpose. In all cases, work shall not proceed until the safety representative has determined that it is safe to do so. The testing laboratory shall have available sufficient protective barriers and warning signs to conduct specified test safely.

J. Electrical equipment and materials furnished and installed by the Contractor, and the testing equipment listed below shall be tested in accordance with the "Inspection and Test Procedures" and "System Function Tests" of the latest Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems published by NETA. Tests shall not include any tests listed as optional in the aforementioned NETA Specifications unless specifically noted in respective equipment specifications for this project.

K. Retesting will be required for all unsatisfactory tests after the equipment or system has been repaired. Retest all related equipment and systems if required by the Engineer. Repair and retest equipment and systems, which have been satisfactorily tested but later, fail, until satisfactory performance is obtained.

L. Putting Equipment and Cables into Service: Submittal and favorable review of the specified factory and field tests shall occur before the Contractor is permitted to place the respective equipment or cable into service.

M. Miscellaneous Tests:

1. Insulation Resistance, Continuity, Rotation: Perform routine insulation resistance, continuity and rotation tests for all distribution and utilization equipment including all motors 1/2 horsepower and larger prior and in addition to tests performed by the testing laboratory specified herein. Supply a suitable and stable source of test power to the test laboratory at each test site. The testing laboratory shall specify requirements. Notify the testing laboratory when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling. All testing shall be performed in the presence of the Engineer. The testing laboratory shall be responsible for implementing all final settings and adjustments on protective devices and tap changes. Any system material or workmanship that is found defective on the basis of acceptance tests shall be reported directly to the Engineer. The testing laboratory shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.

2. Motor Current: Measure and record current in each phase for each new motor. Include measurement of the motor terminal voltages and motor currents when the motor is being operated at normal operating loads. For motors that are part of adjustable frequency drive systems, use true-RMS-reading instruments in making the measurements.

3. Operational Tests: Operationally test all circuits to demonstrate that the circuits and equipment have been properly installed, adjusted and are ready for full-time service. Demonstrate the proper functioning of circuits in all modes of operation, including alarm conditions, and demonstrate satisfactory interfacing with the data acquisition and alarm systems (including SCADA at the WWTP).

3.12 EQUIPMENT PROTECTION

A. Exercise care at all times after installation of equipment, motor control centers, etc., to keep out foreign matter, dust, dirt, debris, or moisture. Use protective sheet metal covers, canvas, heat lamps, etc., as needed to ensure equipment protection.

3.13 CLEANING EQUIPMENT

A. Thoroughly clean all soiled surfaces of installed equipment and materials.

B. Clean out and vacuum all construction debris from the bottom of all equipment.

C. Provide and touch-up to original condition any factory painting that has been marred or scratched during shipment or installation, using paint furnished by the equipment manufacturer.

3.14 CLEANUP

A. Upon completion of the electrical work, remove all surplus materials, rubbish, and debris that accumulated during the construction work. Leave the entire area neat, clean, and acceptable to the Engineer.

END OF SECTION

SECTION 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE

PART 1 GENERAL

1.1 DESCRIPTION

A. This section specifies stranded copper cables, conductors, and wire with 600 volt-rated insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

B. This section specifies copper cables and coax cable with 300 volt rated insulation used for data communication and specifies fiber optic data cable used for data communication.

1.2 REFERENCES

A. This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to document shall mean the documents in effect at the time of Advertisement for bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NFPA 70	National Electric Code (NEC)
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

1.3 SUBMITTALS

A. The following information shall be provided in accordance with the General Conditions (Volume 1).

1. Submittals specified in Section 26 05 00.
2. Complete catalog cuts for all conductors, wire, and cable.

1.4 DELIVERY, STORAGE AND HANDLING

1. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

2. Materials and equipment shall be stored in a manner to keep them dry and clean. Equipment and materials to be located indoors shall be stored indoors and sealed with plastic film wrap. Electrical and electronic equipment found stored or staged outdoors over night or in inclement weather shall be considered grounds for equipment rejection and shall be replaced at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. Unscheduled Conductors and Cables:

1. Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified herein. Unscheduled conductor with insulation shall be provided in accordance with the following:

   a. CABLESPEC "MEPR/CPE" multi-conductor power and control cable
   b. CABLESPEC "XHHW" for single conductors
   c. CABLESPEC "XHHW" for indoor lighting and receptacles

B. Cable Specification Sheets (CABLESPEC):

1. General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in paragraph 3.6.

2.2 COLOR CODING

A. Control Conductors:

1. Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Foreign Voltage (DC)	Blue/White
Foreign Voltage (AC)	Yellow
Power (DC)	Blue
Control (DC)	Violet

B. Power Conductors:

1. Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480/277V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

C. Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

D. Signal Conductors:

1. Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

2.3 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. Single Conductor:

1. Provide stranded conductors for all cable or wires. Provide minimum conductor size of 12 AWG for power and lighting circuits and minimum conductor size of 14 AWG for control circuits.

B. Multiconductor Cable:

1. Provide multiconductor power cable and multiconductor control cable where identified on the drawings. Provide stranded conductors for all cable or wires.

2.4 SIGNAL CABLES

A. General:

1. Factory cable between manufactured instrument system components shall be provided in compliance with the instrument manufacturer's recommendations.

2. Signal cable shall be provided for instrument signal transmission. Single instrument cable (SIC) and multiple-circuit instrument cable (MIC) shall be provided in accordance with the following examples:

a. CABLESPEC “SIC”:

1) Cable designation example:

a) 1PR#16S shielded twisted pair (STP)

2) Cable designation example:

a) 1TR#16S triad (STT)

b. CABLESPEC “MIC":

1) Cable designation example:

a) 4PR#16S with individual shields for each of the four pair and an overall shield and jacket for the multiconductor instrument cable.

B. Communication, Paging, and Security System Cables:

1. Voice communication, paging, and security system cables shall be specified in their respective specification sections.

C. Data Network Communication Cables:

1. General: MODBUS data network communications cables shall be provided in accordance with CABLESPEC “NC4” specification sheets contained in this Section.

2.5 PORTABLE CORD

A. Portable cord shall be provided in accordance with CABLESPEC "CORD," unless otherwise specified. Cords shall contain an equipment grounding conductor.

2.6 SPLICING AND TERMINATING MATERIALS

A. Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Wire nuts for a splice is prohibited.

B. Signal and control conductors shall be connected to terminal blocks and field devices and instruments shall be terminated with conductor terminals as specified in Section 26 05 00 and Section 26 05 19.

C. Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Engineer.

D. Power conductor splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or equal. Splices shall be covered with electrical products designed for the application, insulated, and covered with a heat-shrinkable sleeve or boot, as specified elsewhere.

E. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

F. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub- type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

2.7 CORD GRIPS

A. Cord grips shall be provided on all cord type conductors to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless-steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

PART 3 EXECUTION

3.1 GENERAL

A. Conductors shall be identified at each connection terminal and at splice points. The identification marking system shall comply with Section 26 05 00 and Section 26 05 53

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacturer recommended and UL Listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

C. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

3.2 600 VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

B. Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

C. Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure. Provide dedicated electrical wireways and insulated cable holders mounted on Unistrut in manholes and handholes. Cables shall be tied to the cable holders and identified by circuit numbers in these locations.

D. Raceway fill limitations shall be as defined by NEC and the following:

1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.

2. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems. Install in separate raceways.

3. Slices and terminations are subject to inspection by the Resident Project Representative prior to and after insulating.

4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.

5. In-line splices and tees, where approved by the Resident Project Representative, shall be made with tubular compression connectors and insulated as specified for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or Raychem splicing kits.

6. Terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors within the termination box.

7. Terminations at valve and gate motor actuators shall be made directly into the actuator where possible. Power termination shall be made in the actuator power disconnect. Control and signal cable may be routed to a termination box near the actuator on 20-ampere rated terminal strips with label identification for the control and signal conductors. Single wire control conductors and analog cable (SIC or MIC) then installed in flexible conduit to the actuator control and signal termination compartments.

3.3 SIGNAL CABLE

A. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Circuits shall not be made using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required.

C. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies utilizing coaxial cables. Common ground return conductors for two or more circuits are not acceptable.

D. Shields shall be bonded to the signal ground bus at the control panel only and isolated from ground at the field instrument or analyzer and at other locations. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

E. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes.

F. Where instrument cable splicing is required, provide an instrument stand with terminal box rated for the area and environment and mounted approximately 3 feet above grade for instrument cable splices with the circuits and individual conductors provided with label as specified in Section 26 05 00.

G. Cable for paging, security, voice communication, and telephone systems shall be installed and terminated in compliance with the manufacturers and the Utilities recommendations.

3.4 PORTABLE CORD

A. Portable power cords feeding permanent equipment, such as pendant cords feeding motors for pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless-steel wire to relieve the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with dedicated boxes and terminals blocks.

3.5 FIELD TESTS

A. Insulation Resistance Tests: For all circuits 150 volts to ground or more and for all motor circuits over 1/2 horsepower, test cables per NETA Standards. The insulation resistance shall be 100 megohms or more. Submit results for review. See also General Conditions (Volume 1).

B. Phase Rotation: The phase rotation of all circuits shall be clockwise in sequence. The Contractor shall verify that each three-phase service, feeder and branch circuits meet this requirement. A record shall be kept at each circuit tested and, on completion, given to the Engineer for review.

3.6 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. General:

1. Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC Sheets.

B. CABLESPEC Sheets:

1. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
MSIC	600	SP-OS: MULTIPLE SHIELDED PAIR PR#16 or TRIAD, INDIVIDUAL AND OVERALL SHIELD, ARMORED/JACKETED	INSTRUMENT SIGNAL WIRING
CAT6	600	Category 6+ Premium Premise Horizontal Cable (400MHz)	ETHERNET COMMUNICATION CABLE
SIC	600	P-OS: SINGLE TWISTED SHIELDED PAIR PR#16 or TRIAD, INDIVIDUAL AND OVERALL SHIELD, ARMORED/JACKETED	INSTRUMENT SIGNAL WIRING (4-20MA CIRCUITS)
XHHW-2	600	SINGLE CONDUCTOR, XLP INSULATED INDUSTRIAL GRADE CONDUCTOR	POWER, CONTROL, LIGHTING, & RECEPTACLES (480VAC THROUGH 120VAC AND 24VDC)
CORD	600	HEAVY DUTY CABLE: SOOW	PORTABLE CORD

3.7 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	MSIC
Description:	TYPE MC-HL Armored multiple twisted, shielded pairs, 16 AWG, single pair, triad, or multiple pair control, signal and instrumentation cable in an aluminum sheath. Number of pairs as shown; UL listed, suitable for wet or dry locations and in cable trays.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; #16 twisted shielded pairs/triads, Class B stranded per ASTM B-8
Insulation:	Flame-retardant PVC per UL 83, 15 mil thickness, rated 90°C, with 4 mil Nylon jacket per UL 83.
Shield:	100 percent, aluminum/polyester or mylar tape with 7-strand tinned copper drain wire
Overall Shield:	Aluminum/polyester tape cable shield, 100% coverage with 7-strand tinned copper drain wire, same size as conductors.
Jacket:	40 or 50 mil flame-retardant nylon per UL 1569.
Sheath:	Impervious, Continuous, Welded Corrugated, Aluminum per UL 1569.
Flame Resistance:	IEEE 383-1974, IEEE 1202
Manufacturer(s):	Okonite C-L-X Okoseal-N SP-OS, or equal
Execution:	NA
Installation:	Shall be used for instrument and signal wiring in cable tray and equipment racks under the UV system canopy and surrounding area. Cable shall be installed in I&C Cable Tray. Install in accordance with this Section.
Testing:	Test and commission in accordance with Section 26 08 00.

3.8 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	CAT6
Description:	Category 6A Indoor/Outdoor Cable, 4 Pair, U/UTP, CMR/CMX
Voltage:	300 volts
Conductor Material:	23 AWG Tinned copper
Insulation:	PO – Polyolefin
Shield:	N/A
Jacket:	Polyvinyl Chloride (PVC) Jacket shall be rated for tray cable including wet/moist areas
Flame Resistance:	UL 1666 Riser, FT4, 1202 Vertical Tray, IEC 60332-1-2
Manufacturer(s):	Belden 2148A or approved substitute
Uses Permitted:	Indoor/Outdoor Conduit I&C cable tray. Execution:
Installation:	Install in accordance with this section and associated equipment manufacturer's instructions.
Testing:	Test in accordance with Section 26 08 00.

3.9 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	SIC
Description:	TYPE MC-HL Armored multiple twisted, shielded pairs, 16 AWG, single pair, triad, control, signal and instrumentation cable in an aluminum sheath. UL listed, suitable for wet or dry locations and in cable trays.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; Class-B stranded per ASTM B-8
Insulation:	15 mil, Flame-retardant Okoseal (PVC) with 4 mil nylon, 90 degree C temperature rated, UL 1277. Color Code per ICEA Method-1: Pairs- Black and White 2: Triads- black, white and red.
Lay:	Twisted on a 2-inch lay
Shield:	100 percent, 1.35 mil aluminum/polyester or mylar tape with 7-strand tinned copper drain wire
Overall Shield:	2.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire
Jacket:	Flame-retardant, moisture and sunlight resistant 45 mil Polyvinyl Chloride (PVC). Jacket shall be rated for tray cable including wet/moist areas
Manufacturer(s):	Okonite, Okoseal-N type SP-OS (Shielded Pairs with Overall Shield); or Cooper Industries-Belden equal; or General Cable equal
Installation:	Install in accordance with this Section. Cable shall be installed in I&C Cable Tray.
Testing:	Test in accordance with Section 26 08 00.

3.10 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	XHHW-2
Cable System Identification:	XHHW-2
Description:	Single conductor cross-linked polyethylene power and control cable, UL Listed, Cable Tray rated.
Voltage:	600V
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, cross-linked polyethylene in accordance with ICEA S-66-524
Jacket:	Jacket shall be rated for tray cable including wet/moist areas
Flame Resistance:	N/A
Manufacturer(s):	Okonite X-Olene, Southwire, or approved equal
Uses Permitted:	Conduit, cable tray Execution:
Installation:	Install in accordance with this Section. Extension of power and control armored cables via terminal boards in junction boxes to individual conductors routed through underground raceway systems.
Testing:	Test in accordance with Sections 26 08 00.

3.11 CABLE SPECIFICATION SHEET--CABLESPEC

Cable System Identification:	CORD
Description:	Industrial Grade Flexible Portable Cord: Synthetic Rubber Insulation with Oil-Resistant Thermoset Jacket construction: Type SOOW for 600 Volt circuits
Voltage:	600 V RMS where shown or where unspecified: Type SOOW
Conductor Material:	Flexible stranded Class K copper conductors, per ASTM B189 and B33.
Insulation:	Insulation: EPDM rubber or Ethylene propylene (EPR) per ICEA S-68-516 and rated for continuous operation at 90 degrees C. Green used for ground only
Color:	2/C Black and White; 3/C Black, White, and Green; 4/C Black, White, Red and Green; 5/C Black, White, Red, Green, and Orange
Jacket:	A heavy-duty heat, moisture and oil resistant flexible CPE jacket Color: Black Jacket shall be NEC Rated Extra-Hard Usage, including wet/moist areas.
Manufacturer(s):	Southwire: Royal SOOW cord; American Insulated Wire Cord equal; or Approved equal.
Installation:	Shall be installed for temporary power and control circuits only. CORD shall not be installed for permanent circuit installations. Shall not be used for variable frequency drive (VFD) circuits between the motor and the VFD. Installation shall protect temporary cables from damage. Install in accordance with this Section.
Testing:	Test in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of electrical grounding equipment.

B. This section specifies the system for grounding electrical equipment, exposed non-energized metal surfaces of equipment, and metal structures.

C. Refer to Section 26 05 00 – Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.2 REFERENCE STANDARD

A. American Society for Testing and Materials (ASTM) Publication:

1. B228 Copper Clad Steel Conductors Specification
2. D178 Specifications for Rubber Insulating Matting

B. National Fire Protection Association (NEPA):

1. 70 National Electric Code (NEC)
2. 780 Standard for the Installation of Lightning Protection Systems

C. Underwriters Laboratories (UL) Standards:

1. 96 Lightning Protection Components
2. 96A Installation Requirements for Lightning Protection SystemSystems

D. IEEE Green Book - Grounding

E. International Electrical Testing Association (NETA) Publication:

1. ATS Acceptance Testing Specifications for Electrical Equipment for Power

1.3 SUBMITTALS

A. As specified in Section 26 05 00 – Common Work Results for Electrical.
B. Submit catalog cut sheets.
C. Shop Drawings.
D. Test data.

PART 2 PRODUCTS

2.1 GENERAL

A. The grounding systems shall consist of the ground rods, grounding conductors, ground bus, ground fittings and clamps, and bonding conductors to water piping and structural steel, UFER grounding as shown on the Drawings. One system shown provides service and separately derived system grounds. A second system is an electronic ground system to provide for the discharge of static electricity.

2.2 SYSTEM COMPONENTS

A. Ground Rods:

1. Ground rods shall be cone-pointed, copper-clad Grade 40 HS steel rods conforming to ASTM B 228.

2. The welded copper encased steel rod shall have a conductivity of not less than 27 percent of pure copper.

3. Rods shall be not less than 3/4 inch in diameter and 10 feet long, unless otherwise indicated.

4. Rods longer than 10 feet shall be made up of 10-foot units joined together with threaded couplings. Increase rod diameter sufficiently to prevent the rod from bending or being damaged.

5. The manufacturer’s trademark shall be stamped near the top.

B. Ground Conductors:

1. Buried conductors shall be medium-hard drawn bare copper; other conductors shall be soft drawn copper.

2. Sizes over No. 6 AWG shall be stranded.

3. Coat all ground connections, except the exothermic welds, with electrical joint compound, nonpetroleum type, listed for copper and aluminum applications.

4. If cable sizes are not specified, the minimum sizes shall be as follows:

a. 15 kV – 480 V Transformer:	250 MCM
b. 15 kV Load Interrupter:	4/0 AWG
c. 480 V Switchgear:	4/0 AWG
d. 480 V MCC and Switchboards:	2/0 AWG
e. Lighting Panels:	1/0 AWG

f. Exposed Metal: 2 AWG
g. Control Panels: 12 AWG

C. Ground Connections:

1. Exothermic Connectors:

a. Connection to ground rods and buried connections shall be by exothermic weld.

b. Manufacturers: Thermoweld, Cadweld, or approved equal.

2. Binding Post Connectors:

a. Lugs for attachment of cables to steel enclosures shall be of the binding post type with a 1/2 13 NC stud.

b. Each post shall accommodate cables from No. 4 AWG to No. 4/0 AWG.

3. Irreversible Compression Connectors:

a. Cast copper.
b. Manufacturers: Thomas and Betts, Burndy, or approved equal.

4. Bolted Connectors:

a. Manufacturers: Burndy, O. Z. Gedney, or approved equal.

D. Ground Rod Boxes:

1. Boxes shall be 9-inch-diameter precast concrete units with hot-dip galvanized traffic covers.

2. Units shall be 12 inches deep.

3. Covers shall be embossed with the wording “Ground Rod”.

E. Ground Bus:

1. Ground bus shall be a high-conductivity copper-alloy strap measuring 3/16 inch by 1 1/4 inch and of lengths as shown on the Drawings.

2. Bus shall be predrilled and tapped to accept 8/32 brass machine screws on 12-inch centers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Ground all equipment for which a ground connection is required per NEC whether or not the ground connection is specifically shown on the Drawings.

B. Provide a ground rod box for each ground rod so as to permit ready access for the connection and/or removal of any pressure connectors to facilitate testing.

C. Where ground rods must be driven to depths over 8 feet, increase rod diameter used, sufficiently to prevent the rod from bending or being damaged.

D. Bond metallic water piping at its entrance into each building. Ground separately derived electrical system neutrals to the metallic water piping in addition to the system driven ground, per NEC requirements.

E. Provide a ground wire in every conduit carrying a circuit of over 150 volts to ground.

F. Make embedded or buried ground connections, taps and splices with exothermic welds. Coat ground connections.

G. Effectively bond structural steel for buildings to the grounding system using exothermic welds.

H. Provide UFER grounding system consisting of encased bare copper wire in concrete slab. Wire shall be at least 20 ft long and not smaller than #4 AWG.

3.2 RACEWAY GROUND

A. Metallic Conduits:

1. Assembled to provide a continuous ground path and bonded using insulated grounding bushings.

2. Bond using insulated grounding bushings.

B. Non-Metallic Conduits: Insulated ground conductor sized in compliance with the NEC.

C. Grounding Bushings: Connected to the grounding system using conductors sized in compliance with NFPA 70.

D. Provide a ground wire in every conduit carrying a circuit of over 50 V to ground.

3.3 EQUIPMENT AND ENCLOSURE GROUND

A. Connect electrical and distribution equipment to the grounding system. Cables sized as specified.

B. Connect non-electrical equipment with metallic enclosures to the grounding system.

C. Securely bond transformer yard fences and gates as specified.

3.4 TESTING

A. Conduct ground-resistance tests using a ground megohmmeter with a scale reading of 25 ohms maximum.

B. Test methods shall conform to NETA Standard ATS using the three-electrode method. Conduct tests only after a period of not less than 48 hours of dry weather.

C. Maximum resistance shall be 5 ohms. If 5 ohms cannot be achieved, add additional ground rods and ground grid conductors until the maximum resistance is achieved. If soil conditions provide that this value is impossible to achieve, add ground rods and conductors to achieve the lowest resistance realistic and submit to the Engineer for favorable approval. If Engineer does not approve the value and configuration, follow Engineer's direction for further reduction of ground resistance.

D. Furnish to the Engineer a test report with recorded data of each ground rod location.

E. Furnish a separate report on the rubber mats. Make measurements in conformance with manufacturer's instructions.

3.5 INSTALLATION – LIGHTNING PROTECTION

A. The tip of an air terminal shall be not less than 10 inches above the area it is to protect.

B. Air terminals exceeding 24 inches in height above the area they are to protect shall be supported at a point not less than one-half their height.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

D. Conceal the lightning system and down conductors.

END OF SECTION

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of electrical conduits, wireways, pull boxes, and fittings. Raceways shall be provided for all wiring unless shown or specified otherwise.

B. Refer to Section 26 05 00 – Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.2 SUBMITTALS

A. As specified in Section 26 05 00 – Common Work Results for Electrical.
B. Submit catalog cut sheets.

PART 2 PRODUCTS

2.1 RACEWAY

A. Requirements for raceway types are listed in the RACESPECs sheets at the end of this section.

2.2 BOXES AND FITTINGS

A. Junction Boxes, Pull Boxes and Wiring Gutters:

1. Indoor:

    a. Type FD cast ferrous for all device boxes and for junction boxes less than 6-inches square. NEMA 12 welded steel 6-inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight.

    b. Conduit Bodies: Ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.

2. Outdoor:

    a. Type FD cast ferrous for all devices and for junction boxes less than 6-inches square. NEMA 4X stainless steel for 6-inches square and larger.

3. Outdoor boxes and enclosures shall be provided with neoprene gaskets on the hinged doors or removable covers.

4. Boxes and enclosures in indoor corrosive areas shall be NEMA 4X stainless steel or nonmetallic.

5. Boxes in classified areas shall be NEMA Class 7 galvanized cast ferrous.

6. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code.

7. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle.

8. Covers larger than 3 by 4 feet shall be split.

B. Conduit Seals:

1. Conduit seals shall be explosion-proof with a minimum 40 percent wire fill capacity of the EYSX type. Where shown on Drawings, use retrofit conduit sealing fittings of the EYSR type.

2. Install conduit seals for use in classified areas as shown on Drawings or where any conduit leaves the classified space.

3. Use PVC-coated fittings with urethane interior coating for PVC-coated GRS; use copper free cast aluminum for rigid aluminum.

4. The sealing compound shall be as prescribed by the manufacturer of the sealing conduit body.

5. Use the sealant, such as Chico, in areas that are defined as hazardous and meet the NEC requirements for Article 500.

2.3 UNDERGROUND MARKING TAPE

A. Six-inch-wide, detectable, metallic-lined tape with red polyethylene film on top and clear polyethylene film on the bottom.

B. Tape legend shall be clearly printed with black over red tape and shall read “CAUTION ELECTRIC LINE BURIED BELOW”.

C. Use for early warning protection of underground raceways.

D. Manufacturers: Brady “Identoline”, Services and Materials “Buried Underground Tape”, Somerset (Thomas & Betts) “Protect-A-Line”, or approved equal.

2.4 FIRESTOPS

A. Apply in accordance with manufacturer's recommendations.
B. Manufacturers: Flamemastic 77, Vimasco No. 1-A, or approved equal.
C. Products which are affected by water are not acceptable.

PART 3 EXECUTION

3.1 GENERAL

A. Specific raceway types and applications are indicated on the Drawings and/or in the raceway schedule. When not indicated on the Drawings and/or in the raceway schedule Table A specifies the type of raceway required for each location and application by RACESPEC sheet. Use fittings, hubs, and boxes as specified by the raceway type in RACESPEC. Unless otherwise indicated, in Table A, unscheduled conduit shall be galvanized, rigid steel, RACESPEC type GRS.

TABLE A

Location	Application/Condition	RACESPEC
Indoor noncorrosive	Exposed	GRS
Indoor corrosive	Exposed; includes Wet Well location	PRS
Outdoor	Exposed	PRS
Concealed	Embedded in concrete structure or beneath slab-on-grade	PVC40
Underground	Instrumentation, communications and data signals encased in concrete, duct bank	GRS
Underground	Instrumentation, communications and data signals directly buried	PRS
Underground	Power and control directly buried	PVC40
Underground	Power and control encased in concrete, duct bank	PVC40
Nonhazardous	Final connection to equipment and light fixtures	LFS
Underground	Telephone service direct buried	PVC80
Architecturally finished areas	Final connection to light fixtures	FLEX
Transition	Above-grade to/from below-grade	PRS

3.2 CONDUIT

A. General:

1. The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

2. Conduit runs shall be limited to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

3. Provide conduit and raceway systems that are electrically continuous per electrical code requirements or provide additional ground conductors as required by the electrical code.

B. Indoor and Outdoor Conduit Systems:

1. Unless otherwise indicated, in general, conduit inside structures shall be exposed.

2. Unless otherwise indicated, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein.

3. Install conduit to conform to the requirements of the RACESPEC sheets and the following:

   a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.

   b. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.

   c. Exposed conduit shall be run on supports spaced not more than 10 feet apart.

   d. Where three or more conduits are located in parallel run, space them out from the wall using framing channel.

   e. Where conduits are suspended from the ceiling, support systems shall comply with the requirements of Section 26 05 29 – Hangers and Supports for Electrical Systems.

   f. Secure conduit rack supports to concrete walls and ceilings by means of cast in place anchors or framing channel concrete inserts.

   g. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degrees C.

   h. Install conduits between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, place conduits under the reinforcement.

   i. Route conduit clear of structural openings and indicate future openings.

   j. Flash and seal watertight those conduits which pass through roofs or metal walls.

k. Neatly group conduit into any openings cut into concrete and masonry structures, and grout using non-shrink type grout.

l. During construction, cap conduits to prevent entrance of dirt, trash, and water.

m. Terminate exposed conduit stubs for future use with galvanized pipe caps.

n. Determine concealed conduit stub-up locations from the manufacturer’s Shop Drawings.

o. Terminate concealed conduit for future use in equipment or by galvanized couplings plugged flush with structural surfaces.

p. Where the Drawings indicate future duplication of equipment wired hereunder, provide concealed portions of conduits for future equipment.

q. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.

r. Terminate all conduits that enter enclosures by fittings that ensure that the NEMA rating of the enclosure is not affected or changed.

s. Transitions from concealed or underground or embedded locations to exposed or above-grade locations shall be made using PVC-coated rigid steel conduit for a distance of at least 12 inches on either side of transition. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry, or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.

t. Conduit across structural joints where structural movement is allowed shall have an OZ Gedney “Type DX”, Crouse-Hinds “Type XD”, or approved equal, bonded, weathertight expansion and deflection fitting of that conduit size.

u. Treat cut surfaces or damaged ends with corrosion-resistant coatings, such as “Devcon Z” prepared by Subox Coatings, “Galvanox Type I” prepared by Pedley Knowles, or approved equal. Application shall follow manufacturer’s recommendation.

v. At all boxes and equipment, provide insulated-type metallic grounding bushings for metallic conduits. Bond together all conduits to provide continuity of the equipment grounding system. Size bonding conductor per NEC.

w. Clean, cap/plug, and provide all spare raceways with a nylon pull rope.

C. Underground Conduit Systems:

1. All excavation, backfilling, and concrete work shall conform to respective sections of these Specifications. Underground conduit shall conform to the following requirements:

   a. Exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

   b. Unless otherwise indicated, underground conduits and conduit banks shall have 2 feet minimum earth cover.

   c. Using a special rubber gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements, seal watertight those conduits not encased in concrete and passing through walls that have one side in contact with earth.

   d. Immediately upon completion of pouring concrete, thoroughly swab conduits on the inside. After the concrete has set, and before backfilling, pull a mandrel, having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, through each conduit. If the mandrel showed signs of protrusions on the inside of the conduit, repair or replace the conduit.

   e. Clean, cap/plug, and provide all spare raceways with a nylon pull rope.

2. Provide detectable underground marking tape placed 6 to 12 inches below finished grade and directly above the conduit.

3. Transition from Underground to Above Grade: Provide PRS conduit sweep and PRS conduit riser to a distance of at least 12 inches above grade.

4. Underground sweeps shall be PRS unless otherwise noted on the Drawings.

5. Unless otherwise indicated, use 6-inch coarse sand backfill on all sides of underground conduit.

D. Existing Conduit Systems:

1. Where existing conduit raceways are utilized:

   a. Blow out the conduit using compressed air to remove foreign material and water. Pull wire brush through conduit and blow out the conduit a second time using compressed air.

   b. Pull a test mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, through each spare conduit. If the mandrel showed signs of protrusions on the inside of the conduit, repair or replace the conduit. Notify the Engineer if the existing conduit cannot be utilized.

c. Clean up conduit threads at exposed conduit ends using a wire brush.

d. Treat minor surface rust with a cleaning agent and apply zinc, rust inhibiting coating to the damaged area.

3.3 RACEWAY SPECIFICATION (RACESPEC) SHEETS

A. The following RACESPECs are included in this section:

RACESPEC Symbol	Raceway Description
FLEX	Flexible steel conduit
GRS	Rigid steel conduit
LFS	Liquidtight flexible steel conduit
PRS	PVC coated rigid steel conduit
PVC40	Schedule 40 PVC conduit
PVC80	Schedule 80 PVC conduit
RAC	Rigid Aluminum Conduit
SS	Rigid stainless steel conduit
WW	Wireway and auxiliary gutter

Raceway Identification:	FLEX
Description:	Flexible steel conduit.
Application:	Final connection to lighting fixtures in architecturally finished areas only.
Compliance:	UL 1.
Construction:	Spirally-wound galvanized steel strip with successive convolutions securely interlocked.
Minimum Size:	1/2 inch.
Fittings:	Compression type.
Other:	FLEX shall be provided with an internal ground wire.
Installation:	Flexible steel conduit shall be made up tight and with conductive “coppershield” thread compound.

Raceway Identification:	GRS
Description:	Rigid steel conduit.
Compliance:	ANSI C80.1, UL 6.
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Manufacturers:	Allied Tube and Conduit Corp., Wheatland Tube Co., or approved equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Hubs: Insulated throat with bonding locknut, hot-dip galvanized. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection. O-Z Gedney, CHM-XXT, or approved equal.
Unions:	Electrogalvanized ferrous alloy type Appleton UNF or UNY, Crouse Hinds UNF or UNY, or approved equal. Threadless fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6-inches square. NEMA 12 welded steel 6-inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight. Conduit Bodies: Ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
Outdoor:	Type FD cast ferrous for all devices and for junction boxes less than 6-inches square. NEMA 4X stainless steel for 6-inches square and larger.
Corrosive:	NEMA 4X stainless steel.
Hazardous:	NEMA Class 7 cast ferrous.

Elbows:	
3/4 through 1-1/2 Inches:	Factory fabricated or field bent.
2 through 6 Inches:	Factory fabricated only.
Conduit Bodies:	
3/4 through 4 Inches:	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
5 Inch and 6 Inch:	Electrogalvanized iron or cast iron box.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
Manufacturers:	Appleton, Crouse-Hinds, Hubbell, O.Z. Gedney, or approved equal.
Installation:	Rigid steel conduit shall be made up tight and with conductive "coppershield" thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot dip galvanized malleable iron straps with nesting backs. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing. Exposed male threads or rigid steel conduit shall be coated with zinc-rich paint.

Raceway Identification:	LFS
Description:	Liquidtight flexible steel conduit.
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 360.
Construction:	Spirally-wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum Size:	3/4 inch.
Fittings:	
General:	Watertight, outdoor and wet rated. Grounding ferrule shall be threaded to engage conduit spiral. Provide O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90 degree fittings shall be used where applicable.
Dry Locations:	Material: Cadmium-plated malleable iron body and gland nut with cast-in lug, brass.
Wet, Outdoor or	
Corrosive Locations:	Material: Stainless steel.
Installation:	The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.
	Liquidtight flexible steel conduit shall be made up tight and with conductive “coppershield” thread compound.

Raceway Identification:	PRS
Description:	Rigid steel conduit, corrosion-resistant, polyvinyl chloride (PVC) coated.
Compliance:	ANSI C80.1, UL 6, NEMA RN1.
Finish:	PRS shall be hot dipped galvanized rigid steel conduit. The inside and outside, as well as the threads shall be galvanized. A minimum 40-mil thick PVC coating shall be bonded to the outside of the conduit and the inside shall be coated with 2-mil urethane. Coating shall be free of pinholes. Bending of conduit shall not damage either the interior or exterior coating. Bond strength shall exceed the tensile strength of the PVC coat. Elbows shall be factory made and coated.
Minimum Size:	3/4 inch.
Fittings:	Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. A 2-mil urethane coating shall be applied to the interior, and the threads of all fittings and couplings. Conduit and fittings shall be manufactured by the same company.
Hubs:	Hubs for connection of conduit to junction, device, pull, or terminal boxes shall be threaded and made of cast ferrous alloy. Hubs shall be galvanized steel and have insulating bushings. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection.
Boxes:	
Nonhazardous:	NEMA 250, Type 4X stainless steel.
Hazardous:	NEMA 250, Type 7D cast ferrous.
Installation:	PVC-coated conduit shall be supported away from the structure using PVC-coated conduit wall hangers. All conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer's recommendations. Plastic coated conduit shall be made tight with special

wrenches and fittings designed for tightening PVC-coated conduit. All threads shall be protected against corrosion per NEC 300.6 (a) by liberally applying an approved electrically conductive, corrosion resistant compound – “coppershield”. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas, including threads, shall be patched, using manufacturer’s recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.

Raceway Identification:	PVC40
Description:	Rigid nonmetallic polyvinylchloride conduit for normal duty applications including direct burial.
Compliance:	NEMA TC2, UL 651.
Construction:	Schedule 40, polyvinylchloride (PVC).
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased.
Fittings:	PVC solvent weld type.
Boxes:	
Indoor:	NEMA Class 4, nonmetallic.
Outdoor and Corrosive:	NEMA Class 4X, nonmetallic.
Installation:	Exposed PVC conduit shall be run on supports spaced not more than 3 feet apart for conduits up to 1 inch 5 feet apart for conduits 1-1/4 inches to 2 inches and 6 feet apart for conduits 2-1/2 inches and larger. PVC conduit shall not be provided where it will be damaged by heat.
	PVC conduit shall have bell ends where terminated at walls.

Raceway Identification:	PVC80
Description:	Rigid nonmetallic conduit, extra heavy wall thickness for all locations including direct bury under roadways and where exposed to physical damage.
Compliance:	NEMA TC2, UL 651.
Construction:	Schedule 80, high-impact, polyvinylchloride (PVC).
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased.
Fittings:	PVC solvent weld type.
Boxes:	
Indoor:	NEMA Class 4, nonmetallic.
Outdoor and Corrosive:	NEMA Class 4X, nonmetallic.
Installation:	Exposed PVC conduit shall be run on supports spaced not more than 3 feet apart for conduits up to 1 inch 5 feet apart for conduits 1-1/4 inches to 2 inches and 6 feet apart for conduits 2-1/2 inches and larger. PVC conduit shall not be provided where it will be damaged by heat. PVC conduit shall have bell ends where terminated at walls.

Raceway Identification:	RAC
Conduit:	
Description:	Rigid Aluminum Conduit manufactured from 6063 alloy with T 1 temper.
Finish:	Corrosion resistant aluminum.
Compliance:	UL6A, ANSI C80.5, WW-C-540c.
Construction:	Corrosion resistant aluminum
Manufacturer:	Allied Tube and Conduit Corp., Wheatland Tube Co., or approved equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Elbows:	
3/4 through 1 Inch:	Factory fabricated or field bent with approved bender.
1-1/2 through 4 Inch:	Factory fabricated only.
Fittings:	
Conduit Bodies:	
Material/Finish:	Cast copper-free aluminum.
Size:	3/4 inch through 4 inch.
Cover:	Stamped, domed top, copper-free aluminum with neoprene gasket. Stainless steel screws. Conduit body with gasketed cover shall be outdoor, raintight, wet location rated.
Compliance:	UL514B, Fed spec W-C-586D, NEMA FB-1.
Hubs:	Watertight, gasketed, copper-free aluminum, insulated throat with ground screw.
Unions:	copper-free aluminum type Appleton UNF or UNY, Crouse Hinds UNF or UNY, or approved

equal. Threadless fittings are not acceptable.

Conduit Seals:	Copper-free aluminum, Type EYSX.
Manufacturers:	Crouse-Hinds, O.Z. Gedney, or approved equal.
Boxes:	
Indoor/Dry Locations:	Locations which are both indoor and dry.
Less than 6 in. sq.:	Type FD copper-free aluminum for all device boxes. Copper-free aluminum covers with stainless steel screws. Gasketed, watertight, wet-rated for process areas.
6 in. sq. and larger:	NEMA 12 rated, welded copper-free aluminum with hinged door and clamp lock. Boxes within process areas shall be NEMA 4 welded copper-free aluminum.
Outdoor Locations:	
Less than 6 in. sq.:	Type FD copper-free aluminum for all device boxes. Copper-free aluminum covers with stainless steel screws. Gasketed, watertight, wet-rated.
6 in. sq. and larger:	NEMA 4 rated, welded copper-free aluminum with hinged door and clamp lock.
Manufacturers:	Crouse-Hinds, O.Z. Gedney, or approved equal.
Hazardous Areas:	Copper-free aluminum, NEMA 7, Explosionproof, raintight and wet location rated.
Installation:	Aluminum conduit shall be made up tight and with approved, conductive “Aluminum Antioxidant Joint Compound”. Joints shall be made with standard couplings or threaded unions. Where not shown on Drawings, support RAC and associated components using stainless steel supports which include a non-conductive barrier between the stainless steel and the aluminum to prevent galvanic corrosion.

Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.

Aluminum conduit is not to be installed in concrete or soil unless shown on the Drawings. For aluminum conduit that is installed in concrete or in contact with soil, supplementary corrosion protection, such as paints or wraps approved for the purpose, is required.

Raceway Identification:	SS
Description:	Rigid stainless steel conduit.
Compliance:	ANSI C80.1, UL 6.
Material:	316 stainless steel.
Manufacturers:	Calbrite or approved equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Hubs: bonding locknut, 316 stainless steel. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection.
Unions:	316 stainless steel. Threadless fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast 316 stainless steel for all device boxes and for junction boxes less than 6-inches square. NEMA 12 welded steel 6-inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4X watertight. Conduit Bodies: 316 stainless steel type with screw taps for fastening covers. Gaskets shall be made of neoprene.
Outdoor:	Type FD cast 316 stainless steel for all devices and for junction boxes less than 6-inches square. NEMA 4X stainless steel for 6-inches square and larger.
Corrosive:	NEMA 4X stainless steel.
Hazardous:	NEMA Class 7 cast 316 stainless steel.
Elbows:	
3/4 through 1-1/2 Inch:	Factory fabricated or field bent.

2 through 6 Inch:	Factory fabricated only.
Conduit Bodies:	
3/4 through 4 Inch:	316 stainless steel. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
Installation:	Rigid stainless steel conduit shall be made up tight and with conductive “copper shield” thread compound. Joints shall be made with standard couplings or threaded unions. Rigid stainless steel conduit shall be supported away from the structures using hot dip galvanized malleable iron straps with nesting backs. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing. Galvanic isolation.
Raceway Identification:	WW
Description:	Wireway and auxiliary gutter, flanged, oil tight type with hinged covers.
Compliance:	JIC EMP-1.
Minimum Size:	8-inch by 8-inch.
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces. Paint with factory standard finish.
Application:	As indicated on the Drawings.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Applicable provisions of Section 26 05 00 become a part of this Section as if repeated herein.

1.2 APPLICABLE STANDARDS

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

1. Federal Specifications:

    a. RR-F-621C Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
    b. RR-G-661D Grating, Metal, Bar Type (Floor, except for Naval Vessels)

2. American Concrete Institute (ACI):

    a. 318 Building Code Requirements for Reinforced Concrete

3. ASTM International (ASTM):

    a. A36 Structural Steel

    b. A153 Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

    c. A615 Deformed and Plain Billet - Steel Bars for Concrete Reinforcement

    d. C33 Concrete Aggregates

    e. C139 Concrete Masonry Units for Construction of Catch Basins and Manholes, Specification for

    f. C150 Portland Cement

    g. C478 Precast Reinforced Concrete Manhole Sections, Specification for

    h. C857 Recommended Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

    i. C858 Standard Specification for Underground Precast Concrete Utility Structures

4. American Association of State Highway and Transportation Officials (AASHTO):

    a. HB-13 Standard Specifications for Highway Bridges

5. American National Standard Institute (ANSI):

    a. C2 National Electrical Safety Code

6. National Fire Protection Association (NFPA):

    a. 70 National Electrical Code (NEC)

1.3 SUBMITTALS

A. Submit material or equipment data in accordance with the requirements of Section 26 05 00 and the General Conditions (Volume 1).

B. Manufacturer's Data and Shop Drawings:

1. Manholes and Handholes - Include a table of dimensions which shows proposed size of each handhole.

2. Manholes and Handhole Frame and Cover

3. Sealing Material for Precast Manhole Joints

4. Steps, ladder rungs and other hardware

5. Location and type of joints

C. Certificates

1. Test Reports: Submit for approval 30 days before the materials are used, copies of laboratory test reports for the following:

    a. Arc-proofing test for cable fireproofing materials.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and equipment shall conform to the respective specifications and standards and to the Specifications herein. Electrical ratings shall be as indicated.

B. Conduit: Provide per Section 26 05 33.

C. Wire and Cable: Provide per Section 26 05 19.

2.2 HANDHOLES

A. Provide handholes of reinforced precast concrete, or injection molded composite plastic material. Handholes shall include a base, a body, extensions, and a cover. Handholes with a perimeter of 10 feet or more (e.g., 3 feet by 2 feet) shall have both pulling irons and cable racks. All hardware shall be stainless steel, or hot-dip galvanized after fabrication; cable racking hardware, however, shall be non-metallic and corrosion resistant. If no handhole size is shown on the Drawings, size units per NEC or provide 12 inches by 24 inches by 18 inches deep, whichever is larger. Structure shall be fabricated in accordance with ACI 318.

B. Aggregate used in pre-cast handholes shall conform to the specifications given in ASTM C33.

C. Cement used shall be Type 11, low alkali Portland cement and shall meet ASTM C150, Type 11.

D. Reinforcing bars shall be intermediate grade billet steel conforming to ASTM A615.

E. Design wheel loads for handhole covers shall be HS 20-44 as given in AASHTO HB-13.

2.3 PRECAST MANHOLES

A. Provide in accordance with the requirements of Section 02085.

B. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking.

C. Provide all necessary lugs, rabbets, and brackets. Set pulling-in iron shall be installed in the wall opposite each duct line entrance. The words "ELECTRICAL" shall be cast in the top face of all manhole covers. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable. Cable racking hardware shall be non-metallic and corrosion resistant as manufactured by Pacific Utilities Supply, or equal.

D. Metal Frames, Covers: Provide steel or malleable iron frames, and covers conforming to Federal Specification RR-G-661, Type I.

E. Complete manholes shall be rated for HS 20-44 wheel loading as given in AASHTO HB-13.

PART 3 EXECUTION

3.1 TRENCHING, BACKFILL, AND COMPACTION

A. See Division 02.

3.2 WIRE AND CABLE INSTALLATION

A. See Section 26 05 19.

3.3 UNDERGROUND RACEWAYS WITH CONCRETE ENCASEMENT

A. All underground raceways shall be encased in concrete under all road access routes where heavy machinery may drive unless otherwise specifically shown otherwise on the Drawings.

1. Concrete encasement shall be minimum of 3 inches around outer walls of raceways and minimum of 2 inches between raceways. Conduits shall be PVC-40.

2. Concrete shall be Portland Cement type with 4 sacks cement per cubic yard of concrete, maximum coarse aggregate size of 3/8-inches and shall have minimum strength of 2,000 psi after 28 days. Amount of water shall not exceed slump required for placement. Five pounds red lead oxide shall be added per cubic yard of concrete for medium voltage raceway encasement only.

3. Underground raceways shall slope toward manholes, pull boxes, etc., at minimum rate of 3 inches per 100 feet unless indicated otherwise on Drawings. Raceway entrances in manholes, handholes, etc., shall be by means of bell ends and shall be sealed against entry of silt, debris, rodents, etc., into raceways.

4. Top of concrete encasement shall be minimum of 24 inches below grade.

5. Minimum radius of all horizontal bends in underground duct banks shall be 12 times nominal conduit size. Bends shall be formed of factory-made sweeps or continuous assembly of bend segments or curved segments, except that PVC-40 conduits may be field formed. Minimum radius of all vertical bends in underground raceways shall be twelve times nominal size of conduit.

6. Underground raceways within roadways shall be run parallel or perpendicular to road centerline.

7. Pull wires left in underground raceways shall be 1/8-inch nylon rope or 3/16-inch polypropylene.

8. Terminate conduits in end-bells where duct lines enter manholes and handholes. Provide structural support for concrete encased duct banks at the point where they terminate. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of a duct line is completed, draw a brush through having the diameter of the duct, and having stiff

bristles until the conduit is clear of all particles of earth, sand, and gravel; then immediately install conduit plugs.

9. Construct underground raceway systems (whether single raceways, or multiple raceway banks) utilizing snap together plastic "chairs" spaced and staked to the trench floor, no more than 6 feet apart along the entire length of the trench to maintain the specified minimum encasement between raceways, and between the duct bank and trench walls and floor. Provide Carlon Snap-N-Stac, or equal.

B. Connections to Existing Ducts: Where connections to existing duct lines are indicated, excavate the lines to the maximum depth necessary. Cut off the lines and remove loose concrete from the conduits before new concrete encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct line, to take the shear at the joint of the duct lines. Remove existing cables that constitute interference with the work. Abandon in place those used ducts and cables that do not interfere with the work.

C. Removal of Ducts: Where duct lines are removed from existing manholes, close the openings to waterproof the manhole. Chip out the wall opening to provide a key for the new section of wall.

D. See Section 26 06 33 for additional requirements.

3.4 UNDERGROUND RACEWAYS WITHOUT CONCRETE ENCASEMENT

A. Provide raceways without concrete encasement only if specifically shown on the Drawings, otherwise, provide concrete encasement as above.

B. Provide sand backfill three inches all around the raceway.

C. Construct raceways per the applicable provisions above for underground raceways with concrete encasement.

D. See Section 26 05 33 for additional requirements.

3.5 MANHOLES AND HANDHOLES

A. Install and test in accordance with the requirements of the General Conditions (Volume 1).

B. Provide manholes and handholes complete with all accessories, as indicated. Identify each casting by having the manufacturer’s name and address cast into an interior face or permanently attached thereto.

C. Manhole, Handhole or Concrete Pull box Grounding: Ground rods installed in electrical distribution system handholes or concrete pullboxes shall be properly connected to the cable shielding, metallic sheath, and armor at each cable joint or splice by means of No. 4 AWG or equivalent braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Ground wires shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Ground wires shall be neatly and firmly attached to handhole walls and the amount of exposed bare wire shall be held to a minimum.

D. Installation of Cable in Manholes and Handholes: Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form all cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators at a maximum of 18 inches. In existing handholes and vaults where new ducts are to be terminated or where new cables are to be installed, provide cable supports and grounding as required for a neat and workmanlike installation with all cables properly arranged and supported. Support cable splices in underground structures by racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure. Provide additional cable racks in each existing underground structure through which new cable is run.

E. Fireproofing (Arc Proofing) of Cables in Manholes, Handholes and Vaults: All wire and cables which will carry current at 2,200 volts or more in manholes, handholes, and vaults shall be fireproofed.

1. Arc-proofing Test for Cable Fireproofing Materials: Test one sample assembly consisting of a 3-inch diameter lead tube with a 1/4-inch wall thickness, fireproofed as specified. Make tests at three different points. At each point the testing shall consist of an arc magnetically blown against the test assembly until melting occurs at the point of arc contact. The arc shall be struck between two 7/8-inch electrodes located one inch from the sample assembly. Electrodes must be electrodes located one inch from the sample assembly. Electrodes must be squared off after each test run. Arc current shall be between 195 and 210 amperes at 40 vdc. For each test the fireproofing shall prevent damage to the lead for at least 25 seconds at any point and an average time of no less than 30 seconds for the test. In lieu of the above test, the Contractor may submit copies of the report of such a test previously made for the manufacturer, with certification that the material supplied for this project is the same as that used in the test. Test elements and requirements shall be essentially as specified in the test above.

2. Fireproofing Tape: Strips of fireproofing tape approximately 1/16-inch thick by 3 inches wide shall be wrapped tightly around each cable spirally in half-lapped wrapping, or in two butt-joined wrappings with the second wrapping covering the joints in the first. The tape shall be applied with the coated side toward the cable and shall extend one inch into the ducts. To prevent unraveling, the fireproofing tape shall be random wrapped the entire length of the fireproofing with pressure sensitive glass cloth tape. The fireproofing tape shall consist of a flexible, conformable fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050-inch thick and shall weigh not less than 2.5 pounds per square yard. The tape shall be noncorrosive to cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section specifies products and procedures used to identify electrical system equipment and components.

1.2 REFERENCE STANDARDS

A. None.

1.3 SUBMITTALS

A. As specified in Section 26 05 00 and the General Conditions (Volume 1).

B. Submit under one submittal the following items:

1. Nameplate Schedules.
2. Raceway/Conduit Schedules.
3. Wire Marker Schedules.

C. Provide two physical samples for each marker, tag, or nameplate type per submittal.

PART 2 PRODUCTS

2.1 EQUIPMENT NAMEPLATES

A. Provide nameplates on equipment.

B. Panel Nameplates: For equipment such as automatic transfer switches, switchgear, control panels, electrical equipment enclosures, disconnect switches, motors, and pumps, the nameplates shall be:

1. Located on the enclosure face.

2. Rectangular screw-on type with self-tapping 316 stainless steel screws.

3. Laminated engraving plastic nameplate.

   a. White letters on black backgrounds.
   b. 2.25-inch-tall.
   c. Length as required.
   d. 1/16-inch thick.

e. UV and scratch resistant.

4. Lettering: 1/4-inch-high lettering for equipment name and tag number.

5. Nameplate text shall include:

   a. Line 1: Asset number (e.g., “P2-040”).
   b. Line 2: Descriptive tag (e.g., “Effluent Pump #1”).
   c. Line 3: Associated MCC (e.g., “MCC2A”).
   d. Line 4: Voltage (e.g., “480 volts”).

C. Nameplate schedule shall be included with equipment submittals.

2.2 RACEWAY/CONDUIT MARKERS

A. Provide raceway/conduit markers.

   1. 316 Stainless steel.
   2. Minimum dimensions: 1-inch by 3-inch by 18-gauge thick.
   3. Two holes at each end for wire attachment.

B. Lettering: 1/4-inch tall, laser etched with black fill.

C. Attach with 316 stainless steel wire, 16 AWG minimum.

2.3 PERMANENT WIRE MARKERS

A. Identify each power and control conductor at each end of each terminal to which it is connected. Include identification for each spare conductor.

B. Conductors size No. 10 AWG or smaller shall have identification sleeves:

   1. Machine print on sleeves with permanent black ink the letters and numbers that identify each wire.

   2. Figures: 1/8 inch high.

   3. Sleeves: White tubing, sized to fit the conductor insulation.

   4. The sleeves shall be shrunk to fit the conductor with hot air after installation.

   5. Acceptable Manufacturer:

      a. TMS Thermofit Marker System by Raychem Co.
      b. Sleeve style wire marking system by W. H. Brady Co.
      c. Approved equal.

6. Adhesive strips are not acceptable.

C. Use cable markers of the locking tab type for conductors No. 8 AWG and larger:

1. Tabs: White plastic with conductor identification number permanently embossed.

2.4 RACEWAY NUMBERING SYSTEM

A. General:

1. Identify each conduit; rack and tray shall be identified by a unique number shown on the Drawings.

B. Conduit Identification Tag:

1. Pressure stamp conduit numbers into a non-corrosive metal tag. Fix a tag with number to each end of each conduit and at each manhole, pull box, and handhole with Type 304 Stainless Steel wire.

PART 3 EXECUTION

3.1 GENERAL

A. Label electrical and control equipment associated within scope of work.

3.2 RACEWAY/CONDUIT MARKERS

A. Neatly attach marker to the raceway with 316 stainless steel wire.

B. Exposed Conduit:

1. Marker shall be placed within 24-inches of termination or wall penetration.

2. A single marker will be allowed when the entire length of conduit is clearly visible from one location.

C. In concrete vaults with conduit flush with wall, attach markers to concrete with stainless steel hardware. Markers to be located within 6 inches of conduit.

3.3 LOW-VOLTAGE WIRE AND CABLE IDENTIFICATION

A. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pull box, junction box, handhole, and manhole using numbered and lettered wire markers. Electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number.

Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.

B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

C. Provide schedule identifying various power and lighting conductors from power source to equipment or device served.

D. Color Coding:

1. Provide color coding for circuit conductors. Conductors No. 6 and smaller shall be of appropriate color for the entire length. Insulation color shall be green for grounding conductors. Current carrying conductor colors shall be as follows:

    a. 480Y/277 V, Three-Phase, Power: (A) Brown, (B) Orange, (C) Yellow, and (N) Grey.

    b. 208Y/120 V, Three-Phase, Power: (A) Black, (B) Red, and (C) Blue, and (N) White.

    c. 240/120 V, Three-Phase, Power: (A) Black, (B) Orange, and (C) Blue, and (N) White.

    d. 120/240 V, Single-Phase, Power: (A) Black and (B) Red, and (N) White.

    e. 120 V, Control: Multi-color.

2. Provide appropriate color coding electrical tape at terminations on conductors without continuous color coded insulation. Conductor colors shall be as listed above.

3.4 SIGNAL CABLE IDENTIFICATION

A. Identify each wire or cable at each termination, in each pull box, and in each handhole using numbered and lettered wire markers. Electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.

B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

3.5 SWITCH AND OUTLET BOXES

A. Label light switches and outlets with panel name and circuit number.

END OF SECTION

SECTION 26 05 73 - SHORT CIRCUIT, COORDINATION, AND ARC FLASH REPORT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provide the services of a recognized independent testing laboratory or coordination analysis consultant (Consultant) to provide the following reports:

1. Short Circuit Report.
2. Protective Device Coordination Report.
3. Arc Flash Report.

B. The work of the following sections is related to the work of this section. Other sections, not referenced below, may also be related to the proper performance of this work. It is the Contractor’s responsibility to perform all the work required by the Contract Documents.

1. Section 26 05 00.

1.2 REFERENCE STANDARDS

A. Institute of Electrical and Electronic Engineers (IEEE) Publications:

1. IEEE 141 – Recommended Practice for Electric Power Distribution for Industrial Plants.

2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

3. IEEE 1584 – IEEE Guide for Performing Arc-Flash Hazard Calculations.

4. NFPA 70 – National Electric Code.

5. NFPA 70E – Standard for Electrical Safety Requirements for Employee Workplaces.

6. OSHA 29-CFR – Occupational Safety and Health Standards: Electrical Part 1910 Subpart S.

1.3 SUBMITTALS

A. Procedures: As specified in 26 05 00 and the General Conditions (Volume 1).

B. Schedule:

1. Submit Short Circuit, Coordination, and Arc Flash Reports with equipment submittals.

2. Approved report required prior to energizing equipment.

3. Provide and install arc flash labels prior to commissioning.

C. Provide separate submittal for each project site/location.

D. Submit the name and the qualifications of the laboratory or consultant for review by the Engineer. Qualifications must include professional registration of proposed personnel as electrical engineers.

E. Certified Short Circuit, Coordination, and Arc Flash Reports:

1. Arc flash warning labels.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Prepared by recognized independent testing laboratory or coordination analysis consultant who is regularly engaged in power system studies.

B. Consultant Certification: Short Circuit, Coordination, and Arc Flash Reports to be stamped and signed by an electrical engineer registered in the State of Oregon.

PART 2 PRODUCTS

2.1 SHORT CIRCUIT, COORDINATION, AND ARC FLASH REPORTS

A. Scope of Effort:

1. Perform the studies using actual equipment data.

2. The reports shall include available fault current and protection (fuse) information from Electrical Utility. Contact The Electrical Utility for this information.

3. For the Water Street Lift Station, the reports shall include all equipment shown on the one-line diagrams, including but not limited to, the following major components:

   a. Service Entrance Disconnect Switch (1).
   b. Automatic Transfer Switch (1).

c. Motor Control Center (1):
d. Pump Motor Controllers (2).
e. Lighting Panel (1).

B. Coordination Objective:

1. The protective device on the line side closest to the fault or abnormal conditions shall isolate the problem portion of the system and minimize damage in that portion. The rest of the system shall be maintained in normal service. The coordination shall be in conformance with the recommendations of latest IEEE Standard 242.

2. Use the circuit breaker manufacturer's selective coordination tables to determine coordination in the instantaneous trip region.

C. Report Submittals:

1. Submit the analysis, which shall include impedance and short-circuit calculations, list of any assumptions made in the analysis, the recommended settings of the protective devices, and the system time/current characteristic curves. The submittal shall be made so as to allow time for review and resubmittal, if necessary, before the implementation of final settings and adjustments by the testing laboratory.

2. Short Circuit Report: As a minimum, include the following in the report:

   a. Equipment manufacturer's information used to prepare the study.

   b. Assumptions made during the study.

   c. Short circuit calculations listing short circuit levels at each bus.

   d. Evaluation of the electrical power system and the model numbers and settings of the protective devices associated with the system.

   e. Time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.

   f. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment connected to that bus.

3. Protective Device Coordination Report: As a minimum, include the following on 5-cycle, log-log graph paper:

    a. Time-current curve for each protective relay or fuse showing graphically that the settings will allow protection and selectively within Industry standards. Identify each curve and specify the tap and time dial setting.

    b. Time-current curves for each device to be positioned for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, notify the Project Representative as to the cause.

    c. Time-current curves and points for cable and equipment damage.

    d. Circuit interrupting, device operating, and interrupting times.

    e. Indicate maximum fault values on the graph.

    f. Sketch of bus and breaker arrangement.

4. Arc Flash Report: As a minimum, include the following in the report:

    a. Equipment manufacturer's information used to prepare the study.

    b. Assumptions made during the study.

    c. Reduced copy of the one line drawing.

    d. Arc flash evaluations summary spreadsheet including:

        1) Bus name.
        2) Upstream protective device name, type, settings.
        3) Bus line to line voltage.
        4) Bus bolted fault.
        5) Protective device bolted fault current.
        6) Arcing fault current.
        7) Protective device trip/delay time.
        8) Breaker opening time.
        9) Solidly grounded column.
        10) Equipment type.
        11) Gap.
        12) Arc flash boundary.
        13) Working distance.
        14) Incident energy.
        15) Required protective fire rated clothing type and class.

    e. Bus detail sheets.

f. Arc flash warning labels printed in color on adhesive-backed labels:

1) Arc flash warning labels are to be produced and attached to each piece of electrical equipment included in the scope of these reports.

2) These labels must indicate approach boundaries, incident energy level, and the minimum PPE that is required when servicing the equipment within the arc flash boundary.

3) Labels shall be installed by Contractor on associated equipment per the direction of the Consultant preparing the report.

PART 3 EXECUTION

3.1 GENERAL

A. Perform the studies in accordance with:

1. IEEE Standards 141, 242, and 1584.
2. NFPA 70E.
3. OSHA 29-CFR, Part 1910 Subpart S.

B. Perform the studies using actual equipment data.

C. Provide on-site labor to collect field information and verify record information to prepare the reports.

3.2 CONFIRM EXISTING CONDITIONS

A. Owner will provide available record information as requested by the Consultant/Contractor.

B. Consultant preparing the report is responsible to field verify record information and collect additional information for performing the study. Provide a minimum of one 8-hour day to perform this field work.

C. Contractor shall replace or modify adjustable settings based on the coordination study to address coordination trip issues.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. The electrical equipment and conductors to be tested are specified herein and shown on the electrical drawings of the Contract Documents.

2. The Contractor shall retain an independent International Electrical Testing Association (NETA) member Engineering and Testing Firm (Testing Firm) for specified on-site acceptance testing of the project electrical power distribution system and utilization equipment covered by this contract.

3. The Contractor is responsible for installing the Arc Flash Hazard labeling work as specified in Section 26 05 00.

4. Tests performed by the Testing Firm shall be witnessed by the Resident Project Representative. Provide the Resident Project Representative 30-day advanced notice for Testing Firm tests. Insulation tests by the Contractor typically will not be witnessed. Critical equipment witness testing may be requested by the Resident Project Representative.

5. The manufacturer of the electrical equipment supplied for the project shall complete their on-site factory inspection, testing, and setup prior to the Testing Firm's Acceptance Testing and subsequent verification work. The power monitors shall be set up by the factory representatives and power monitor readings and settings verified by the Testing Firm. Manufacturer work is specified in the respective equipment sections.

6. The Installation Contractor shall test motors, conductors, and equipment as specified and shown. Contractor shall provide the labor, tools, material, including quality power sources required by the Testing Firm equipment, and other services necessary to provide specified tests and retesting.

7. Submit proposed electrical test procedures for tests to be performed by the Installing Contractor, other than insulation resistance testing, and proposed test procedures for tests to be performed by the Testing Firm.

1.2 QUALITY ASSURANCE

A. References

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/NETA ATS	International Electrical Testing Association (NETA) - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

B. Testing Firm:

1. The Testing Firm and their proposed project team shall possess the following minimum qualifications:

   a. Testing Firm shall be an independent testing organization providing unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems to be evaluated.

   b. Testing Firm shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.

   c. Testing Firm shall be a “NETA Accredited Company” of the InterNational Electrical Testing Association (NETA providing testing in accordance with ANSI/NETA ATS published specifications or the pre-approved firms that use the NETA methods and published testing specifications.

   d. If firm's own published testing specifications are proposed, then submit a copy to the Engineer for acceptance and submit the qualifications of the testing staff.

e. Testing Firm's lead technical person shall be currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution systems testing. Submit proof of technical training and certification for performing testing work.

f. Testing Firm's technicians shall be regularly employed, qualified testing staff.

C. Testing Firm Qualifications:

1. For any Testing Firm not pre-qualified, the Contractor shall receive Resident Project Representative approval of the proposed Testing Firm, their proposed project team, and their test procedures prior to the Pre-Test Submittals.

a. Project Team:

1) Identify lead technical person and testing staff and provide documentation of training and experience demonstrating compliance with the qualifications specified.

b. Testing Firm:

1) Provide reference names and current phone numbers of the Owner, Contractor, Engineer, or Resident Project Representative that has knowledge of the Firm’s work:

c. Provide documentation demonstrating NETA Accreditation and compliance with the qualification specified.

1.3 SUBMITTALS

A. Contractor shall submit the following information in accordance with the General Conditions (Volume 1):

B. Testing Firm Qualifications:

1. For any Testing Firm not pre-qualified per paragraph 1.02 Testing Form, submit qualifications per paragraph 1.02 Testing Firm Qualifications.

C. Pre-Test Submittals:

1. Description or samples of specified test procedures.
2. Sample test report forms for the specified tests.
3. Preliminary Schedule listing equipment to be tested.
4. Notification form for the work scheduled.
5. Pre-Functional test procedures and testing schedule.

6. Functional test procedures and testing schedule.

Form No.	Title
26 08 00-1	Motor Data Form
26 08 00-2	Installed Motor Test Data Form
26 08 00-3	Wire and Cable Resistance Test Data Form
26 08 00-4.1 & 4.2	Metering Pump Installed Test Forms
40 61 06-1	Analog Instrument Loop Test Form
40 61 06-2	Discrete Instrument Loop Testing Form

D. Post-Test Submittals:

1. Completed Section 26 08 00 Test Form Records.
2. Test Reports specified in Part 3 of this Section.

PART 2 PRODUCTS

2.1 TESTING EQUIPMENT AND INSTRUMENTS

A. The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology.

B. The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

2.2 SYSTEM INTEGRATOR

A. All programming and testing of the software programmed process control systems shall be accomplished by the Software System Integrator (SSI) under separate contract. The Contractor shall hire a Hardware System Integrator (HIS) for all hardware configuration and testing for new status wiring and proof testing of existing systems.

B. The instrumentation testing documents in specification 40 61 06 “Instrument Loop Testing Forms” shall be utilized by the HSI for final documentation of instrumentation testing. These documents shall be organized and submitted to the Owner’s Representative prior to substantial completion.

PART 3 EXECUTION

3.1 GENERAL

A. The Contractor shall submit a schedule for the Testing Firm work and notify the Resident Project Representative 30 days prior to commencement of any witnessed testing.

B. The required tests, including correction of defects where found, and subsequent retesting, shall be completed prior to energizing the electrical distribution system, utilization systems, and conductors and completed prior to functional testing. The installation of the protective device, breaker, and relay settings shall be completed and verified.

3.2 INSTALLATION CONTRACTOR TESTING

A. General:

1. Submit all completed test report forms in a 3-ring binder type notebook at the project Substantial Completion date.

B. Insulation Resistance Measurements:

1. Tests:

a. Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Where not specified, the minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA- ATS, ICEA, NEMA, or ANSI standards for the equipment or material being tested.

2. The ambient temperature at which insulation resistance is measured shall be recorded on the test form. A megohmmeter shall be used for insulation resistance measurements.

3. Conductor and Cable Tests:

a. The phase-to-ground insulation resistance shall be measured for circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation resistance measurements shall be recorded on Form 26 08 00-1 and submitted. Insulation with resistance of less than 100 megohms is not acceptable.

4. Motor Tests:

    a. The Installed Motor Test Form, Form 26 08 00-2 shall be completed for each motor after installation and submitted. All motors shall have their insulation resistance measured before they are connected.

5. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistance values less than 50 megohms are not acceptable.

6. Verify that motors are connected to rotate in the correct direction with the load disconnected. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

7. Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall be less than 5 percent difference between phases.

C. Power Distribution Equipment:

1. Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Insulation resistance values less than 10 megohms are not acceptable.

D. Power Utilization Equipment:

1. Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.

E. Signal and Data Cable Tests:

1. Signal conductors and shield drain shall be tested for insulation resistance with the other conductors in the cable grounded. Each shield drain conductor shall be tested for continuity.

2. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt or 1000-volt meg-ohmmeter shall be used for insulation resistance measurements as appropriate.

F. Pre-Functional Checkout:

1. Prior to energizing equipment, the Contractor shall perform a pre-functional checkout of the power and the control circuit. Protective devices shall be installed and available for service and calibrated or adjusted with specified setpoints

installed. Contractor selected initial setpoints shall be installed and recorded, when specified setpoints are not required from the manufacturer or the Engineer.

2. Contractor shall submit a description of proposed test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of pre-functional testing.

3. Pre-functional checkout shall consist of energizing each control circuit and operating each control device, protective device, monitoring or alarm device, and each interlock and verify the specified action or response occurs. Coordinate testing with the requirements with the Resident Project Representative.

G. Functional Testing:

1. Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.

2. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits associated with the Trojan equipment. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.

3. Record and submit data sheets using manufacture's standard.

3.3 TESTING FIRM ACCEPTANCE TESTING REQUIREMENTS

A. Acceptance Test Reports:

1. The Contractor shall maintain a written record of all inspection and test results and, upon completion of the project, shall assemble and certify a final test report

2. A copy of the preliminary test results shall be provided to the Resident Project Representative at the end of each day of testing.

3. Furnish two copies of the complete acceptance testing final report to the Resident Project Representative at Substantial Completion of the project.

B. Acceptance Test Documentation: The Contractor shall submit test documentation forms and a detailed description of the proposed inspection and test procedures to be performed by the Testing Firm. Testing shall not commence until the Resident Project Representative has approved the proposed forms and procedures.

C. The description shall identify the test equipment required for each specified test to be performed. Test report forms shall include the following information:

1. Electrical equipment description.
2. Electrical equipment identification number.
3. Electrical equipment nameplate data.
4. Electrical equipment settings.
5. Time and date of test.
6. Ambient conditions at time of test.
7. Inspection checklist and results.
8. Test results.
9. Test equipment used with manufacture, model number, and calibration date.
10. Remarks about test procedures, results, and suggestions.
11. Name and signature of testing personnel.
12. Name and signature of test witness.

D. Acceptance Testing Firm Tests:

1. Acceptance testing procedures and test results shall be as specified in ANSI/NETA ATS. The following types of equipment and systems shall be inspected and tested by the Testing Firm. Acceptance testing work shall not be limited to equipment shown on the drawings. Refer to Division 26 specification for the electrical equipment specified.

    a. Refer to the electrical drawings for location and identification of the electrical distribution system equipment, utilization equipment, and electrical conductors, included but not limited to:

        1) Panel boards
        2) Mini-power centers
        3) Power Monitors
        4) Cables Low-Voltage 600 Volt Maximum.
        5) Shielded cables.

3.4 ACCEPTANCE TEST VALUES

A. Minimum acceptable test values shall be as specified in ANSI/NETA ATS. Where acceptance test values are not specified, the equipment manufacturer's recommended test values shall be used. Where acceptance test values are not specified and the equipment manufacturers recommended test values are not available, request acceptance test values from the Resident Project Representative.

3.5 ACCEPTANCE TEST FINAL REPORT

A. Test report shall be assembled as described in ANSI/NETA ATS. Test results shall be organized by electrical distribution system equipment, project utilization equipment, and electrical conductors with individual tab dividers with labels to identify each group of items and cross-referenced to the Contract Documents. The equipment description, equipment number, and equipment tag number shall be used as shown on the drawings or listed in specifications.

B. Final Test Reports that are illogically assembled, labeled, and organized shall be returned for rework at no cost to the Owner and resubmitted in an acceptable format.

C. Deficiencies and non-compliant test results found during acceptance testing shall be identified in the test report and cover letter. The Testing Firm shall certify in the final test report that all deficiencies and non-compliant test results listed have been "corrected" and shall include a description of the resolution for each problem listed.

END OF SECTION

26 08 00 -1. MOTOR DATA FORM:

Equipment ___________________________ Equipment Name: _____________________________

Number(s)____________________________ Site Location: ___________________________________

Nameplate Markings:

Mfr _________________________ Mfr Model ___________Frame _________HP ________________

Volts ________________ Phase ___________ RPM ___________ Service Factor _________________

FLA ________ LRA __________ Freq __________ Amb Temp Rating ___________________degrees C

Time Rating___________________________ Design Letter __________________________________

KVA Code Letter _______________________ Insulation Class _______________________________

The following information is required for explosion proof motors only:

A. Approved by UL for installation in Class ______, Div _________

B. UL frame temperature code ________________; Group Atmosphere ______________________

The following information is required for high efficiency motors only:

A. Guaranteed minimum efficiency at full load or NEMA efficiency index _____________________

B. Nameplate or nominal efficiency____

Miscellaneous information:

A. Type of Enclosure___________________ Enclosure Material______________________________

B. Temp Rise ____degrees C

C. Space Heater Included? □ Yes □ No; if Yes, watts ______ volts ______

D. Type of motor winding over temperature protection, if specified: ________________________

Use the space below to provide additional information on other motor modifications, if specified:

____

____

____

____

26 08 00 -2. INSTALLED MOTOR TEST FORM:

Motor Equipment Number: _____________ Date of Test: ___________________________________

Equipment Driven: ____

Controller Location: _______________________________ Ambient Temp ºF _____________________

Resistance:

Insulation resistance phase-to-ground megohms:

Phase A ______________, Phase B _____________, Phase C ______________

Current at Full Load:

Phase ______________ Current, _______________ amps

Phase ______________ Current, _______________ amps

Phase ______________ Current, _______________ amps

Thermal Overload Device:

Manufacturer/Catalog # _______________ Amperes _______________

Circuit Breaker (MCP) Setting: ____

Motor Nameplate Markings:

Mfr ___________ Mfr Type ______________ Frame _____________ HP ______________

Volts ___________ Phase ___________ RPM _________ **Service Factor _____________

Amps ___________ Freq _____________ Ambient Temp Rating _____________degrees C

Time Rating ________________________ **Design Letter ____________________________

Code Letter _________________________ Insulation Class __________________________

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED____ Date ___________________

Contractor's Representative

WITNESSED ____ Date ___________________

Owner's Representative

26 08 00 -3 WIRING AND INSULATION RESISTANCE TEST DATA FORM:

Equipment or ID No.: ____

List all wiring associated with the equipment in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	MCC/ Bucket Location	Field Location	Continuity Testing		Insulation Resistance			
			Conductor to Conductor	Conductor to Shield	Open Shield to Ground	Shield to Conductor	Conductor to Ground	Closed Shield to Ground
A			(A/B)	(A/SH)				
B			(B/C)	(B/SH)				
C			(C/A)	(C/SH)				
N (Y motors)			(A/D) (B/D) (C/D)	(D/SH)				
Misc.								

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED____ Date __________________

Contractor's Representative

WITNESSED ____ Date __________________

Owner's Representative

26 08 00 - 4.1 METERING PUMP INSTALLED TEST FORMS:

Equipment/Tag Number: ______________ Date of Test: ________________________________

Equipment Description: ____

Location/Process: _______________________________ Ambient Temp ºF _______________

Associated Circuit Breaker/Fuse Identification: Panel # _______________ CB/Fuse #__________

Nameplate Markings:

Mfr ________________________ Mfr Model ________________________ HP ________

Volts _______________ Phase __________ RPM __________ Service Factor _______

FLA ________________ Freq _________ Amb Temp Rating ________degrees C

Stroke Adjustment Range: ____

Factory Set Range of Device: ___________, Field Set Range of Device:___________________

Note other Configuration Settings modified in Device:

____

____

Resistance of Analog Signal wire (Ohm Meter Readings – NOTE: Not a Meger test):

Signal Wire to GND ___________, Return to GND ___________,

Shield to GND (not terminated) ____________, Signal to Return ____________,

Signal to Shield _____________, Return to Shield _____________,

List all wiring associated with the equipment in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	PLC Panel Location	Field Location	Continuity Testing		Insulation Resistance			
			Conductor to Conductor	Conductor to Shield or N/A	Open Shield to Ground	Shield to Conductor N/A	Conductor To Ground	Closed Shield to Ground
A								
B								
C								
D								
E								
F								

26 08 00 - 4.2 METERING PUMP INSTALLED TEST FORMS

Control Function	PLC Signal Generated	Expected Control	Actual Control	PLC Output Raw	PLC Input Scaled	HMI Display Control
Speed		0-100% (4-20mA)				
Start/Stop		0 = Stop 1 = Start				
Running		0 = Stopped 1 = Running				
Dosing		0 = No Dosing 1 = Dosing				

Speed Control:
Associated PLC: ___________________________ Rack: ___ Slot: ___ Channel: ___
Associated PLC tag name: ___________________________
Associated HMI tag name: ___________________________

Start/Stop Control:
Associated PLC: ___________________________ Rack: ___ Slot: ___ Channel: ___
Associated PLC tag name: ___________________________
Associated HMI tag name: ___________________________

Running Status:
Associated PLC: ___________________________ Rack: ___ Slot: ___ Channel: ___
Associated PLC tag name: ___________________________
Associated HMI tag name: ___________________________

Dosing Status:
Associated PLC: ___________________________ Rack: ___ Slot: ___ Channel: ___
Associated PLC tag name: ___________________________
Associated HMI tag name: ___________________________

Note any other anomalies during testing:

____

____

CERTIFIED____ Date ____________________
Contractor's Representative

WITNESSED ____ Date ____________________
Owner's Representative

SECTION 26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Provide transformers as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.2 SUBMITTALS

A. Submit Shop Drawings in compliance with pertinent provisions of Section 26 05 00 including physical dimensions, nameplate data, electrical ratings (kVA, nominal primary voltage, tap voltages, nominal secondary voltage, and percent impedance), weight, physical dimensions, mounting requirements, and manufacturer’s detailed specifications.

B. Shop Drawing depicting method for raising and lowering the wall-mounted transformers.

1.3 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
IEEE C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers
UL 506	Specialty Transformers
NEMA ST20	Dry-Type Transformers for General Application
NEMA TP-1	Guide for Determining Energy Efficiency for Distribution Transformers

1.4 FACTORY TESTING

A. Tests on transformers shall include the manufacturer’s standard tests, including winding resistance, ratio, polarity, phase relation, no load loss, impedance, full load losses, and dielectric tests. Certified copies shall show compliance with all referenced standards.

1.5 WARRANTY

A. In addition to the warranty specified in Division 1, the manufacturer’s warranty to Owner shall in no event be for a period of less than 1 year starting from when the equipment and installation are substantially complete.

B. Warranty shall include repair parts, labor, and travel expenses.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with pertinent provisions of the General Conditions (Volume 1) and manufacturer’s requirements.

PART 2 PRODUCTS

2.1 GENERAL PURPOSE TRANSFORMERS

A. Provide transformers manufactured and tested to meet or exceed NEMA ST 20, UL 1562, ANSI C57.12, and IEEE standards for premium efficiency.

B. Efficiency: DOE 10 CFR Part 431 (2016).

C. UL Listed.

D. NEMA 1 or NEMA 2 rating.

E. Operational Frequency: 60 Hz.

F. Provide kVA rating, voltages, primary and secondary winding configuration as shown on the Drawings.

G. Provide overload capacity of not less than 10 percent for intermittent operation.

H. Construct transformer to include:

1. Below 30 kVA: Class F or better insulation having a 115-degree C rise average maximum over a 40-degree C ambient temperature.

2. 30 kVA and Above: Class H or better insulation having a 150-degree C rise average maximum over a 40-degree C ambient temperature.

3. High grade, non-aging cores with sheet silicone steel laminations having core plating insulation on both sides of each lamination.

4. Two 2-1/2-percent primary taps above and below nominal voltage.

5. Copper windings.

6. Transformers shall have space on primary terminals to terminate two sets of primary power conductors. Space shall be sufficient to terminate two sets of (3)#4, (1)#8 Gnd.

7. Ground bus shall have space to terminate the following:

    a. Equipment grounding conductors (Quantity two #8).
    b. System Bonding jumper for the separately derived system (Quantity one #8).
    c. Main Bonding Jumper to bond from neutral.
    d. Secondary grounding conductor (Quantity one #8).

I. Acceptable Manufacturer (for transformers not pre-installed in MCCs):

    1. General Electric.
    2. Square D.
    3. Eaton: Cutler-Hammer.
    4. Or Approved Equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install transformers in accordance with manufacturer's recommendations and as indicated on the Drawings.

B. Install wall-mounted transformers on prefabricated brackets designed for that purpose. If space does not allow for prefabricated brackets, submit Shop Drawings of field manufactured structure for Engineer's approval.

    1. Contractor shall submit Shop Drawing depicting method for raising and lowering wall-mounted transformers.

C. Install floor-mounted transformers on 4-inch concrete pad.

D. Provide flexible, liquid-type metallic conduit to prevent the transmission of sound through the conduit system.

E. Install potted, non-ventilated types below 30 kVA on resilient vibration-isolating mountings.

F. Adjust voltage taps for required system voltage when necessary.

G. Ground transformer in accordance with NEC requirements for separately derived systems.

H. Lace secondary conductors to resist short circuit forces. Follow manufacturer's recommendations.

3.2 FIELD TESTS

A. Test per NETA Paragraph 7.2. Submit results for review.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting and appliance panelboards.

2. Overcurrent protective devices for panelboards.

1.2 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 2017).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NECA 407 - Standard for Installing and Maintaining Panelboards 2015.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2014.

E. NEMA PB 1 - Panelboards 2011.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less 2013.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.

H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

K. UL 67 - Panelboards Current Edition, Including All Revisions.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

M. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.

N. UL 1699 - Arc-Fault Circuit-Interrupters Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See General Conditions (Volume 1) submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Identify mounting conditions required for equipment seismic qualification.

E. Manufacturer's equipment seismic qualification certification.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

E. Substitutions: See General Conditions (Volume 1)

F. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS – GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Seismic Qualification: Provide panelboards and associated components suitable for application under the seismic design criteria specified in Section 260548 where required. Include certification of compliance with submittals.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.

2. Ambient Temperature:

a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

D. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location.

2. Listed series ratings are acceptable only where specifically indicated.

3. Label equipment utilizing series ratings as required by NFPA 70.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Boxes: Galvanized steel unless otherwise indicated.

a. Provide wiring gutters sized to accommodate the conductors to be installed.

3. Fronts:

    a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

    b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

    c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 264300, list and label panelboards as a complete assembly including surge protective device.

2.3 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Aluminum or copper.

3. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers: Thermal magnetic bolt-on type.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.

2. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:

    a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated.

    b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

3. Conductor Terminations:

    a. Provide mechanical lugs unless otherwise indicated.

    b. Provide compression lugs where indicated.

    c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

6. Provide the following circuit breaker types where indicated:

    a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

    b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.

    c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.

    d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.

7. Do not use handle ties in lieu of multi-pole circuit breakers.

8. Provide the following features and accessories where indicated or where required to complete installation:

   a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

   b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

   c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.

PART 3 EXECUTION

3.1 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 260529.

F. Provide required seismic controls in accordance with Section 260548.

G. Install panelboards plumb.

H. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

I. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

J. Mount floor-mounted power distribution panelboards on properly sized 3-inch-high concrete pad constructed in accordance with Section 033000.

K. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling.

L. Provide grounding and bonding in accordance with Section 260526.

M. Install all field-installed branch devices, components, and accessories.

N. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 260573.

O. Provide filler plates to cover unused spaces in panelboards.

3.2 FIELD QUALITY CONTROL

A. See General Conditions (Volume 1) for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Test GFCI circuit breakers to verify proper operation.

D. Test AFCI circuit breakers to verify proper operation.

E. Test shunt trips to verify proper operation.

F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.3 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 24 19 - MOTOR CONTROL CENTERS

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies freestanding, factory assembled 600-volt smart motor control centers (MCC) with all appurtenances, and accessories.

B. Equipment List:

Equipment	Equipment No. *
South Motor Control Center Main	WTR11MCC01
Transient Voltage Surge Suppressor South MCC Main	WTR11TVS01
Power Monitor South MCC Main	WTR00PM_01
South Motor Control Center WTP	WTR11MCC02
Transient Voltage Surge Suppressor South MCC WTP	WTR11TVS02
Power Monitor Souh MCC WTP	WTR11PM_02
North Motor Control Center Main	WTR10MCC01
Transient Voltage Surge Suppressor North MCC Main	WTR10TVS01
Power Monitor North MCC Main	WTR10PM_01

* Based on equipment numbering system. See Asset Tagging Standard dated 01/06/2021

1.2 QUALITY ASSURANCE

A. Referenced Standards: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/NEMA ICS 1	General Standards for Industrial Controls and Systems
ANSI/NEMA ICS 2	Industrial Control Devices, Controllers and Assemblies
NEMA 1	National Electrical Manufacturer Association Enclosure 1
NFPA 79	Electrical Standard for Industrial Machinery
UL 845	Motor Control Centers

B. Qualifications: Not Used.

1.3 SUBMITTALS

A. Procedures: General Conditions (Volume 1)

B. Product Data:

1. Elementary connection and interconnection diagrams as required in this Section, in accordance with NFPA 79 and/or NEMA ICS standards.

2. Time current curves for all protection devices.

3. List of starters and feeder tap compartments indicating the size and type of circuit protection.

4. Interrupting, withstand and continuous current rating of:

   a. Bus bars.
   b. Feeder tap units.
   c. Starter units.
   d. Main incoming units.

5. Catalog and technical data indicating the equipment meets the specifications.

6. Installation instruction, outline dimensions, front view drawing identifying control and monitoring devices, nameplate engravings, shipping section dimensions, weight, and foundation requirements assembly.

7. External connection diagram showing function and identification of all terminals requiring field connections.

8. Operations and Maintenance manuals as specified in the General Conditions (Volume 1).

9. Schematics and wiring diagrams.

10. Plan drawings showing conduit entry locations.

11. Recommended spare parts list.

12. Certified copies of all material test reports.

13. Training schedule and materials.

14. Certification and calculations that the equipment complies with the seismic requirements for the area being installed and all code requirements.

C. Completed manufacturer factory and field test reports.

PART 2 PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. The equipment in this section has been designed around Allen Bradley Cetnerline 2100 MCCs with IntelliCENTER Technology. The Contractor shall submit substituted equipment required in this section based on favorable review of substitution. Substituted equipment must meet all requirements of these specifications and satisfy the intent of the design. Any additional MCC device configurations/functionality for substitute equipment shall be the responsibility of the Contractor (e.g. Rockwell Ethernet/IP communications may require installation and configuration, including mapping of a communication translation device).

B. All protective devices shall be fully rated. Series rating of protective devices is not allowed.

2.2 ACCEPTABLE MCC MANUFACTURER

A. Allen Bradley.

2.3 SERVICE

A. Motor control centers shall be rated 600 volts, 60 hertz, 3 phase, 4-wire as specified, and suitable for operation at the specified voltages and short circuit capacities.

2.4 STRUCTURE AND CONSTRUCTION

A. Structure:

1. Motor control centers shall be made of No. 14 gage steel minimum, and each section shall be as specified on the contract drawings. The individual unit compartments shall be a minimum of 12 inches high. There shall be 72 inches available for stacking starter units. Compartments shall have pan-type doors with a minimum of two quarter-turn hold-down latches; and neoprene gaskets.

2. A full height vertical wireway, 20-square-inch minimum, shall be provided for each vertical motor control center section. The wireway shall contain full height removable doors. Horizontal wireways shall be provided top and bottom, extending the length of motor control centers.

3. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full length of the motor control center lineup. A removable lifting angle shall be mounted on top and shall extend the width of the motor control center lineup.

4. Motor Control Centers and related equipment shall be braced for site seismic criteria.

B. Construction:

1. Motor control centers located indoors shall have NEMA 1.

2. Starter units, size 5 and smaller, and feeder tap units less than 225 amperes shall be drawout plug-in construction with hardened, plated copper free-floating stabs and steel spring backups. The door shall have interference tabs which prevent door closure if unit is improperly installed. Units shall be latched in the position to assure proper bus contact. The unit disconnect device shall be interlocked to prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions.

3. Fusible switch or circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "OPEN" position.

4. Hardware for mounting future starter and feeder tap units shall be provided at compartments specified as "FUTURE."

2.5 FINISH AND COLOR

A. The finish and color shall be in accordance with Allen Bradley standard grey.
B. Touchup of MCC must be completed for substantial completion.

2.6 BUS

A. General: Bus shall be tin-plated copper with bolted connections between vertical and horizontal bus bars. Access for tightening these connections shall be from the front, without the need for tools on the rear of the connection. Insulated horizontal and vertical bus barriers shall be provided. Barriers shall be fabricated from high-strength, glass-filled polyester resin.

B. Horizontal Bus: Unless otherwise specified, the main horizontal bus shall be rated a minimum 600 amperes continuous.

C. Vertical Bus: Unless otherwise specified, the vertical bus shall be rated a minimum 600 amperes continuous. Refer to drawings for additional information.

D. Neutral Bus: Where specified, a neutral bus shall be provided. The neutral bus shall have the same rating as the main horizontal bus and shall be provided full length of the motor control center.

E. Ground Bus: A 1/4-inch by 2-inch copper ground bus shall be provided the full length of the motor control center. Ground bus shall be located at the bottom of the motor control center. Provide a lug to terminate a bare 4/0 AWG copper ground conductors at each end of the ground bus.

F. Units shall be top fed to match existing field wiring.

2.7 WIRING

A. General: Motor control centers shall be provided with NEMA Class II, Type B wiring. All starter units shall have terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller. Motor control centers shall be provided with all necessary interconnecting wiring and interlocking. When a control section, as described in this Section, is specified on the drawings or schedules, wire directly to the relays or programmable controller's input/output modules as part of the interconnecting wiring. Attach polyester plastic protected connection diagram to inside of each unit door.

B. The elementary and connection diagrams for each starter unit as shown o the drawings are Allen Bradley standard schematics. Refer to the drawings for the cross-reference schematic drawing numbers.

C. Power Wire: Power wire shall be copper 90 degrees C "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded.

D. Control Wire: Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C and UL listed for panel wiring.

E. Ethernet communication wiring shall be CAT 6 and factory installed. All connections shall be standard Allen Bradley/Rockwell hardware with a single connection location for each MCC. MCC shall be connected to the local network switch located in the control panel in the MCC room.

F. Terminations and Cable Connections:

1. Terminals: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.

2. Cable Connectors: Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 MCM, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors. Incoming line and outgoing feeder compartments shall be provided with crimp type lugs, 3M, Burndy, or approved equal.

G. Conductor Markers: Markers used for identification shall meet the requirements of Section 26 05 00.

2.8 MAIN AND FEEDER BRANCH CIRCUIT PROTECTION

A. General: Main and feeder tap units shall consist of fused disconnect switches or circuit breakers, as specified. The trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the breaker. The motor circuit protector shall be set at its lowest position at the factory.

B. Fused Disconnect Switches: Fused disconnect switches shall be equipped with visible knife blades, shielded line terminals, and a quick-make, quick-break switch operator. Fuse clips shall be UL Class R rejection type. Type RK-1 dual-element fuses shall be used for both motor and non-motor loads. Unless otherwise specified, assembly shall have a UL listed short circuit capacity of 65,000 amps, symmetrical. Fuses shall be nonrenewable. Fuse removal shall be readily accomplished with the use of a fuse puller.

C. Circuit Breakers (Thermal Magnetic): Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amperes RMS symmetrical.

D. Circuit Breakers (Magnetic Only): Magnetic circuit breakers shall be molded-case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amps symmetrical.

2.9 MOTOR CONTROLLER UNITS

A. General: Motor controller units shall be combination type with contactor and fused disconnect switch or motor circuit protector as specified on the drawings or the MCC schedule. The starter units shall have a minimum UL listing of 65,000 amps RMS, symmetrical or as specified in the schedule.

B. Fused Disconnect Switches: Fused disconnect switches shall be as specified in this Section. Type RK-5 fuses shall be used for starter sizes 1 through 5. Class L time-delay fuses shall be used for size 6. Unless otherwise specified, assembly shall have a UL listed short circuit capacity of 65,000 amps symmetrical. Provide fused switches where shown.

C. Motor Circuit Protectors: The protection shall be provided by Allen Bradley E300 electronic overloads.

D. Control Transformers:

1. Each control transformer shall be rated 480/240-120V, single phase, 2 wire, 60 Hz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

NEMA starter size	Volt-ampere rating
1	100
2	150
3	200
4	300
5	500

2. Each control transformer shall be provided with time-delay, slow-blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two UL Class CC time-delay primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters. Fuses shall be sized in accordance with NEC. Primary fuse shall have a time/current characteristic specifically designed for control circuit transformer protection.

3. Fuse holder for secondary fuse shall be drawout indicating type and mounted on the door of the compartment. Fuse holders for primary fuses shall be fuse clips with full barriers between fuses.

E. Contactors:

1. Full-Voltage Non-Reversing (FVNR): Unless otherwise specified, contactors shall be full voltage, 3-pole, 600-volt AC, NEMA size 1 minimum. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools.

2. Full-Voltage Reversing (FVR): Reversing starters shall have mechanically interlocked contactor coils to prevent simultaneous engagement and shall have an additional contactor and auxiliary relays as required.

3. Two-Speed, Two-Winding (2S2W): Two speed starters shall have two mechanically and electrically interlocked contactors. Separate running over-current protection shall be provided for each speed.

F. Transient Surge Suppressor: A transient surge suppressor shall be provided in each starter. Suppressor shall be encapsulated in a small module suitable for mounting directly to the starter coil. Additional panel space for suppressor shall not be required. Suppressors shall be rated 120V AC.

G. Auxiliary Contacts: Contactors shall be equipped with auxiliary contacts, rated 10 amperes at 120 volts AC. Each contactor shall be equipped with interlocks as shown on the drawings, but not less than two normally open and two normally closed electrically isolated auxiliary contacts. Auxiliary contacts shall be wired out to terminal blocks.

H. Overload Relay: Shall be E300 OL devices as shown on the drawings. The OL device shall protect the power wiring and motor from excessive over currents. The relay shall be ambient compensated. The sensing element shall conform to ANSI/NEMA ICS 2-222.06, Class 20 tripping time. The management system shall incorporate Ethernet TCP/IP communications protocol. Each E300 Overload Relay shall include the I/O expansion unit.

I. Terminal Blocks: Terminal blocks shall be screw type rated 600 volts, 20 amperes for control wiring and 30 amperes power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). The number of terminal blocks shall be specified on the drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.10 MISCELLANEOUS

A. For motor starter units the control devices such as pushbuttons, selector switches, indicating lights, and overload reset pushbuttons shall be mounted on the unit compartment door via the HMI module.

B. Elapsed time indicator shall be incorporated into the HMI module.

C. Nameplates: Nameplates shall be provided in accordance with the requirements of Section 26 05 00. Nameplates shall be provided for all cubicles and compartments. A nameplate shall be provided identifying the motor control center.

D. Power Monitor: Power monitor shall be an Power Monitor 500 M8 with Ethernet/IP for Power Quality and Energy Management.

E. Provide phase fail relays which shall comply with the requirements of the control circuits.

F. Transient voltage surge suppressor shall be provided.

2.11 DRY-TYPE TRANSFORMERS

A. Dry-type power transformers shall meet the requirements of Section 26 22 13. The size and voltage shall be as specified.

2.12 PANELBOARDS

A. Where specified, panelboards mounted in motor control centers shall be flush mounted and shall have the quantity and size of branch circuit breakers specified. The panelboard shall meet the requirements of Section 26 24 16.

2.13 ETHERNET SWITCH

A. Per Section 40 66 00 with the exception of number and type of ports.

B. 10/100BaseTX: sixteen RJ-45 Copper Ports.

C. Prewired to all Ethernet devices within the MCC.

D. Preconfigured per Drawings.

E. One port reserved for communication to MCP 851,101.

F. Five spare ports.

G. Acceptable Manufacturers:

1. Allen Bradley Stratix.
2. Or Approved Equal.

2.14 SPARE PARTS

A. The following spare parts shall be provided:

1. Ten percent of the quantity provided, but not less than 12, of each fuse type and size provided by the contractor for installed equipment.

2. Ten percent of the quantity provided, but not less than 12, of each lamp type provided by the contractor for installed equipment.

PART 3 EXECUTION

3.1 GENERAL

A. The motor control centers shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

B. Field wiring shall meet the requirements of Section 26 05 19. Cables larger than No. 6 AWG which hang from their vertical connections shall be supported within 2 feet of the connection.

C. The E300 overload unit shall be provided, sized and adjusted based on the actual full load amperes of the motor.

D. The motor circuit protectors shall be adjusted to the lowest setting not causing false tripping.

3.2 TRAINING

A. Provide coordinated training course, approved by the Project Representative, to instruct three County personnel on motor control centers and one IT person for Ethernet/IP communications. The training will be conducted at the South Treatment Plant, coordinate with the Project Representative for room location. The training shall include, but not be limited to, the following:

1. Conduct four hours of training on operation and maintenance of the motor control centers specific to the supplied motor control center.

2. Training may be split into two identical courses covering the above material as directed by the Project Representative.

3.3 FIELD TESTS

A. Motor control centers shall be tested in accordance with Section 26 08 00.
B. Complete test report form 26 08 00 for each corresponding unit.

END OF SECTION

SECTION 26 27 16 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies local control panels for controlling process equipment, consisting of free standing and wall mounted enclosures, wiring, and electrical control devices. This section also applies to vendor packaged systems such as the filter local control panels.

B. Equipment List:

Equipment	Equipment No.
North WTP Local Control Panel	WTR10LCP0001
North Filter Local Control Panel	WTR11LCP0001
South Local Control Panel	WTR20LCP0001
South WTP Local Control Panel	WTR20LCP0002
South Filter Local Control Panel	WTR21LCP0001
Well #4 Local Control Panel	WEL04LCP0001
Well #4 Motor Control Panel	WEL04LMC001
Well #6 Local Control Panel	WEL06LCP0001
Well #6 Motor Control Panel	WEL06LMC001
Well #7 Local Control Panel	WEL07LCP0001
Well #7 Motor Control Panel	WEL07LMC001
Well #8 Local Control Panel	WEL08LCP0001
Well #8 Motor Control Panel (Exist VFD Panel)	WEL08LMC001 (Relabel Existing)
Well #9 Local Control Panel	WEL09LCP0001
Well #9 Motor Control Panel	WEL09LMC001

C. Local Control Panels (LCP) shall contain PLC and other low voltage control devices not requiring Arc Flash Analysis. Local Motor Control (LMC) shall contain 480V and other devices requiring Arc Flash Analysis. This reduces the operator/technician exposure to Arc Flash hazards when operating at the LCP.

1.2 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
EIA RS-310-C	Racks, Panels, and Associated Equipment
ANSI/NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies

Reference	Title
ANSI/NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA 4X	National Electrical Manufacturer Association Enclosure 4X
NEMA 12	National Electrical Manufacturer Association Enclosure 12
NFPA 70	National Electrical Code
UL 508	Industrial Equipment

B. Listing and labeling: See Section 26 05 00.

C. Qualifications: Not used.

1.3 SUBMITTALS

A. Procedures: See General Conditions (Volume 1).

B. Shop drawings and equipment data: Section 26 05 00.

C. Layout drawings of the local control panel enclosures indicating the front door and rear panel equipment arrangement and dimensions. Provide a list of materials and components with the layout drawings.

D. Instrumentation systems' manufacturer design.

E. Elementary and internal connection diagrams: Section 26 05 00.

F. A written description of the elementary diagram sequence of operation.

G. Operating and maintenance information: General Conditions (Volume 1).

H. Completed test report form 26 05 00-K.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. nVent Hoffmann Engineering Company.
B. Saginaw Control & Engineering.
C. Or Approved Equal.

2.2 GENERAL

A. Manufacture control panels in accordance with the general layouts, schedules, and details to suit the locations shown.

B. The instrumentation systems' manufacturer to completely design the panel structures, internal and external devices, equipment arrangement, wiring, and piping.

C. Provide control devices, control transformers, fuses, blown-fuse indicators, timing relays, control relays, selector switches, indicating lights, nameplates, terminal blocks, conductor markers, and miscellaneous materials as specified.

D. Flush mount all instruments, control devices, and similar equipment shown or required to be located on the face of the panels with no mounting screws or bolts protruding through the panel face beyond the covering area of the escutcheon.

E. Cleanly make cutouts for instruments in the manufacturer's shop. If a cutout is required for the fixed-mounted instruments, neatly work the cutout and trim in a flat black finish molded plastic material similar to the normal instrument escutcheons.

2.3 ENCLOSURES

A. General:

1. Comply with the requirements of ANSI/NEMA ICS-6.

2. Panel doors:

   a. Conceal hinges or piano hinges as applicable.

   b. Open at least 110 degrees.

   c. Provide each main door with a 3-point latching mechanism having roller latching at top and bottom and a vault-type-operating handle.

   d. Provide steel doors with turned edges and brace for rigidity.

3. Provide a 1/8-inch thick neoprene gasket on the panel frame to give the door a firm closure against the panel.

4. Provide mounting pans on the rear inner wall of the panel and also on the inner sides if any devices are to be located there.

B. Panel Classification: Unless otherwise indicated:

1. Indoor enclosures: NEMA 12.
2. Outdoor enclosures or in corrosive areas: NEMA 4X, nonmetallic.
3. Outdoor enclosures in non-corrosive and non-classified areas: NEMA 3R.
4. Class I, Division 1 or Division 2 areas are to meet the NEC requirement for that area.

C. Size:

1. Minimum enclosure area: Unless otherwise indicated, height by width, twice the sum of the area of the individual components mounted on the back panel.

2. Enclosure depth: Depends on the type of components used, but not less than 6 inches.

D. Finish and Color: In accordance with Section 26 05 00.

E. Mounting:

1. Unless otherwise indicated, provide the enclosures with provisions for wall mounting.

2.4 PANEL WIRING

A. Internal Wiring:

1. Single conductor 90 degree C "XHHW-2" wire with wire size in accordance with NFPA 70.

2. Wireways:

a. Interconnect major groups of devices mounted within the panel with wireways.

b. The wireways may be EMT, flexible metal conduit for runs less than 3 feet or 2-1/2 by 2-1/2-inch or 4-inch by 4-inch steel wireways.

c. Provide PVC slotted-side panel wiring duct adjacent to relays.

d. PVC slotted side panel wiring duct may also be used for control wire.

e. Arrange the duct in horizontal configurations to pass near all relays and devices being fed from the duct.

f. Header ducts: In general, steel wireways as specified above.

3. Provide panel wiring with stranded cross-linked polyethylene fire-resistant insulation and fit with pressure-type connectors at all terminations.

4. Provide milliampere and millivolt control and instrument signal wiring with stranded, pair-shielded polyvinylchloride insulated conductors as specified in Section 26 05 19.

5. Run control and instrument signal wiring separately from the alternating current circuits, unless otherwise indicated on the drawings.

6. Neatly tie all wiring in position with nylon cable ties.

7. Feed instruments with portable cord connections through the instrument panel plug strip located near the top of the panel directly above the instruments. Use

only the specified type of miniature locking plugs and receptacles for this purpose. These instrument supply cords are the only panel wiring which may hang free.

8. Color code internal wiring as follows:

Type	Color
Power (120V AC)	Black
Neutral	White
Control	Red
Foreign voltage	Yellow
DC	Solid Blue (+), Striped Blue (-)
Ground	Green

B. Wire Markers:

1. Provide in accordance with Section 26 05 00.

C. Wiring Methods:

1. Comply with UL 508.
2. Provide plastic wireway with covers to route groups of wires.
3. Provide plastic spiral wrap for exposed wires.
4. Enclose wires that cross door hinge in plastic spiral wrap.

2.5 CONTROL DEVICES

A. Provide in accordance with Section 40 78 00.

2.6 INDICATING LIGHTS (LIGHT EMITTING DIODES)

A. All, per the following:

Color	Function	Example
Red	Run, open valve	Equipment operating, motor running
Green	Ready, closed valve	Equipment ready, end of cycle
White or clear	Normal condition	Control power on, status OK
Amber (yellow)	Automatic	Equipment control in automatic position

B. Indicating lights per Section 40 78 00.

C. Indicating lights shall be Push to Test type.

D. Additional colors for other operation indications shall be as noted on the drawings.

2.7 ALARM AND MALFUNCTION DETECTION

A. Provide devices which are used to directly detect or signal alarm or malfunction conditions with an external manual reset.

B. Provide all devices or relays that are required to provide an external indication of malfunction, or status to a remote system, with an isolated dry NEMA Form C contact in addition to any contacts required for use by the internal control system.

C. If the device contact is required for internal equipment control as well as to signal alarm or malfunction conditions, then the manufacturer may make the reset function a part of the manufacturer's equipment master shutdown system. However, show each source of shutdown by local trouble lights which are manually reset at the equipment control panel.

D. Alarm or malfunction output contacts to open and remain open until manually reset when equipment is shut down due to malfunction.

E. Trouble contacts not to indicate abnormal conditions when the equipment has been manually shut down.

F. Initiate alarm and malfunction signals by a contact opening.

2.8 DEVICES WITH MOTOR STARTERS AND CONTACTORS

A. Equipment provided with control devices having motor starters or contactors, shall comply with the following additional requirements:

1. Disconnect switches:

    a. Provide equipment with a disconnect switch and switch padlock.

    b. Disconnect: Horsepower rated disconnect switch or molded case circuit breaker, except that a manual motor starter may be used for drives less than 2 kVA.

    c. Provide horsepower rated disconnect switches for equipment 2 kVA or greater with UL Class RK1 fuses.

    d. Circuit breaker interrupting ratings-minimum: Unless otherwise indicated or as a result of electrical power study provided for as part of this contract, - 22,000 symmetrical amperes for service at 240V or below and 32,000 symmetrical amperes for service above 240V.

e. When the disconnecting device is not a circuit breaker or fused disconnect, provide adequate overcurrent and short circuit protection for the circuit feeding the disconnecting device.

2. Overload protection: Provide protection for full motor running overload in ungrounded conductors for motors.

3. Overload relay contacts:

a. Do not connect overload relay contacts in the line having provision for grounding.

b. Provide grounding connections in the unfused side of control circuits and connect.

4. Power:

a. Supply power at one voltage as shown or specified.

b. Derive additional voltage requirements, such as 120V control power, from transformers provided internal to the control device as required.

c. Rate each control power transformer at least 150 percent of the calculated maximum load it serves.

2.9 ANALOG INSTRUMENTATION

A. Equipment required to provide analog signals to the process control system specified in Divisions 33 and 40 to provide such signals as an isolated (ungrounded), 4-20 mA DC signal, linearly proportioned to the value of the measured variable.

B. Equipment required to accept analog command signals from the process control system specified in Divisions 33 and 40 to accept externally powered 4-20 mA DC signals. The equipment's input terminals for command signals to be ungrounded and present not more than 250 ohms of resistance to the command signal.

2.10 TERMINAL BLOCKS

A. Rated 20 amperes.
B. Channel-mounted tubular screw type with pressure plate.
C. Mount assembly on channel standoffs.
D. Provide 15 percent spare terminals available for future use.

2.11 SPACE HEATER AND THERMOSTAT

A. Provide a space heater and thermostat near the bottom of each panel section and for each 3 feet of length on large panels.

B. Space Heater:

1. Rated 240 volts, 200 watts, but operated at 120 volts (50 watts).

2. Mount on porcelain standoff insulators at least 1/2 inch from the supporting surface.

3. Connect the heater to a control transformer furnished with the panel.

4. Provide an expanded metal guard to completely cover the heater and to allow free air movement.

5. Acceptable manufacturer:

   a. Chromalox Type PT-AC-1.
   b. Electromode.
   c. Or Approved Equal.

C. Thermostat:

1. Mount at mid panel height.

2. Acceptable manufacturers:

   a. Honeywell.
   b. Or Approved Equal with standoff and Type 62 mounting bracket.

2.12 LABELING AND NAMEPLATES

A. Labeling:

1. Label local control panel components to match the description on the elementary diagram. Label internal components of the local control panel on the back side of the door with the same description used on the front side.

2. Permanently mark label on or near each component. Machine embossed, adhesive backed nameplates shall identify the tag number of equipment inside cabinets.

B. Nameplates: Identify external door-mounted components and the local control panel description with plastic nameplates in accordance with Section 26 05 00.

2.13 GROUNDING

A. Ground all neutrals to the mounting plate using a copper bus or grounding lug. Use a grounding lug for a size No. 2 AWG bare copper conductor to ground the panel to the plant's grounding system.

PART 3 EXECUTION

3.1 GENERAL

A. Alternating Current Control Circuits:

1. 120 volts or less and grounded.

2. Connect one terminal of each load device to the grounded conductor.

3. Place control contacts, including overload device contacts, in the ungrounded side of the circuit.

B. Ground the panel to the plant grounding system shown on the Drawings.

C. Provide conduit, wiring or mounting of devices not shown on the electrical or instrumentation Drawings, but required for a complete and operable system.

3.2 ASSEMBLY

A. Conform to the requirements of UL 508.

B. Test the functional operation of the local control panel prior to shipment.

3.3 INSTALLATION

A. Install all wiring and tubing crossing hinges in a manner that will prevent chafing.

B. Securely clamp bundles of similar conductors to the door and to the panel and run the bundles parallel to the hinge for at least 12 inches.

C. Use spiral nylon cable wrap in the hinge section of the bundle to fully protect the conductors or tubing against chafing.

3.4 GROUNDING

A. Bond hinged or sliding pans, racks, and drawers to a ground bus by means of tinned-copper woven flat braid having a rating of at least 50 amperes.

B. Copper Ground Bus: 1/4 inch by 1 inch minimum of suitable length for all conductor terminations and connected to the motor control center or station ground bus with No. 2 AWG copper, green insulated cable for all freestanding panels.

C. The ground connection to the central ground bus may be run with other cables in an appropriate conduit in the case of small wall-mounted panels.

D. Ground Connection: Not less than No. 10 AWG or as shown.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Applicable provisions of Section 26 05 00 become a part of this Section as if repeated herein.

B. Work Included: Provide all necessary labor, tools and material to install circuit protective devices as shown on the Drawings and as described in these Specifications.

C. Cartridge fuses rated 600 V and less for use in switches and controllers.

1.2 REFERENCE STANDARDS

A. Federal Specifications (FS):

1. W-F-1726 Class H Cartridge Fuses

B. Underwriters Laboratories (UL) Standards:

1. 198C Fuses, High-Interrupting-Capacity-Current Limiting Types

C. National Fire Protection Association (NFPA) Publication:

1. 70 National Electric Code, Article 100

1.3 SUBMITTALS

A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 26 05 00.

1.4 LOCATIONS

A. Refer to Section 26 05 00 for definitions of types of locations.

B. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer’s ambient temperature adjustment factors to fuse ratings.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCHES

A. Fusible switches shall be heavy duty safety switches with the voltage ratings, current ratings, and number of poles as indicated by the Drawings. The switches shall be horsepower rated. Auxiliary contacts shall be provided as indicated on the Drawings. Stationary contacts shall be equipped with arc chutes. Fuse clips shall accept only Class J current limiting cartridge fuses. Where indicated on the Drawings, units shall have service entrance labels and shall be equipped with an insulated neutral lug. Switches shall be Square D, Type HD; Eaton Type DH; or equal.

B. Enclosures shall be as follows:

1. Dry Locations: NEMA Type 1.
2. Corrosive Locations: NEMA Type 4X.
3. Wet locations: NEMA Type 4.

C. Nameplates: Provide an engraved plastic nameplate for each disconnect switch identifying the equipment it protects.

D. Fuses:

1. General: Provide one complete set of fuses of each ampere rating shown on the Drawings plus one spare set for each size shown.

2. Fuse Type: Units shall be Class J current limiting, 700 volt, in the ampere ratings shown. Plug fuses are unacceptable. Barrels shall be non-hygroscopic with brass knurled ferrules.

3. Fuses shall conform to FS W-F-1726 and UL 198B, and shall carry labels showing UL class, interrupting rating, time delay characteristics, and voltage rating.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussman, Inc.
2. Littelfuse
3. Or Approved Equal

2.3 FUSED DISCONNECT SWITCHES

A. Fused disconnect switches shall be heavy duty safety switches with the voltage ratings, current ratings, and number of poles as indicated by the Drawings. The switches shall be 600 volt type and horsepower rated. Auxiliary contacts shall be provided as indicated on the Drawings. Switches shall be Square D Type HD; Eaton DH Series; or equal.

B. Enclosures shall be as follows:

1. Dry Locations: NEMA Type 1.
2. Corrosive Locations: NEMA Type 4X.
3. Hazardous Locations (gases): NEMA Type 7.
4. Hazardous Locations (dusts): NEMA Type 9.
5. Wet Locations: NEMA Type 4X.

C. Nameplates: Provide an engraved plastic nameplate for each disconnect switch identifying the motorized equipment it controls.

PART 3 EXECUTION

3.1 INSTALLATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

D. Install labels indicating fuse replacement information on inside door of each fused switch.

3.2 FUSE APPLICATIONS

A. Motor Branch Circuits: Class rating per respective equipment manufacturer.

3.3 FIELD TESTS

A. Insulation Resistance Tests: Perform insulation resistance tests on circuits to be energized with a line-to-neutral voltage of 120 volts or more. Make these tests after all equipment has been connected, except that equipment which may be damaged by the test voltage shall not be connected. Test the insulation with a 500 Vdc insulation resistance tester with a scale reading 100 megohms. The insulation resistance shall be 20 megohms or more. Submit results for review.

B. Continuity Tests: Perform circuit continuity tests from a low powered dc test source to operate a buzzer or bell. Tests shall be made prior to energizing the protected circuit.

C. Operating Tests: Demonstrate that the protected circuit can be manually controlled by the installed equipment.

END OF SECTION

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Applicable provisions of Section 26 05 00 become a part of this Section as if repeated herein.

B. Work Included: Provide all necessary labor, tools and material to install circuit protective devices as shown on the Drawings and as described in these Specifications.

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI) Publication:

1. Z55.1 Gray Finishes for Industrial Apparatus and Equipment

B. National Electrical Manufacturers Association (NEMA) Publications:

1. ICS 3 Industrial Systems
2. ICS 6 Enclosures for Industrial Controls and Systems
3. 250 Type 1 Enclosures for Electrical Equipment (1,000 Volts Maximum)

C. Federal Specifications (FS):

1. W-C-375 Circuit Breakers, Molded Case, Branch Circuit and Series Service, Series Trip

2. W-F-1726 Class H Cartridge Fuses

D. Underwriters Laboratories (UL) Standards:

1. 50 Electrical Cabinets and Boxes
2. 198C Fuses, High-Interrupting-Capacity-Current Limiting Types
3. 489 Molded Case Circuit Breakers and Enclosures
4. 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
5. 894 Switches for Use in Hazardous (Classified) Locations

E. National Fire Protection Association (NFPA) Publication:

1. 70 National Electric Code

1.3 SUBMITTALS

A. Submit Shop Drawings in compliance with pertinent provisions of the General Conditions (Volume 1) including electrical ratings, physical dimensions, NEMA rating, and manufacturer's detailed specifications.

1.4 LOCATIONS

A. Refer to Section 26 05 00 for definitions of types of locations.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide disconnect with the following ratings:

1. 600 Vac as required by circuit voltage.

2. Ampere value as shown on the drawings and based on the KW or HP nameplate ratings.

3. UL listed short circuit rating of 200,000 RMS amps with Class R fuses where a fused disconnect is indicated.

B. Enclosures shall be as follows:

1. Dry Locations: NEMA Type 1.
2. Corrosive Locations: NEMA Type 4X.
3. Wet locations: NEMA Type 4.

C. Nameplates: Provide an engraved plastic nameplate for each disconnect switch identifying the equipment it protects and the panel/circuit number being fed from.

D. Fuses:

1. General: Provide one complete set of fuses of each ampere rating shown on the Drawings plus one spare set for each size shown.

2. Fuse Type: Units shall be Class J current limiting, 700 volt, in the ampere ratings shown. Plug fuses are unacceptable. Barrels shall be non-hygroscopic with brass knurled ferrules.

3. Fuses shall conform to FS W-F-1726 and UL 198B, and shall carry labels showing UL class, interrupting rating, time delay characteristics, and voltage rating.

2.2 SAFETY SWITCHES

A. Provide NEMA heavy-duty, quick-make and quick-break type:

1. Cover interlock mechanism with handle attached to box.

    a. Handle position indication of ON in up position and OFF in down position.

2. Padlock provision in the ON and OFF positions.

3. Provisions for insulated or bonded neutral.

4. Provision for control circuit interlock

2.3 ENCLOSED CIRCUIT BREAKERS

A. Units shall be thermal-magnetic molded case circuit breakers in surface mounted non-ventilated enclosures conforming to the appropriate articles of NEMA 250.

B. Each unit shall have an external operating handle with a cover interlocking mechanism which will prevent opening of the enclosure when the operating handle is in the "ON" position. The handle shall be capable of being padlocked in either the "ON" or the "OFF" position. A breaker "tripped" position shall be clearly indicated between the "ON" and the "OFF" position.

C. Where indicated on the Drawings, enclosed breakers used as service entrance equipment shall be so labeled for such service and shall contain an insulated neutral lug. The complete unit shall conform to UL 489.

D. The circuit breakers shall be of the voltage, number of poles, frame size and ampere rating shown on the Drawings. Units shall be manually operated, trip-free, thermal-magnetic, molded case, front mounted circuit breakers.

1. Frame sizes larger than 100 amperes shall have adjustable instantaneous magnetic elements. Minimum interrupting rating shall not be less than 10,000 amps asymmetrical and the breaker shall conform to FS W-C-375. Multiple breakers shall have a common trip single operating handle with three positions of indication. Circuit breaker shall be calibrated at 40°C (104°F).

2. Each breaker shall be completely enclosed in a molded case with the calibrated sensing element factory sealed to prevent tampering.

2.4 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy duty safety switches with the voltage ratings, current ratings, and number of poles as indicated by the Drawings. The switches shall be 600-volt type and horsepower rated. Auxiliary contacts shall be provided as indicated on the Drawings. Switches shall be Square D Type HD; Eaton DH Series; or engineer approved equal.

B. Refer to 26 28 13 for fused disconnect fuse requirements.

C. Nameplates: Provide an engraved plastic nameplate for each disconnect switch identifying the motorized equipment it controls.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units plumb within 1/8-inch of vertical, and in accordance with manufacturer's instructions. Make sure that fuse ratings are as shown on the Drawings, and that breaker trip settings are per the Engineer's instructions.

3.2 MOUNTING HEIGHTS

A. Protective devices and switches shall be centered 5'-0" above the floor, unless shown otherwise on the Drawings.

3.3 FIELD TESTS

A. Insulation Resistance Tests: Perform insulation resistance tests on circuits to be energized with a line-to-neutral voltage of 120 volts or more. Make these tests after all equipment has been connected, except that equipment which may be damaged by the test voltage shall not be connected. Test the insulation with a 500 Vdc insulation resistance tester with a scale reading 100 megohms. The insulation resistance shall be 20 megohms or more. Submit results for review.

B. Continuity Tests: Perform circuit continuity tests from a low powered dc test source to operate a buzzer or bell. Tests shall be made prior to energizing the protected circuit.

C. Operating Tests: Demonstrate that the protected circuit can be manually controlled by the installed equipment.

END OF SECTION

SECTION 26 29 13.13 - ACROSS-THE-LINE MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Applicable provisions of Section 26 00 00 become a part of this Section as if repeated herein.

B. Related Work Described Elsewhere:

1. 26 24 19 Motor Control Centers

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association (NEMA) Publications:

1. ICS 1-2008 Industrial Control and General Requirements
2. ICS 2-2005 Controllers, Contactors and Overloaded Relays Rated 600V
3. ICS 6-2006 Industrial Control and Systems: Enclosures

B. Federal Specification (FS):

1. W-C-375E Circuit Breakers, Molded Case; Branch Circuit and Service

C. Underwriters Laboratories (UL) Standard:

1. UL 50 Enclosures for Electrical Equipment

1.3 SUBMITTALS

A. Submit material or equipment data in accordance with the Product Information category of the General Conditions and the submittal requirements of Section 26 05 00.

1.4 LOCATIONS

A. Refer to Section 26 05 00 for definitions of types of locations.

PART 2 PRODUCTS

2.1 MOTOR CONTROL

A. Each motor control shall consist of a manually operated circuit protective device and a magnetically operated motor starter mounted in a common enclosure, complete with auxiliary devices for control of the circuit as indicated.

B. Operating handle of the circuit protective device shall physically indicate "on", "off" and "tripped" positions. Handle shall accept three padlocks with heavy duty, industrial type shackles. Cover shall be interlocked with the operating handle to prevent opening when in the "on" position. A method shall be provided for releasing the interlock for inspection purposes when the switch is "on."

C. Motor circuit protectors shall have adjustable magnetic trips by a single dial with a moveable plug stop. Minimum fault interrupting capability shall be 14,000 amperes.

D. Starters shall be NEMA rated and no smaller than Size 1. Each shall be equipped with an overload element in each phase and auxiliary contacts as indicated on the Drawings, with a minimum of two N.O. auxiliary contacts. Control power shall be fused, 120 volts, derived from either the secondary of a control power transformer or in 120/208-volt power systems supplied by one phase and the neutral. Control power transformer, if supplied, shall have sufficient capacity for all devices connected to the control circuit and not less than 50 VA more than the normal capacity required to operate the starter. Provide push buttons, selector switches, and indicating lights as shown on the Drawings.

E. Enclosures shall be as follows:

1. Dry Locations: NEMA Type 1.
2. Corrosive Locations: NEMA Type 4X.
3. Hazardous Locations (Gases): NEMA Type 7.
4. Hazardous Locations (Dusts): NEMA Type 9.
5. Wet Locations: NEMA Type [4] [4X].

F. Nameplates: Provide an engraved plastic nameplate for each combination starter identifying the motorized equipment it controls.

G. An externally operable manual "reset" button shall be provided through the HIM module provided with the electronic E300 overload. Automatic restart after electronic overload shall not occur.

H. Provide Allen-Bradley Bulletin 513; or engineer approved equal.

2.2 MANUAL MOTOR STARTERS

A. Manual motor starters shall be horsepower rated. Provide nameplates and ambient compensated thermal overload protection. Enclosures shall be as follows:

1. Dry Locations: NEMA Type 1.
2. Corrosive Locations: NEMA Type 4X.
3. Hazardous Locations (gases): NEMA Type 7.
4. Hazardous Locations (dusts): NEMA Type 9.
5. Wet Locations: NEMA Type 4.

B. For all locations, provide Allen-Bradley Bulletin 600; Allen Bradley Bulletin 609; or engineer approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Conduit shall be installed per Section 26 05 33.

B. Conductor shall be installed per Section 26 05 19.

C. Internal wiring shall be installed in conformance with NEMA standards.

D. Enclosures shall be aligned within 1/8 inch of vertical.

E. Contractor shall compile a list and submit the completed list to the Engineer for review of the following data:

1. Equipment driven.
2. Motor nameplate operating information.
3. Overload heater current rating and catalog number.
4. Motor circuit protector rating, trip setting and plug number.
5. Timing relay settings if included in controller.

F. Lace power conductors to resist short circuit forces. Follow manufacturer's instructions.

3.2 GROUNDING

A. Grounding shall be installed in compliance with Section 26 05 26 of these Specifications.

3.3 FIELD TESTING

A. Control and protective devices not factory installed in equipment shall be demonstrated to operate as intended by the Specifications. Tests shall be repeated five times.

B. Phase rotation tests shall be performed on all three phase circuits with a phase rotation indicating meter. Rotation shall be clockwise.

C. Test data shall be recorded and submitted to the Engineer for approval.

D. Refer to 26 08 00 and the General Conditions (Volume 1).

3.4 COMPLETION OF WORK

A. Repair all scratched or damaged surfaces to "like new" condition.

B. All panels, conduit, pull boxes, and junction boxes shall have covers securely in place.

END OF SECTION

SECTION 26 50 00 - LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Applicable provisions of Section 26 05 00 become a part of this Section as if repeated herein.

B. Work Included: Provide a lighting system complete, including fixtures, lamps, standards, bases, hangers, reflectors, glassware, lenses, auxiliary equipment, ballasts, sockets, and photoelectric cells.

1.2 REFERENCE STANDARDS

A. General Standards

1. IES LM-79-08 Electrical and Photometric Measurements of Solid-State Lighting Products

2. IESNA LM-80 Approved Method for Measuring Lumen Maintenance of LED Light Sources

B. Underwriters Laboratories (UL) Standards

1. 57 Electric Lighting Fixtures
2. NFPA National Electric Code

1.3 SUBMITTALS

A. Submit material or equipment data in accordance with the Product Review category of the General Conditions (Volume 1) and the submittal requirements of Section 26 05 00.

B. Submit photometric curves for each fixture configuration proposed. Substitutions will not be considered unless the photometric distribution curve indicates the proposed fixture is approved equal to or exceeds the specified luminaire.

C. Submit shop drawings showing proposed methods for mounting interior lighting fixtures which are not attached directly to the ceiling or wall.

D. Regarding the seismic anchorage requirements for equipment certification and anchorage design, refer to local, state, national and AHJ requirements.

1.4 GUARANTEE

A. Lamps which fail within 90 days after acceptance by the Owner shall be replaced at no cost to the Owner.

PART 2 PRODUCTS

2.1 FIXTURES

A. Fixtures shall be of the types, wattages and voltages shown on the Drawings, comply with UL 57, and be UL classified and labeled for intended use.

B. Luminaire wire, and the current carrying capacity thereof, shall be in accordance with the NEC.

C. Luminaires and lighting equipment shall be delivered to the project site complete, with suspension accessories, aircraft cable, stems, canopies, hickeys, castings, sockets, holders, ballasts, diffusers, louvers, frames, recessing boxes and related items, including supports and braces.

2.2 BALLASTS

A. Ballasts: Provide energy efficient solid state electronic ballasts. Input watts shall not exceed 72 with "E" rated 3,700 lumen lamps operated at 25,000 Hertz. Sound rating shall be "A". Crest Factor shall be 1.6. Unit shall be FCC Certified and UL listed. Minimum lamp starting temperature shall be 50°F. Solid state ballast shall be suitable for dimming of T-8 and T-5 lamps. An internal MOV shall provide transient protection and a 3 year extended warranty shall be provided. Ballast shall be General Electric, Phillips or engineer approved equal

B. High pressure sodium lamp ballasts shall be the auto-regulator type providing 3% voltage variation to the lamp with 10%-line voltage variation. Ballast power factor shall be at least 90%. Ballasts shall bear the UL label.

C. Ballasts in luminaires for exterior use shall provide reliable starting of lamps at 0°F at 90% of the nominal line voltage. All locations, other than totally enclosed rooms, shall be considered exterior.

D. Ballasts producing excessive noise (above 36 dB) or vibration will be rejected and shall be replaced at no expense to the Owner.

E. LED Driver shall be solid state unit mounted within fixture and shall be adequately ventilated and match the LED fixture rating in watts and voltage. Driver shall have a power factor of at least 85% and shall be suitable for dimming from 25% to full rated watts.

2.3 LAMPS

A. General: Lamps shall be new at the time of acceptance and shall be General Electric, Sylvania, or engineer approved equal.

B. Fluorescent lamps shall be the rapid start type, high efficiency, 3,500 Kelvin in color. T-8 or T-5 lamps shall be General Electric; Sylvania Super; or engineer approved equal.

C. High pressure sodium lamps shall have an outer bulb with a diffuse finish and shall be suitable for burning in any position.

D. Metal halide lamps shall conform to 21CFR 1040.30.

E. LED units shall have the minimum rating of watts and output lumens and shall be provided by the same manufacturer as the LED driver

2.4 PHOTOELECTRIC CELL

A. Photoelectric cell shall have adjustable turn on range from 2- to 50-foot candles. Cell shall operate from 120 Vac, 60 Hertz. Switched contacts shall be single pole, single throw and tungsten rated 1,800 watts minimum at 120 Vac. Housing shall be weatherproof with threaded conduit fitting suitable for mounting to a junction box. Cell shall be Tork ; Intermatic ; or engineer approved equal.

2.5 TIME SWITCH

A. Time switch shall be electronic type, programmable, equipped with astronomical (24-hour, seasonally adjusting) dials and reserve power springs for a 10-hour minimum carry-over in the event of a power outage. Units shall be complete with a manual bypass switch.

2.6 LAMP POSTS AND STANDARDS

A. Lamp posts and standards shall be of the type, configuration, and dimensions shown on the Drawings, and shall be suitable for the indicated lamp mounting height.

B. Furnish complete with anchor bolts, bolt circle template, hand holes, and cover plate.

2.7 LIGHT CONTROL RELAYS

A. Units shall be mechanically held with contacts rated 30 Amperes to 600 Volts. Number of poles and operating coil voltage shall be as shown on the Drawings.

2.8 EXIT AND EMERGENCY FIXTURES

A. General: Fixture enclosures shall consist of an injection molded, high impact, NEMA 4X gasketed corrosion resistant reinforced polyester fiberglass housing. All hardware shall be stainless steel.

B. Emergency power shall be automatically supplied to light sources from sealed spiral wound pure lead batteries with a life expectancy rating of 15 years. Units shall comply with all requirements of UL 924.

C. Electronic solid-state logic shall provide 20 millisecond switching, automatic power cutoff at 87-1/2% cell voltage, recharging of batteries within 12 hours, and pilot light indication of battery and charger conditions. A manual test switch shall be provided to allow checking equipment function.

D. Emergency light and exit fixtures shall be equipped with LED lamps. Provide dual or single head as shown on the Drawings.

E. Exit lights shall have 5-3/4-inch red lettering silk screened on a high impact clear acrylic face.

F. For self illuminating non powered exit signs, refer to Drawings

2.9 DIMMING SYSTEMS

A. Fluorescent dimming systems shall be; Lutron; Leviton or engineer approved equal. Dimming electronic ballasts, dimming auxiliaries and intensity selector shall all be compatible with light fixture.

B. Intensity selectors for incandescent dimming systems shall have integral push-to-operate switch and shall be rated for 1,000 watts at 120 Vac. Manufacturer shall be Lutron; Leviton; or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. All fixtures and luminaires shall be clean and lamps shall be operable at the time of acceptance.

2. Install luminaires in accordance with manufacturer's instructions, complete with lamps, ready for operation as indicated.

3. Align, mount, and level the luminaires uniformly.

4. Avoid interference with and provide clearance for equipment. Where an indicated position conflicts with equipment locations, change the location of the luminaire by the minimum distance necessary.

5. Where the Drawings indicate that 4 lamp light fixtures are to be "two level" switched, wire the two inner lamps to one ballast and the two outer lamps to the other ballast.

B. Mounting and Supports:

1. Mounting heights shall be as shown on the Drawings. Unless otherwise shown, mounting height shall be measured to the centerline of the outlet box for a wall mounted fixture and to the bottom of the fixture for all other types.

2. For suspended luminaires, the mounting heights shall provide clearances between the bottoms of the luminaires and the finished floors as indicated.

3. Luminaire supports shall be anchored to the structural slab or structural members as indicated. Supports shall maintain the luminaire positions after relamping and cleaning.

4. Surface mounted fixtures shall be rigidly bracketed from mounting surfaces. Luminaires installed in rows shall have a non-cumulative dimensional alignment tolerance of 1/16-inch. Nipples carrying wiring between luminaires shall be watertight.

5. Pendant luminaires shall be provided with 7/32-inch aircraft cable to assure a plumb installation and shall have a minimum 25-degree clear swing from horizontal in all directions.

C. Mount fluorescent fixtures level and securely support from the ceiling. Provide earthquake clips for fixtures mounted in suspended ceilings.

D. Pendant Fixture Mounting:

1. In office areas with level ceilings, provide stems and canopies to match fixtures.

2. In office areas with sloping ceilings, provide flexible fixture mounting canopies and stems to match fixtures.

3. In other areas, provide flexible fixture hangers, Crouse-Hinds Type ARB; Appleton Type GS; or approved equal.

E. Mount lamp posts and lighting standards plumb and make free of dents or other damage.

F. Battery Operated Emergency Lighting Fixtures and Exit signs:

1. Wall mounted at designated height per manufacturer's instructions.
2. Battery disconnect switch to be left in the "off" position until building power is fully operational.
3. Egress fixtures shall be located per local, county, state and national code requirements.

END OF SECTION

SECTION 31 05 13 - SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes range of soil and subsoil materials intended to be referenced by other sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other sections and on Drawing notes.

B. Section includes:

1. Subsoil materials
2. Topsoil materials

1.2 RELATED SECTIONS

A. Section 31 05 16 - Aggregates for Earthwork
B. Section 31 10 00 – Site Clearing
C. Section 31 23 16 – Excavation
D. Section 31 23 17 - Trenching
E. Section 31 23 19 – Dewatering
F. Section 31 23 23 - Fill

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

B. ASTM International (ASTM):

1. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.
B. Materials Source: Submit name of imported materials source.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Furnish materials of each type from same source throughout the Work.

B. Soil Testing:

1. Soil sampling and testing to be completed by an independent laboratory approved by the Engineer.

2. Frequency of testing shall be determined by the Engineer & Required Testing and Frequency Table in plans.

3. All soil testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by AASHTO T-180.

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Soil Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1, Select Native Material:

1. Select earth obtained from on-site excavations approved for use by Engineer.

2. Graded.

3. Free of peat, humus, vegetative matter, organic matter and rocks larger than 6 inches in diameter.

4. Processed as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.

B. Subsoil Type S2, Imported Fill Material:

1. Imported earth approved for use by Engineer.
2. Meeting the requirements of Subsoil Type S1.

2.2 TOPSOIL MATERIALS

A. Topsoil Type TS1, Select Native Topsoil Material:

1. Top 6 - 12 inches of existing soil containing organic matter.

2. Engineer decision shall be final as to determination of what material is topsoil quality.

3. Graded.

4. Free of roots, rocks larger than 1/2-inch subsoil, debris, large weeds, and foreign matter.

   a. Screening: Single screened.

B. Topsoil Type TS2, Imported Topsoil Material:

1. Imported borrow.

2. Friable loam.

3. Reasonably free of roots, rocks larger than 1/2-inch, subsoil, debris, large weeds, and foreign matter.

   a. Screening: Single screened.

4. Acidity range (pH) of 5-1/2 to 7-1/2.

5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

2.3 SPOILS

A. All excess material not suitable or not required for backfill and grading shall be hauled off site and disposed of at a location provided by the Contractor and approved by the Engineer.

B. Make arrangements for disposal of the material at no additional cost to the Owner.

C. Landfill permit to be obtained by the Contractor and provided to Engineer prior to commencement of disposal.

2.4 SOURCE QUALITY CONTROL

A. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D1557.

B. When tests indicate materials do not meet specified requirements, change material or vary compaction methods and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

C. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate material of every nature and description to the lines and grades as indicated on the Drawings and/or as required for construction of facilities.

B. Site within clearing limits shall be stripped of topsoil as required to obtain additional topsoil necessary to complete Work indicated in the Drawings or as specified.

C. When practical, do not excavate wet topsoil.

D. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

E. Remove excess excavated subsoil and topsoil not intended for reuse from Site.

F. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from Site.

3.2 STOCKPILING

A. Stockpile soils at locations shown in the Drawings or at locations as approved by Engineer for redistribution as specified.

1. Site may not have sufficient area to stockpile excavated material that will be required for fill later in the project. If additional stockpile area is required to complete the Project on schedule, arrange off-site stockpile areas.

2. No additional payments will be made for stockpiling excavated materials off-site.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

F. Stockpile unsuitable and/or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes a range of coarse and fine aggregate materials intended to be referenced by other Sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other Sections and in Drawing notes.

B. Section Includes:

1. Coarse aggregate materials
2. Fine aggregate materials

1.2 RELATED SECTIONS

A. Section 31 05 13 - Soils for Earthwork
B. Section 31 23 17 - Trenching
C. Section 31 23 19 - Dewatering
D. Section 31 23 23 - Fill
E. Section 32 11 23 - Aggregate Base Courses
F. Section 33 11 10 – Water Utility Distribution and Transmission Piping
G. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses

2. AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates

3. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

4. AASHTO TP61 - Standard Method of Test for Determining the Percentage of Fracture in Coarse Aggregate

B. ASTM International (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

5. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Aggregate Testing:

1. Aggregate sampling and testing to be completed by an independent laboratory approved by the Engineer.

2. The frequency of testing shall be determined by the Engineer & Required Testing and Frequency Table in plans.

3. All aggregate testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASSHTO T180.
2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Aggregate Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate Type A1, Dense-Graded Aggregate: Crushed rock with ¾-inch-0, 1-inch-0, 1-1/2-inch-0, 2-inch-0 and 2-1/2-inch-0 gradation as shown in the Drawings and meeting the requirements provided below.

1. Grading - Dense-graded base aggregate shall be crushed rock, including sand. Uniformly grade the aggregates from coarse to fine.

2. Sieve analysis shall be determined according to AASHTO T27.

3. The aggregates shall conform to one of the grading requirements Table 31 05 16-A below.

Table 31 05 16-A
Grading Requirements for Dense-Graded Aggregate
Separated Sizes
Percent Passing (by weight)

Sieve Size	2-1/2" - 0	2" - 0	1-1/2" - 0	1" - 0	3/4" - 0
3”	100				
2-1/2”	95 - 100	100			
2”	-	95 - 100	100		
1-1/2"	-	-	95 - 100	100	
1-1/4”	55 - 75	-	-	-	
1”	-	55 - 75	-	90 - 100	100
3/4"	-	-	55 - 75	-	90 - 100
1/2"	-	-	-	55 - 75	-
3/8”	-	-	-	-	55 - 75
1/4"	30 - 45	30 - 45	35 - 50	40 - 55	40 - 60
No. 4*	-	-	-	-	-
No. 10	1	1	1	1	1

[1] Of the fraction passing the 1/4-inch sieve, 40 percent to 60 percent shall pass the No. 10 sieve.
* Report percent passing sieve when no grading requirements are listed.

4. Fracture of Rounded Rock:

a. Determined according to AASHTO TP61.

b. Provide at least one fractured face based on the following percentage of particles retained on the 1/4-inch sieve for the designated size:

Minimum Percent of Fractured Particles
by Weight of Material

Designated Size	Retained on 1/4-Inch Sieve
1-1/2-inch – 0 and larger	50
Smaller than 1-1/2-inch – 0	70

5. Durability:

   a. Crushed rock aggregate shall meet the following durability requirements:

Test	Test Method	Requirements
Abrasion	AASHTO T 96	35.0 percent maximum
Degradation (Coarse Aggregate)	ODOT TM 208	30.0 percent maximum
Passing No. 20 Sieve, Sediment Height	ODOT TM 208	3.0-inch maximum

6. Sand Equivalent -- Crushed rock aggregate will be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 50.

B. Coarse Aggregate Type A2, Granular Drain Backfill Material: Crushed or uncrushed rock or gravel as shown in the Drawings.

1. Material shall be clean and free draining.
2. Sieve analysis shall be according to AASHTO T27.
3. Grading: Meeting the gradation requirements provided in Table 31 05 16-B below.

Table 31 05 16-B
Grading Requirements for Granular Drain Backfill Material
Separated Sizes
Percent Passing (by weight)

Sieve Size	Separated Sizes 1-1/2-inch – 3/4-inch	Separated Sizes 3/4-inch – 1/2-inch
2-inch	100	
1-1/2-inch	90 - 100	
1-inch	20 - 55	100
3/4-inch	0 - 15	85 - 100
1/2-inch	-	0 - 15
3/8-inch	0 - 5	-

2.2 SAND

A. Sand: Sand material shall consist of granular material, naturally produced or produced from crushed gravel, or dredge sand that is reasonably free of organic material, mica, clay, fly ash, and other deleterious material, meeting the gradations of Table 31 05 16-C below.

Table 31 05 16-C
Grading Requirements for Sand
Separated Sizes
Percent Passing (by weight)

Sieve Size	Coarse Sand	Medium Sand	Fine Sand
1-inch	100	100	100
3/8-inch	95 - 100	95 - 100	-
#4	80 - 100	70 - 95	90 - 100
#30	10 - 30	10 - 45	-
#100	-	2 - 10	2 - 10
#200	0 - 8	0 - 7	0 - 4
Sand Equivalent	50 min.	50 min.	50 in.

2.3 SOURCE QUALITY CONTROL

A. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D1557.

B. Sand - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D1557.

C. When tests indicate materials do not meet specified requirements, change material and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials imported to site as shown in the Drawings or at locations as approved by Engineer for redistribution as specified.

B. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

C. Prevent intermixing of aggregate types or contamination.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes clearing site of incidental paving and curbs, debris, grass, trees, and other plant life in preparation for site or building excavation work.

1.2 DEFINITIONS

A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

B. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 12 inches below subgrade.

C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

D. Limits of Disturbance: Work area boundary as shown on the Plans.

E. Root Wad: Tree stump and root mass including all roots greater than 1-inch diameter.

F. Stripping: Removal of topsoil remaining after applicable scalping is completed.

1.3 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Clearing, Grubbing, and Stripping Plan: Drawings clearly showing proposed limits to clearing, grubbing, and stripping activities at Site.

C. Certification or disposal permit for landfill and/or waste disposal site.

D. A copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

1.4 QUALITY ASSURANCE

A. Existing Conditions: Determine the extent of Work required and limitations before proceeding with Work.

B. Obtain Engineer’s approval of staked clearing, grubbing, and stripping limits prior to commencing clearing, grubbing, and stripping.

C. Conform to applicable local, state, and federal codes for environmental requirements and disposal of debris,

1. Burning on project site will not be permitted.
2. Use of herbicides will not be permitted.

D. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.

E. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of laborers, other persons, and property in the vicinity of the work and requirements of the General Provisions.

PART 2 PRODUCTS

2.1 MATERIALS

A. Existing Materials: All materials, equipment, miscellaneous items, and debris involved, occurring or resulting from demolition, clearing, and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or specifications.

B. Wound Paint: Emulsified asphalt formulated for use on damaged plant tissues.

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements within limits shown in approved Clearing, Grubbing, and Stripping Plan.

B. Remain within the property lines at all times.

C. Do not injure or deface vegetation or structures that are not designated for removal.

3.2 EXAMINATION

A. Verify existing plant life designated to remain is tagged or identified.
B. Identify waste and salvage areas for placing removed materials.

3.3 PREPARATION

A. Carefully coordinate the work of this Section with all other work and construction.

B. Call Local Utility Line Information service at 1-800-332-2344 (or 811), not less than three working days before performing Work.

C. Request underground utilities to be located and marked within and surrounding construction areas.

1. Disconnect or arrange for disconnection of utilities (if any) affected by required work.

2. Keep all active utilities intact and in continuous operations.

D. Prepare Site only after:

1. Erosion and sediment controls are in place.

a. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls and in compliance with COP Erosion and Sediment Control Manual and ESC Permits.

2. Tree and vegetation protection is installed.

a. Protect existing site improvements, trees, and shrubs to remain to preclude damage during construction.

3. Temporary fencing is installed along the Limits of Disturbance.

4. Notification of utility agencies; disconnect or arrange for disconnection of utilities (if any) affected by required work. Keep all active utilities intact and in continuous operation.

3.4 PROTECTION

A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.

B. Survey control: Protect benchmarks, survey control points, and existing structures from damage or displacement.

C. Preservation and Trimming of Trees, Shrubs, and Other Vegetation:

1. Avoid injury to trees, shrubs, vines, plants, grasses, and other vegetation growing outside of the areas to be cleared and grubbed and those trees and shrubs designated to be preserved.

2. Protect existing trees and shrubs against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of roots by stockpiling construction

materials, excavated materials, excess foot or vehicular traffic, and parking of vehicles within drip line.

3. Provide temporary guards, as necessary, to protect trees and vegetation to be left standing.

4. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

5. Provide protection for roots and limbs over 1-1/2-inch diameter cut during construction operations. Coat cut faces with emulsified asphalt.

6. Repairable damage to trees and shrubs designated to remain shall be made by a professional tree surgeon approved by the Engineer. Cost shall be borne by the Contractor.

D. Landscaped Areas:

1. When any portion of the Work crosses private property or landscaped areas, excavate topsoil separately and pile it on the opposite side of the trench from the subsoil.

2. Conduct Work in a manner that will restore original conditions as nearly as practicable.

3. Remove and replace any trees, shrubs, plants, sod, or other vegetative material as needed to complete Work.

4. All shrubs or plants shall be balled by experienced workers, carefully handled and watered, and replaced in their original positions without damage. Sod shall be handled in a similar manner.

5. Wherever sod cannot be saved and restored, the ground must be reseeded and cared for until a stand of grass is reestablished.

6. Plants or shrubs killed or destroyed shall be replaced and paid for by the Contractor.

7. It is the intent of this paragraph that the Contractor shall leave the surface and plantings in substantially the same conditions as before the Work is undertaken.

E. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, sidewalks, paving, and curbs.

F. Repair and Replacement:

1. Damaged items, including but not restricted to those noted above, shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.

2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

3.5 LIMITS

A. As follows, but not to extend beyond Limits of Disturbance and within the approved disturbance limits in the Environmental Zones:

1. Excavation: 5 feet beyond top of cut slopes.

2. Trench Excavation: 6 feet from trench centerline, regardless of actual trench width.

3. Fill:

    a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
    b. Stripping: 2 feet beyond toe of permanent fill.

4. Structures: 15 feet outside of new structures.

5. Roadways: Clearing, grubbing, scalping, and stripping 5 feet from roadway shoulders.

6. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within the Limits of Disturbance as material is generated. Stockpiling shall not be permitted without written approval of Owner.

3.6 CLEARING AND GRUBBING

A. Clear and grub areas within limits shown in approved Clearing, Grubbing, and Stripping Plan.

B. Except in areas to be excavated, all holes resulting from the clearing and grubbing operations shall be backfilled and compacted in accordance with the applicable sections of these Specifications.

C. Clearing:

1. Remove trees, saplings, snags, stumps, shrubs, brush, vines, grasses, weeds, and other vegetative growth within the clearing limits shown in the Drawings, except

those trees and shrubs noted to remain in the Drawings or as directed by the Engineer.

2. Clearing shall be performed in such a manner as to remove all evidence of the presence of vegetative growth from the surface of the project site and shall be inclusive of sticks and branches of thickness or diameter greater than 3/8-inch and of grasses, weeds, exceeding 12 inches in height except as otherwise indicated.

3. Clear undergrowth and deadwood, without disturbing subsoil.

D. Grubbing: Clear areas required for access to site and execution of Work and remove all stumps, root wads, and roots over 1-inch diameter to the following depths:

1. Future Structures and Building Areas	24 Inches
2. Roads and Parking Areas	16 Inches
3. All other Areas	12 Inches

3.7 TREE REMOVAL

A. Exercise care in cutting, felling, trimming, and handling of those trees shown for removal to prevent damage to neighboring trees and structures to remain.
B. Tree Salvage: As shown on the Plans.
C. No trees may be removed unless approved and permitted by the Engineer.
D. Do not top trees unless otherwise specified or approved by Owner in writing.

3.8 REMOVAL AND DISPOSAL

A. Native vegetation may be mulched and used on Site.

B. Asphalt and Gravel Surfaces:

1. Asphalt, concrete, and gravel surfaces designated for removal shall be done to full depth.

2. Asphalt, concrete, and gravel removed at Site may be reused at Site where shown in the Drawings or following approval of the Engineer.

3. Haul removed asphalt, concrete, and gravel which is unsuitable for reuse or that exceeds quantity required.

C. Remove debris, rock, abandoned piping, and extracted plant life from Site.

D. Remove from the Site all debris, materials, equipment, and items found thereon and materials and debris resulting from the Work, except as otherwise indicated.

1. All existing improvements designated on the Drawings or specified to be removed including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing, and similar structures occurring above, at, or below existing ground surface shall be included in the Work.

2. Unless otherwise specified, any resulting voids shall be thoroughly cracked out for drainage and backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

F. Do not burn or bury materials on site. Leave site in clean condition.

G. Removal: All material resulting from demolition, clearing and grubbing, and trimming operations shall be removed from the Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.

H. Cleanup: During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, and debris.

I. Adjacent areas shall be returned to their existing condition prior to the start of Work.

3.9 CLEANUP

A. During the time Work is in progress, make every effort to maintain the Site in a neat and orderly condition.

B. All refuse, broken pipe, excess fill material, cribbing, and debris shall be removed as soon as practicable.

C. Should the Work not be maintained in a satisfactory condition, the Owner may cause the work to stop until the cleanup of the Work has been done to the satisfaction of the Engineer.

D. The Work will not be considered complete or the final payment certificate issued until all rubbish, unused material, or equipment shall have been removed and the premises left in a condition satisfactory to the Owner and the Engineer.

END OF SECTION

SECTION 31 20 00 - SOIL MATERIALS

PART 1 GENERAL

1.1 SECTION INCLUDES

Structural Fill materials.

1.2 REFERENCES

A. ASTM D2487 - Classification of Soils for Engineering Purposes.

B. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

C. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS FOR REVIEW

Samples: Submit, in air-tight containers, 10 lb sample of the structural fill to testing laboratory.

1.4 SUBMITTALS FOR INFORMATION

Materials Source: Submit name of imported materials source.

1.5 QUALITY ASSURANCE

Perform work in accordance with Oregon Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.1 STRUCTURAL FILL MATERIALS

Structural fill: Conforming to the Oregon Standard Specifications for Road, Bridge, and Municipal Construction, specified as Gravel borrow.

2.2 SOURCE QUALITY CONTROL

A. Testing and Analysis of Structural Fill Material: Perform in accordance with ASTM D698. If tests indicate materials do not meet specified requirements, change material and retest.

B. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 SOIL REMOVAL

A. Excavate topsoil from areas designated.
B. Remove lumped soil, boulders, and rock.
C. Remove excavated material from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by the Project Manager.
B. Stockpile in sufficient quantities to meet Project schedule and requirements.

3.3 STOCKPILE CLEANUP

Remove stockpile, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 20 10 - TRENCHING, BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.1 WORK INCLUDED

This section refers to excavation, trenching, pipe bedding and backfill, and other related work.

1.2 STANDARDS

The following standards apply to the work included in this section.

A. Soil densities are expressed as a percent of the laboratory standard maximum dry soil density as determined in accordance with Method of Test for “Moisture-Density Relations of Soils Using 10-pound hammer and 18-inch Drop”, ASTM Designation: D1557 (AASHTO T-180) method A or C as required.

B. Free draining soil densities are expressed as a percent of the laboratory density when tested in accordance with Method of Test for “Relative Density of Cohesionless Soils,” as ASTM Designation: D2049. In this specification, a “free draining soil” is defined as a soil whose dry density in pounds per cubic foot at 70 percent relative density is greater than its dry density at 90 percent of laboratory standard maximum dry density.

C. In-place tests of soil density shall be made in accordance with Method of Test for “Density of Soil in Place by Sand-Cone Method,” ASTM Designation: D1556, or nuclear method, ASTM Designation D2922.

1.3 CLASSIFICATION OF EXCAVATION

Unclassified excavation shall include all materials excavated or removed regardless of the type, character, composition or condition of the material so excavated, except rock excavation. The excavation procedure will depend on the construction methods used by the Contractor.

PART 2 PRODUCTS

2.1 PIPE ZONE MATERIAL

Pipe zone material shall consist of imported ¾” minus granular material compacted to 95% of T-180, free from roots or organic material, mud, muck and frozen material. All pipe zone material shall pass a ¾ inch screen unless otherwise shown on the plans. Not more than 15 percent shall pass a NO. 200 sieve.

2.2 NATIVE BACKFILL MATERIAL

Native backfill shall be excavated native material free from roots or other organic material, mud, muck, frozen material, and stones larger than 3 inches in diameter.

2.3 SELECT MATERIAL FOR FOUNDATION

Backfill to replace unsuitable material in the bottom of pipe trenches shall consist of crushed, partially crushed or naturally occurring granular material from approved sources, uniformly graded from ¾-inch to zero with not more than 5 percent passing the No. 200 sieve unless shown otherwise on the plans.

2.4 SELECT BACKFILL

Select backfill shall consist of material specific for foundation stabilization.

2.5 ROCK EXCAVATION

The term “rock” shall be understood to mean solid sandstone, limestone, granite, basalt, or stratified masses that requires the use of systematic drilling and blasting for removal. Boulders one-half cubic yard in volume or larger will be classified as rock. Cemented gravel (conglomerate), shale, clay, and other sedimentary materials will be classified as rock only when systematic drilling and blasting is required for removal. Loam, sand, gravel, clay or other material stratified between the layers of rock will not be classified as rock.

PART 3 EXECUTION

3.1 CLEANING AND GRUBBING

Unless specified in the Supplemental Specifications and/or indicated otherwise by the proposal, the Contractor shall do all clearing and grubbing necessary to the construction and the costs thereof shall be absorbed in the lump sum or unit prices of the bid.

Clearing must be restricted to the minimum required for excavation and disposal. All stumps, brush, debris trees and other cleared material shall be disposed of in a manner approved by the Engineer. The Contractor must secure the necessary permits and conform to all regulations of the agencies having jurisdiction. Burning, if allowed, must be located so as not to burn or damage trees or vegetation adjacent to the right-of-way area.

3.2 CUTTING PAVEMENT, SIDEWALKS, CURBS & GRAVEL SURFACES

Saw cut pavement or other street surfaces only to the minimum width which will permit the proper excavation and bracing of the trench. Sidewalks generally shall be sawed to regular lines and squares, but, where practical, removal may be avoided by the use of tunnels. Where the bid prices provide payment for cutting and replacing pavement, sidewalks, or curbs, if in order to minimize surface disturbance and traffic interfere, the contractor elects to use the cut and tunnel method, contractor shall be allowed the same full measurement as though all material had been removed.

Wherever old pavement is encountered at any depth below an existing wearing surface, no extra payment will be made for work incidental to cutting or removing such pavement. It is the responsibility of the contractor to ascertain the conditions which exist with regard to old pavements or wearing surfaces, and all costs due to their existence shall be absorbed in the unit price of the bid.

3.3 PRIVATE PROPERTY AND LANDSCAPED AREAS

In any portion of the line crossing private property or landscaped areas, excavate the topsoil separately and pile it on the opposite side of the trench from the subsoil or remove it to a stockpile at an approved location. Conduct all work in a manner that will replace original conditions as nearly as practical.

3.4 TRENCH EXCAVATION

A. General. The Contractor shall perform all excavation of every description and of whatever substances encountered to the alignment and depth shown on the plans or otherwise specified. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed from the site and disposed of in a lawful manner. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations and any water accumulating therein shall be removed by pumping or by other approved methods.

Lay pipe in continuous open trench except that in special locations, short tunnels, or the cut and tunnel method of excavation may be used either under specific instructions of the Engineer or at the request of the Contractor with approval by the Engineer. The Engineer may require the use of tunnels to pass obstructions or to minimize traffic interference.

The Contractor shall not tear up a street or excavate any trench until all lumber, pipe, and other material is on hand, and all equipment necessary for the rapid completion of the pipeline therein. The length of open trench in advance of pipe installation shall be on approval by the Engineer and kept to a minimum.

Excavate trenches to lines and grades as staked. The width of the trench at and below the top of pipe shall be 1’6” greater than the nominal diameter of the pipe. In the event the Contractor should over-excavate in width or depth, Contractor shall provide select bedding (Class A or B) for the full length of the over-excavate at no expense to the Owner.

In trenches where ledge or boulders are encountered, there shall be a minimum of six inches of clearance under and on the sides between the pipe and rock surface.

Bell holes and depressions for joints shall be dug after the trench bottom has been graded. In order that the pipe rest on the prepared bottom for as nearly its full length as practical, excavation for joints shall be only of such length, depth, and width as required for properly making the joint.

The width of trench above the top of pipe may be as wide as necessary for sheeting and bracing and the proper performance of the work except that the width must be consistent with limitations caused by other utilities and structures and the maintenance of traffic.

B. Excavation Below Grade: When unstable materials is encountered in the bottom of the trench, the Engineer shall order Class A or B bedding unless Class B bedding is included as part of the pipeline item. If the unstable materials extends below the bottom grade for Class B bedding, the Engineer shall authorize its removal and replacement with select material. Excavation below grade which is made inadvertently or without authority shall be restored to grade by backfilling and compacting with select material or with concrete.

C. Bracing and Sheeting Trenches: Wherever necessary to prevent caving, excavations in sand, gravel, sandy soil, or other unstable material shall be adequately sheeted and braced. Where sheeting and bracing are used, the trench width may be increased accordingly. Trench sheeting shall remain in place until the pipe has been laid, tested for defects, and repaired if necessary, and the earth around it compacted to a depth of two feet over the top of the pipe. No extra payment shall be made for materials left in trench.

D. Trenching by Machine or by Hand: Where the operation of trench machinery will cause damage to trees, buildings, or existing utilities, hand methods shall be used.

E. Excavation for Appurtenances: Excavation for valves and other appurtenances shall be sufficient to leave 12-inch minimum and 24-inch maximum clearance on all sides. The depth, provisions for removing water, and other applicable portions of these specifications shall apply for excavation for valves and other appurtenances.

F. Non-uniform Material: Voids formed by removal of boulders or other interfering objects extending below normal excavation limits shall be filled with pipe zone material compacted to 95 percent maximum dry soil density.

G. Special Support: Special means of support may be provided but under no conditions shall the pipe be installed permanently on timbers, earth mounds, pile bents or other similar supports.

3.5 TRENCH EXCAVATION IN ROCK

A. Quantity Measurement: It shall be the Contractor's responsibility, when directed by the Engineer, to remove all loam, sand, gravel, clay, or other such material above the rock and clean off and expose the rock surface in a satisfactory manner so that the engineer may examine the surface and obtain any measurements required. Measurement will include only the actual volume of the rock to be removed.

Excavate rock to a depth six inches greater than the required grade for the pipe. Backfill to pipe grade with ¾ inch minus crushed aggregate thoroughly compacted.

The quantity of rock shall be measured by the Engineer and the Contractor or a representative before backfilling the trench and the amount of other rock determined, agreed upon, and made a matter of record by both parties.

B. Use of Explosives: When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care so as not to endanger life or property, cause slides or disturb materials outside the neat lines of the trenches or excavations. Explosives shall be used only with permission and a permit from the Fire Marshall.

All explosives shall be stored in a safe, secure manner in compliance with local laws and ordinances, and all such storage places shall be marked clearly "Dangerous Explosives". No explosives shall be left in an unprotected manner along or adjacent to any highway, street, alley or other area, where such explosives could endanger persons or property. Storage of the explosives shall be in accordance with the requirements of the State Industrial Accident Commission or similar appropriate body having the jurisdiction in such matters in the state in which the work is performed.

Only persons experienced in handling explosives shall be allowed to use them on the work. Where state or local laws require that explosives be handled only by licensed personnel, it shall be the Contractor's responsibility to see that this requirement is met.

The Contractor shall provide all necessary approved types of tools and devices required for loading and using explosives, blasting caps, and accessories. The Contractor shall conform acts to and shall obey all federal, state and local laws that may be imposed by any public authority or directions that may be given from time to time by the Engineer relative to the handling, placing and firing of explosives. No blasting shall be done adjacent to any portion of exposed work or structures unless proper precautions are taken to ensure that the structures and materials surrounding and supporting the same will not be damaged by the blasting. When blasting rock in trenches, the Contractor shall cover the area to be shot with blasting mats or other approved type of protective material that will prevent the scattering of rock fragments outside the excavation. The Contractor shall give ample warning to all persons in the vicinity before blasting, including warning signs to turn off two-way radios, and shall station workers and provide signals of danger in suitable places to warn people and vehicles before firing any blasts. Unless otherwise approved by the Engineer, all blasts shall be fired with an electric blasting machine which shall not be connected by the person who will operate the blasting machine. After a blast has been fired, the blaster shall make a minute inspection to determine if all charges have exploded before employees are allowed to return to the operation. Misfires shall be corrected in accordance with the requirement of the applicable portions of the state or local Safety Code for Blasting.

The Contractor shall be responsible for any and all damages to property and injury to persons resulting from blasting or accidental or premature explosions that may occur in connection with Contractor's use of explosives.

C. Repair and Damage: If injury from blasting occurs to any portion of the work or to the material surrounding or supporting the same, the Contractor, at Contractor's expenses, shall remove such injured work, repair the work, and replace the material surrounding or supporting the same, or shall furnish such material and perform such work or repair or replacement as the Engineer shall order. Any damage whatsoever to any existing structures due to blasting shall be promptly, completely, and satisfactorily repaired by the Contractor at Contractor's expense.

3.6 PIPE BEDDING AND BACKFILL

A. General: Joints shall not be left uncovered except in the immediate area of pipe laying. Under no circumstances shall water be permitted to rise in the trench until after the pipe has been placed, tested, and backfilled.

B. Pipe Bedding and Backfill Classifications: Pipe bedding shall consist of pipe zone material placed in the pipe zone as shown on the plans. Pipe backfill shall consist of native backfill material or select backfill material placed to the finished grade or underside of base for pavement. Select backfill material shall be used within all traveled ways and parking lots. Payment for select backfill material shall be made in accordance with the Lump Sum bid, and shall be included in pipe cost. Soils shall be blended sufficiently to secure the best practicable degree of density, stability, and optimum moisture content.

Ductile iron pipe shall be installed flat-bottom trench (with bell holes), except in rock excavation where AWWA C600 Type 4 or Type 5 bedding shall be used.

Polyvinyl Chloride (PVC) Pressure Pipe shall be installed flat-bottom trench (with bell holes), except in rock excavation where AWWA C900 Type 4 or Type 5 bedding shall be used.

C. Placement of Pipe Bedding Material:

1. Materials shall be brought up at substantially the same rate on both sides of the pipe and care shall be taken so that the pipe is not floated or displaced. Fill material shall not be dropped directly on the pipe.

2. Pipe zone material shall be compacted by hand tamping to a density of 95 percent of maximum dry soil density. The material shall be compacted to ensure that the specified soil density is obtained beneath the haunches of the pipe. At the time of placement, the materials shall have the optimum moisture content required for compaction and the moisture content shall be uniform throughout each layer. Materials shall be placed in layers not more than six inches thick after compaction.

D. Placement of Backfill Material:

1. Traveled Ways: Within the limits of traveled ways, backfill from 12 inches above the top of pipe to a surface three feet below the street grade shall be mechanically compacted in maximum 12-inch layers, or water settled if approved by the Engineer, to a density of not less than 95 percent of relative maximum density. There shall be no stones larger than six inches in any dimension. From a surface three feet below street grade to a bottom of the base for pavement, the backfill shall contain no stones larger than six inches and shall be compacted in six-inch layers to 95 percent of relative maximum density.

2. Trench backfill shall not be placed until conformance of pipe zone bedding and backfill with specified compaction test requirements has been confirmed. When approved by the Engineer, free-draining materials may be densified by hydraulic methods if the native soil in which the trench was excavated is also free-standing, but such methods shall not disturb pipe zone bedding and backfill. Cohesive materials shall be compacted with tamping or rolling equipment. To prevent excessive live loads on the pipe, sufficient densified backfill, but not less than 30 inches over the pipe, shall be in place before power-operated hauling or rolling equipment travels over the pipe.

3. Beyond Limits of Traveled Ways: Outside of traveled ways, backfill may consist of native material from the trench excavation compacted sufficiently so that excessive or dangerous settlement does not take place. Leave the surface of the trench slightly mounded to allow for normal settlement. No debris, stones, broken pavement, or concrete larger than 12 inches in any dimension shall be allowed in the backfill.

4. Mobile pavement breakers or pile-driving equipment shall not be used for compacting backfill at any stage of operation.

5. Pea gravel may be provided at the option of the contractor in lieu of densified select backfill, however, no extra compensation will be paid for furnishing or placing pea gravel.

6. Native backfill shall be mounded to a height of four inches over the top of the trench for ordinary backfill outside traveled ways.

7. After backfilling, the Contractor shall pave or grade all roads and shall maintain them during the period required by the general provisions of this contract in such a manner as to provide safe travel by the public, free of settlement, mud holes, ruts, and high centers.

8. Material for backfilling around valves and other appurtenances shall be select backfill material. Materials shall be deposited in a manner to ensure that the valve or other appurtenance is not disturbed from the proper alignment and backfill shall be compacted to the ground surface.

9. Payment and Improper Procedures: There will be no separate payment for backfilling. Improper backfill operations or failure to follow the instructions of the Engineer as to backfill procedures shall be justification for stopping the work.

3.7 CONSTRUCTION IN ROADWAY

A. All work involved in crossing public roads and in placing the pipeline in the traveled portion of state or county roads shall be performed in strict accordance with applicable agency specifications pertaining to such work. The Contractor shall provide traffic control and safety measures and shall perform the work during the periods specified by the Oregon State Department of Transportation and other applicable agencies.

B. Where the pipeline crosses or is under the traveled portion or shoulder of the road, the depth of the pipe shall be such as to provide a minimum of 36 inches of cover.

C. Where driveways or other access to property will be blocked, the occupant of the premises concerned shall be orally notified at least 24 hours in advance.

D. Gravel or bituminous surfacing shall be replaced to applicable city, county or state standards.

E. Drainage and Culvert Replacement: Drainage ditches and culverts, where disturbed, shall be restored to their original alignment and grade, backfilled with select backfill, and left in a condition to provide drainage equal to or better than the existing and as determined by the Engineer. No additional payment shall be made for these items.

3.8 CLEANUP

During the time that the work is in progress, the Contractor shall make every effort to maintain the site in a neat and orderly condition. All refuse, broken pipe, excess fill material, cribbing, etc., shall be removed and disposed of in a lawful manner as soon as practical. Should the work not be maintained in a satisfactory condition, the Engineer may cause the work to stop until the cleanup portion of the work has been done to the satisfaction of the owner and/or the engineer.

The work will not be considered complete nor final payment certificate issued until all rubbish, excess fill material, unused material or equipment have been removed and the premises left in a condition satisfactory to the Owner and to the Engineer.

PART 4 PAYMENT

Payment shall be included in the Lump Sum bid and included in the Bidder’s Breakdown of Lump Sum Bid under pipe costs.

END OF SECTION

SECTION 31 20 20 - BACKFILLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Building perimeter and site structure backfilling to subgrade elevations.
B. Site filling and backfilling.
C. Fill under slabs-on-grade.
D. Fill for over-excavation.
E. Consolidation and compaction as scheduled.

1.2 REFERENCES

A. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

PART 2 PRODUCTS

2.1 FILL MATERIALS

Structural Fill: As specified in Section 31 05 16 & 31 20 00.

PART 3 EXECUTION

3.1 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with structural fill and compact to density equal to or greater than requirements for subsequent fill material.

3.2 BACKFILLING

A. Backfill areas to contours and elevations with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Structural fill: Place and compact materials in equal continuous layers not exceeding 8 inches compacted depth.

D. Employ a placement method that does not disturb or damage other work.

E. Maintain optimum moisture content of backfill materials to attain required compaction density.

F. Slope grade away from building minimum 2 inches in 10 ft., unless noted otherwise.

G. Remove surplus backfill materials from site.

3.3 TOLERANCES

Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.4 FIELD QUALITY CONTROL

A. Compaction testing will be performed in accordance with ASTM D2922.
B. Reshape and re-compact fills subjected to vehicular traffic.

3.5 SCHEDULE

A. Interior Slab-On-Grade: Structural Fill compacted to 95 percent.
B. Footings: Structural Fill compacted to 95 percent.

END OF SECTION

SECTION 31 20 30 - PAVING AND SURFACING

PART 1 GENERAL

1.1 SCOPE

This section covers the temporary and permanent replacement of surfaces cut and disturbed by the trench excavation and new pavement.

1.2 QUALITY ASSURANCE

Perform work in accordance with Oregon Department of Transportation standard specifications for road and bridge construction.

1.3 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

PART 2 PRODUCTS

2.1 MATERIALS

Unless specified otherwise, the surface shall be restored with asphalt concrete. All hard surface pavement shall have new base material

A. Base Course and Leveling Course: 3/4” - 0 crushed aggregate 12 inches total depth unless shown otherwise on the plans.

B. Surface:

1. Asphalt concrete shall meet the current requirements Standard for Road and Bridge Construction. The gradation of aggregates shall be Class B grading. The contractor shall furnish certification from contractor's supplier that the mix formula, based on tests made with materials from the source to be used for this job, will provide pavement of the required density, strength and durability. Asphalt concrete for pavement replacement shall be at least equivalent to the original pavement and with a minimum depth of four (4) inches.

2. Portland cement concrete pavement shall have a depth equivalent to the original to a maximum of 7 inches. Concrete shall conform to the requirements of Section 03300 for Class II concrete.

3. Gravel surface shall be at least equal to the original or as specified in the plans. The original material may be used if adequate and uncontaminated.

4. Temporary patch shall be hot mix or cold mix asphalt concrete.

PART 3 EXECUTION

3.1 MAINTENANCE OF BACKFILLED TRENCH SURFACES

A. Maintain a temporary surface, safe for both pedestrians and motorists, until authorized to place permanent surfacing. The temporary surface may be gravel, planks or steel plate covers. Plank shall not be less than three (3) inches thick, cut to fit, and laid flush with the pavement surface.

B. If called for in the proposal, the temporary surface shall be asphalt concrete placed at a minimum depth of one (1) inch. It shall be the Contractor's responsibility to add this as necessary to maintain a satisfactory surface.

3.2 PERMANENT SURFACE REPLACEMENT

A. Preparation Surface Replacement. Remove temporary pavement patch and any backfill material that does not meet specifications for base material. Recompact the subgrade and place and compact the aggregate base to the depth shown on the plans. Saw edges of the existing bituminous surfacing to a vertical edge and remove all loose or broken pavement caused by the construction operations prior to paving. Apply tack coat to the exposed edges with an asphaltic material in order to obtain a bonded joint. Clean the edges of existing Portland cement concrete paving and sidewalks of all loose, crumbled, and spilled concrete to provide a solid, vertical face. Sidewalks shall be cut out to square blocks.

B. Place asphaltic concrete surfacing on the trench sections to a minimum depth of two (2) inches where bituminous pavement was removed. The asphaltic concrete shall be laid in lifts required to match existing pavement with a minimum of 2-inch depth and a maximum of 3-inch depth for each lift, spread and struck off and while still hot the course of asphaltic concrete shall be thoroughly and uniformly compacted by rolling with a roller of not less than 6-ton or a vibrator with at least a 6-ton rating. The asphaltic concrete shall be deposited on the trench at a temperature between 250 and 300 degrees Fahrenheit.

C. Portland Cement Concrete Pavement Replacement. The placing of concrete pavement and sidewalk shall conform to all of the applicable requirements of Division 3 - Concrete.

D. Gravel Surface Replacement. All trench sections within the unpaved shoulders of a street, public or otherwise, that are used for traffic and any traveled way with an existing gravel surface shall be resurfaced with base course and gravel according to the plans.

E. Replacement of Damaged Pavement. Any pavement or roadway surfacing not immediately over or adjacent to the trench, which is disturbed or damaged as the result of operations of the contractor shall be repaired or replaced by the contractor at contractor's expense with material equivalent to the existing pavement and to the satisfaction of the engineer and the owner.

F. The contractor shall be responsible for the pavement for a period of one year, and should it fair due to poor workmanship or materials or settlement of the backfill under the replaced pavement, Contractor shall make repairs at Contractor's expense as required by the Owner.

END OF SECTION

SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes excavation required for building foundations, site structures, or under slabs-on-grade or paving. Excavating for utilities outside building is included in Section 31 23 17, Trenching.

B. Section Includes:

1. Excavating for building foundations
2. Excavating for paving, roads, and parking areas
3. Excavating for slabs-on-grade
4. Excavating for site structures
5. Excavating for landscaping

1.2 RELATED SECTIONS

1. Section 31 05 13 - Soils for Earthwork
2. Section 31 05 16 - Aggregates for Earthwork
3. Section 31 10 00 - Site Clearing
4. Section 31 23 17 - Trenching
5. Section 31 23 19 - Dewatering
6. Section 31 23 23 - Fill
7. Section 33 11 10 - Water Utility Distribution and Transmission Piping.
8. Supplemental Information: Geotechnical report; bore hole locations, and findings of subsurface materials.

1.3 DEFINITIONS

A. Common Excavation: All excavation required for Work, regardless of the type, character, composition, or condition of the material encountered. Common Excavation shall further include all debris, junk, broken concrete, and all other material. All excavation shall be classified as Common Excavation, unless provided as Rock for under Section 31 20 10, Rock Removal below.

B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, excluding rock as defined below.

C. Concrete Excavation: The removal of pieces of concrete larger than 1 cubic yard in volume that requires drilling, splitting and breaking methods, or a necessitating a trench width increase of 18 inches or more than the width of the preceding 10 feet of trench. Concrete excavation includes materials composed of Portland cement that are not identified other than manholes, structures, sewer pipe, or other appurtenances.

D. Exploratory Excavation: The removal and replacement of material from locations shown on the Drawings, or as directed for the purpose of investigating underground conditions and identifying potential utility conflict between existing and proposed utilities.

E. Overbreak: Material beyond and outside of the slope limits established by the Owner's Representative, which becomes displaced or loosened during excavation and is excavated.

F. Pothole Excavation: Pothole excavation is the removal and replacement of all materials via coring, vacuum extraction, or similar method, not classified as exploratory excavation, for the purposes of locating an underground utility and to investigate underground conditions.

G. Spoils: Excavated materials from Site unsuitable for use as fill or not required for backfill and grading.

H. Unsuitable Materials: See Spoils.

1.4 REFERENCES

A. Local utility standards when working within 24 inches of utility lines.

1.5 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Excavation Protection Plan: At a minimum, to include the following:

1. Methods and sequencing of mass excavation.
2. Proposed onsite and off-site spoil disposal locations.
3. Anticipated difficulties and proposed resolutions.
4. Proposed routes for Owner's access to Owner's facilities impacted by excavation Work.
5. Proposed haul routes.

B. Excavation support plan and utility protection plan as specified in Section 31 50 00, Excavation Support and Protection.

1.6 QUALITY ASSURANCE

A. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

B. Provide adequate survey control to avoid unauthorized over-excavation.

C. Weather Limitations:

1. Material excavated when frozen or when air temperature is less than 32 degrees Fahrenheit (F) shall not be used as fill or backfill until material completely thaws.

2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to commencing work in this Section, become familiar with site conditions. In the event discrepancies are found, notify the Engineer as to the nature and extent of the differing conditions.

B. Call Local Utility Line Information service at 1-800-332-2344 (or 811) not less than 3 working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

C. Identify required lines, levels, contours, and datum.

D. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.3 EXISTING UNDERGROUND UTILITIES

A. Protect active utilities encountered, located or otherwise, and notify persons or agencies owning same.

B. Remove inactive or abandoned utilities from within the project grading limits in accordance with Drawings.

C. For sewer and other miscellaneous drainage facilities, fill and plug pipes as follows:

1. General:

   a. Remove all structures to a minimum of 3 feet below subgrade, unless otherwise noted.

   b. Cover top surface of all abandoned structures with two sheets of nonwoven geotextile, extended at least 1-foot beyond the outside walls of the abandoned manhole, sump, or basin.

   c. Plug all abandoned pipes with permanent plugs as specified Drawings.

2. Sumps:

   a. Remove existing sediment, soil, and water. Properly dispose of these materials in accordance with the requirements of these specifications.

   b. Remove top cone and first solid concrete section to a depth of approximately 8 to 10 feet below ground.

   c. Fill sump with CLSM.

   d. Backfill remaining voids for facilities within existing or proposed roadways with approved materials meeting the requirements of Section 32 11 23, Aggregate Base Courses.

3. Salvaging Manhole Frames, Covers, and Grates:

   a. Remove manhole frames, covers, and grates scheduled for salvage and store in approved location.

b. Frames, grates, and covers meeting Specifications may be salvaged from structures to be adjusted and may be reused in the Work if of suitable size and condition.

c. Replace, at no additional cost to the Owner, all items damaged or lost by the Contractor with similar items that are comparable in all respects with those they are to replace, and which are adequate for the intended purpose.

d. Clean salvaged components to be reused of foreign material by methods that will not harm the components.

4. Existing Manhole Frames and Covers: Manhole frames and covers removed by the Contractor are the property of the Owner. Notify the Engineer a minimum of 48 hours before removal to arrange for pickup of the removed frames and covers, if not reused.

3.4 PRESERVATION OF EXISTING IMPROVEMENTS

A. Protect adjacent existing structures which may be damaged by excavation work.

1. Conduct operations in such a manner that existing street facilities, utilities, railroad tracks, structures, and other improvements, which are to remain in place, will not be damaged. Furnish and install cribbing and shoring or whatever means necessary to support material around existing facilities, or to support the facilities themselves, and maintain such supports until no longer needed.

2. Open slopes shall not be cut within 5 feet of any existing spread footings unless approved by the Engineer.

3. Do not interfere with 45 degree bearing splay of foundations unless approved by the Engineer

4. Excavated material shall not be placed adjacent to existing or proposed structures.

3.5 EXCAVATION

A. General:

1. Method of excavation shall be the Contractor’s option, but care shall be exercised as final grade is approached to leave it in undisturbed condition.

2. If the final grade for supporting structures is disturbed, it shall be restored to requirements of these Specifications and satisfaction of the Engineer at no additional cost to Owner.

3. The Contractor is advised that footings should be poured as soon as possible to minimize unfavorable final grade conditions from developing.

4. Provide all measures to ensure public safety.

B. Control of Water:

1. Provide and maintain equipment to remove and dispose of water during the course of the work of this Section and keep excavations dry and free of frost or ice.

2. Bearing surfaces that become softened by water or frost must be re-excavated to solid bearing at Contractor’s expense and backfilled with compacted crushed rock at Contractor’s expense.

3. Grade top perimeter of excavation to prevent surface water from draining into excavation.

4. See additional requirements in Section 31 23 19, Dewatering.

C. Frozen Ground: Frost protection shall be provided for all structural excavation work. Foundation work shall not be placed on frozen ground.

D. Excavate material of every nature and description to the lines and grades as indicated in the Drawings and/or as required for construction of the facility.

1. Allow for forms, shoring, working space, granular base, topsoil, and similar items, wherever applicable.

2. Trim excavations to neat lines. Remove loose matter and lumped subsoil.

E. Excavated Materials: Soils excavated at Site will be treated and used as one of two general categories of material as provided below.

1. Fill:

a. Subsoil Type S1, Select Native Fill, as approved for use by Engineer.

2. Spoils:

a. Ensure there is sufficient suitable material available to complete embankments and other required fillings prior to disposing of any excavated materials.

b. Make arrangements for disposal of spoils and include as part of contract work in preparing of project bids.

c. Landfill permit or written permission from private property owner to be obtained by the Contractor and provided to the Engineer.

F. Shoring:

1. The Contractor shall be solely responsible for excavation protection and worker safety and shall provide sheeting and shoring wherever required, all in accordance with current local, state, and federal laws, codes, and ordinances.

2. Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it shall be the responsibility of the Contractor to design, furnish, place, maintain, and remove such supports in accordance with applicable ordinances and safety requirements.

3. The design, planning, installation, and removal of all sheeting accomplished in such a manner as to maintain the undisturbed state of the soil below and adjacent to the excavation.

G. Slope existing banks with machine to angle of repose or less until shored.

1. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

2. Protection of excavation side slopes:

   a. Use excavation methods that will not shatter or loosen excavation slopes.

   b. Where practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line.

   c. Avoid overbreaks. Overbreak is incidental to the Work, except in cases where the Owner's Representative determines that such overbreak was unavoidable.

   d. Excavation in rock or rocky cuts:

      1) Once completed, thoroughly test the slopes with bars or other approved means to remove all loose, detached, broken, or otherwise unstable material.

      2) Remove jutting points. Scale slopes using mine scaling rods or other approved methods to remove loose or overhanging materials and provide a safe, trim, neat, and stable condition.

      3) Dispose of the materials removed under this subparagraph in the same manner as other excavated material.

   e. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.

3. Construct slopes free of all exposed roots.

4. Construct slopes free of unstable rock and loose stones exceeding 3 inches in diameter.

5. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend off-site, outside of easements, outside of rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

6. Trim all surfaces neatly and smoothly.

H. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 17, Trenching and Section 31 23 23, Fill.

I. Notify Engineer of unexpected subsurface conditions.

J. Over-excavation for Unsuitable Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.

2. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2-inch – 0 gradation, as specified in Table 31 05 16-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

3. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.

K. Rock Removal:

1. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.

2. Concrete removal, as defined herein, shall be treated as Rock Removal.

L. Stockpile excavated material in area(s) designated on or off site in accordance with Section 31 05 13, Soils for Earthwork.

3.6 FIELD QUALITY CONTROL

A. Perform excavation and controlled fill operations in accordance with the requirements of this Section.

B. Coordinate the visual inspection and approval of all bearing surfaces by Engineer before installing subsequent work.

3.7 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability and store excavated materials at a distance from top of excavation.

B. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17 - TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for excavation and backfill of all utilities, including installation of pipe bedding, pipe zone backfill, trench backfill, and related Work as shown on the Drawings and as specified.

B. Section includes:

1. Excavating trenches for pipe, utility vaults, and other utilities.
2. Compacted fill from top of utility bedding to final grades.
3. Trench and utility vault backfilling and compaction.

C. Related Sections

1. See General Conditions (Volume 1) for Quality Requirements
2. Section 03 30 00 - Cast-In-Place Concrete
3. Section 31 05 13 - Soils for Earthwork
4. Section 31 05 16 - Aggregates for Earthwork
5. Section 31 10 00 - Site Clearing
6. Section 31 23 16 - Excavation
7. Section 31 23 23 - Fill
8. Section 33 11 13 - Water Utility Distribution and Transmission Piping
9. Section 33 31 10 - Sanitary Utility Sewerage Piping: Sanitary sewer piping and bedding
10. Section 33 41 10 - Storm Utility Drainage Piping
11. Supplemental Information: Geotechnical report; bore hole locations and findings of subsurface materials.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

5. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.3 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill. Lean cement concrete fill. A self-compacting, cementitious material.

B. Flexible Pipe: For the purposes of these Specifications, tubing between 1/2-inch and 4-inch diameter constructed of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) are considered flexible pipes. HDPE piping 4 inches in diameter and larger is also considered flexible pipe.

C. Geosynthetics: Geotextiles, geogrids, geomembranes, and drainage composite materials.

D. Imported Material: Materials obtained from sources offsite, suitable for specified use.

E. Lift: Loose (uncompacted) layer of material.

F. Obstructions: Items which may be encountered during utility and vault trenching which do not require replacement.

G. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

H. Pipe Bedding: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 6 inches below the bottom outside surface of pipe, conduit, cable, or duct bank to the trench foundation so as to uniformly support the barrel of the pipe.

I. Pipe Zone: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 12 inches above the top outside surface of pipe, conduit, cable, or duct bank.

J. Pipe Bedding, Pipe Zone, and Trench Backfill Classifications:

1. Class A: Backfill with suitable native or imported material that is approved to meet the characteristics required for the specific surface loading or other criteria of the backfill zone.

2. Class B: Backfill with imported granular material consisting of gravel or crushed rock meeting the requirements of this Section and Coarse Aggregate Type A1 as specified in Section 31 05 16, Aggregates for Earthwork; typical designated size shall be 1-inch-0 or 3/4-inch-0.

3. Class C: Backfill with Fine Sand, as specified in Section 31 05 16, Aggregates for Earthwork.

4. Class D: Backfill with approved pit run or bar run material, well-graded from coarse to fine; maximum dimension shall be 3 inches.

5. Class E: Backfill with CLSM. Per ODOT Standard Specifications.

K. Pothole Excavations: Removal and replacement of all materials via coring, vacuum extraction, or similar method for the purposes of locating an underground utility and to investigate underground conditions.

L. Prepared Trench Bottom: The bottom of the trench on which the pipe bedding is to lie and which provides support for the pipe.

M. Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM Standards.

N. Rigid Pipe: For the purposes of these Specifications, pipe constructed of PVC, ductile iron, steel, concrete, and clay pipes are considered rigid pipes.

O. Sewer, Pipes, and Mains: Conduits of circular or other geometric shapes, used to convey liquids or gases, or other material.

P. Trench Backfill: Trench backfill zone for full trench width extending from the top of the pipe zone to pavement base rock, ground surface, or other surface material.

Q. Trench Stabilization: Removal of unsuitable material in the bottom of a trench and replacement with specified material for support of a pipe, main, conduit, structure, or appurtenances.

R. Utility: Any buried pipe, duct, conduit, or cable.

S. Well-Graded: A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Excavation Protection Plan: At a minimum, to include the following:

1. Methods and sequencing of mass excavation.

2. Proposed on-site and off-site spoil disposal locations.

3. Anticipated difficulties and proposed resolutions.

4. Proposed routes for Owner’s access to Owner’s facilities impacted by excavation Work.

5. Proposed haul routes.

C. Product Data:

1. Geotextile fabric, indicating fabric and construction
2. Marking tapes
3. Tracer wire
4. Connectors for tracer wire and/or marking tapes
5. Tracer wire locate boxes
6. Marker balls
7. Locator stations
8. Ground wires
9. Plastic or copper markers for service laterals.

D. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

E. Concrete: Mix designs in accordance with Submittal requirements of Section 03 30 00, Cast-in-Place Concrete.

1.5 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

1.6 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

B. Coordinate trenching and utility installation work with other work at utility construction location occurring near or adjacent to specified herein.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S2, Imported Fill Material as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Lean concrete, Flowable Fill, with compressive strength of 100 pounds per square inch (psi).

2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete with compressive strength of 3,000 psi.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Sand: As specified in Section 31 05 16, Aggregates for Earthwork.

F. Trench Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

2.2 MARKING TAPE

A. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.

2. Foil Thickness: Minimum 0.35 mils.

3. Laminate Thickness: Minimum 5 mils.

4. Width: 6 inches.

5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.

6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.

7. Manufacturers and Products:

a. Reef Industries; Terra Tape, Sentry Line Detectable
b. Mutual Industries; Detectable Tape
c. Presco; Detectable Tape

B. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities and as specified in NEMA Z535.1, Safety Color Code.

Color	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines

2.3 ELECTRONIC LOCATING MATERIALS

A. Marker Balls:

1. Exterior Material: High-density polyethylene.

2. Size: Maximum 4-1/2 inches in diameter.

3. Range: Locatable with standard electronic marker locating devices at depths up to 5 feet.

4. Field Type: Spherical RF field regardless of orientation.

5. Contain no floating or movable parts, and no batteries or active components.

6. Color: Provide colored marker balls per Article 2.03 B above.

7. Manufacturer and Product: Omni Marker Model 162 (green), Omni Marker Model 161 (blue), or approved equal.

B. Tracer Wire:

1. Direct burial No. 12 AWG solid, annealed copper-clad steel (CCS) high strength tracer wire.

2. Tensile Breaking Load: 380-pound average.

3. Jacket:

   a. High molecular weight high-density polyethylene complying with ASTM D1248, 30-volt rating.

   b. Color: Provide in colors per Article 2.2 B above.

4. Manufacturer and Product: Copperhead Industries; LLC, 12 CCS high strength reinforced tracer wire, or approved equal.

C. Tracer Wire Connectors:

1. Waterproof, corrosion proof and suitable for No. 12 AWG solid core wire.

2. Prefilled with silicone and suitable for use with low-voltage tracer lines of less than 50 volts.

3. Lug Connectors:

   a. Waterproof plastic housing that encases the silicone prefilled lug terminals.

   b. Manufacturer and Product: King Innovations; DryConnTM Direct Bury Lug or approved equal.

4. Twist Connectors:

    a. Waterproof epoxy-filled packaging that encases the silicone prefilled twist connectors.

    b. Manufacturer and Product: 3M Division; DBY Direct Bury Splice Kit 09053 connectors or approved equal.

D. Ground Wire: No. 12 AWG bare solid copper wire.

E. Locator Station:

1. Test Station:

    a. Lexan® polycarbonate.
    b. Color: Provide in colors per Article 2.03 B above.

2. Terminals suitable for No. 12 AWG leads.

3. Use single (two lead) locator stations with two terminals, one for ground wire and one for tracer wire, when only one tracer wire is terminated in manhole.

4. Use multi-lead locator stations with the appropriate number of terminals when 2 or more tracer wire leads are terminated in manhole.

5. Manufacturer and Product: Cott Manufacturing Company; FlangeFink® Cathodic Protection Test Station.

PART 3 EXECUTION

3.1 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 (or 811) not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

3. Maintain and protect above and below grade utilities indicated to remain.

B. Identify required lines, levels, contours, and datum locations.

C. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

D. The site of an open cut excavation shall be first cleared of all obstructions preparatory to excavation in accordance with Section 31 10 00, Site Clearing.

E. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

   1. Intent of Drawings and Specifications is that all streets, structures, and utilities be left in condition equal to or better than original condition.

   2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material, which is satisfactory to Owner.

F. Potholing / Exploratory Test Pits: Dig such exploratory test pits and perform potholing as may be necessary in advance of trenching to determine the exact location and elevation of subsurface structures, pipelines, duct banks, conduits, and other obstructions which are likely to be encountered or need to be connected to and shall make acceptable provision for their protection, support, and maintenance of their continued operation.

G. Paved or Surfaced Streets:

   1. Wherever paved or surfaced streets are cut, saw wheel or approved cutting devices shall be used.

   2. Width of pavement cut shall be as shown in the Drawings.

   3. Any cut or broken pavement shall be removed from site during excavation.

H. Traffic:

   1. Maintain street traffic at all times as required by the Drawings and as specified herein.

   2. Erect and maintain barricades, warning signs, traffic cones, and other safety devices during construction in accordance with the latest edition of Manual of Uniform Traffic Control Devices (MUTCD), Part 6, to protect the traveling public in any area applicable.

   3. Provide flaggers as required during active work in roadway areas.

I. Operations shall be confined to rights-of-way and easements provided. Avoid encroachment on, or damage to, private property or existing utilities unless prior arrangements have been made with copy of said arrangement submitted to Engineer.

3.2 EASEMENTS

A. Where portions of the Work are located on private property, easements and permits will be obtained by the Owner. Easements shall provide for the use of property for construction purposes to the extent indicated on the easements.

B. Copies of these easements and permits will be available from the Owner for inspection by the Contractor. It shall be the Contractor's responsibility to determine the adequacy of the easement obtained in every case.

C. Confine construction operations to within the easement limits or street right-of-way limits or make special arrangements with the property owners for the additional area required and notify the Engineer with a copy of the written approval from property owners of any such conditions.

D. Any damage to private property, either inside or outside the limits of right-of-way or easements provided by the Owner, resulting from Work shall be the responsibility of the Contractor. Before the Engineer will authorize final payment, the Contractor will be required to furnish the Owner with written releases from property owners where the Contractor has obtained special agreements or easements or where the Contractor's operations, for any reason, have not been kept within the construction right-of-way obtained by the Owner.

3.3 PROTECTION

A. Existing Facilities:

1. It is the intent of these specifications that all streets, structure, and utilities be left in a condition equal to or better than original condition at the completion of the Project.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material to the satisfaction to the Engineer.

3. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

B. Removal of Water:

1. As specified in Section 31 23 19, Dewatering.

2. At all times during construction provide and maintain ample means and devices with which to remove promptly and dispose of properly all water entering the excavations or other parts of the Work.

3. Keep all excavations dry until the utilities or vaults to be placed therein are completed. In water bearing sand, well points and/or sheeting shall be supplied, together with pumps and other appurtenances of ample capacity to keep the excavation dry as specified.

4. Dispose of water from the Work in a suitable legal manner without damage to adjacent property or structures.

C. Trench Protection:

1. Provide the materials, labor, and equipment necessary to protect trenches at all times.

2. Trench protection shall provide safe working conditions in the trench and protect the Work, existing property, utilities, pavement, etc.

3. The method of protection shall be according to the Contractor’s design.

4. The Contractor may elect to use a combination of shoring, overbreak, tunneling, boring, sliding trench shields, or other methods of accomplishing the work provided the method meets the approval of all applicable local, state, and federal safety codes.

5. Damages resulting from improper shoring, improper removal of shoring, or from failure to shore shall be the sole responsibility of the Contractor.

3.4 LINES AND GRADES

A. Trench excavation for piping, utility vaults, and other utilities shall be performed to the alignment and grade as indicated in the Drawings.

B. Where grades are not shown in the Drawings, utilities shall be laid to grade between control elevations shown.

C. Water mains shall be installed with a minimum cover of 36 inches.

D. The Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

E. Changes in the grade and horizontal alignment of the pipeline as shown in the Drawings or as provided elsewhere in the Specifications may be necessary due to unanticipated interferences or other reasons.

1. No additional compensation will be allowed the Contractor for changes in horizontal alignment.

2. No additional compensation will be allowed for changes in grade which require additional depth of trench excavation and backfill up to 2 feet from those shown in the Drawings.

F. Use laser-beam instrument with qualified operator to establish lines and grades.

3.5 OBSTRUCTIONS

A. Obstructions to the construction of the trench, such as tree roots, stumps, abandoned pilings, abandoned buildings and concrete structures, logs, rubbish, and debris of all types shall be removed without additional compensation from the Owner.

B. The Engineer may, if requested by the Contractor or Owner, make changes in the trench alignment to avoid major obstructions if such alignment changes can be made within the perpetual easement and right-of-way and without adversely affecting the intended function of the facility or increasing costs to the Owner.

3.6 INTERFERING ROADWAYS AND STRUCTURES

A. Remove, replace and/or repair any damage done during trenching activities to fences, buildings, cultivated fields, drainage crossings, and any other properties without additional compensation from the Owner.

1. Replace or repair these structures to a condition as good as or better than their pre-construction condition prior to commencing work in the area.

B. Paved Roadways:

1. Where paved roadways are cut as part of trenching activities, Class D trench backfill will be required to the bottom of pavement base.

2. New pavement shall be equal to or better than the existing paved surface.

3. New surface shall not deviate by more than 1/4-inch from the existing finish elevation.

C. Existing Structures:

1. If existing structures are encountered as part of trenching activities which will prevent construction and are not adequately shown in the Drawings, the Contractor shall notify the Engineer before continuing with the Work.

2. The Engineer may make such field revisions to the utility alignment as necessary to avoid conflict with the existing conditions.

3. The cost of waiting or “down time” during such field revisions shall be borne by the Contractor without additional cost to the Owner or liability to the Engineer.

4. If the Contactor fails to so notify the Engineer when a conflict of this nature is encountered, but proceeds with construction despite this interference, the Contractor shall do so at the Contractor’s own risk with no additional payment.

3.7 TRENCHING

A. Excavate subsoil as required for construction of utilities to elevations shown in the Drawings.

B. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.

C. Open Trench Limit:

1. Do not advance open trench beyond the distance which will be backfilled and compacted the same day.

2. A maximum length of open trench shall not exceed 100 feet at any one time.

3. Temporary resurfacing shall be completed within 300 feet of the associated open trench limit for each main pipe laying operation.

4. Cover or backfill excavations at the end of each day.

5. If the trench is not backfilled at the end of each working day:

   a. Provide means to prevent caving of excavation sides, as necessary, during non-working hours.

   b. Cover the excavation with a system as needed to provide public safety and prevention of entry during non-working hours.

   c. Provide signed and stamped submittal of caving prevention system and cover system.

6. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

D. Utility Crossings: Avoid horizontal and vertical conflicts with existing utilities.

1. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.

2. Vertical clearance between the new pipe and existing utilities shall be 12 inches minimum, unless otherwise noted on the Drawings.

3. Where existing utility lines are damaged or broken during trenching activities, the utility shall be repaired or replaced. For water or sewer bearing lines, care being taken to insure a smooth flow line and absolutely no leakage at the new joints.

4. All expenses involved in the repair or replacement of leaking or broken utility lines that have occurred due to the Contractor's operations shall be borne by the Contractor, and the amount thereof shall be absorbed in the unit prices of its bid.

E. Water Lines Crossing Sewer Lines: Whenever water lines cross sewer lines, the Contractor shall comply with local Health Department requirements.

1. Wherever possible, the bottom of the water line shall be 18 inches or more above the top of sewer pipe. One full length of the water line pipe shall be centered at the crossing.

2. For clearances less than 1-1/2 feet, the Contractor shall replace the existing sewer pipe with ductile iron or PVC of equal size, centered at the utility crossing, or shall encase existing sewer pipe with concrete for a minimum of 10 feet on both sides of crossing, as directed by the Engineer, at no additional cost to the Owner.

F. Excavate trenches to width and depth as indicated on Drawings. No additional payment will be provided for trenching activities beyond dimensions shown in the Drawings.

1. Excavation for trenches in which pipelines are to be installed shall provide adequate space for workers to place and joint the pipe properly and safely, but in every case the trench shall be kept to a minimum width.

2. The width of the pipe trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall not exceed 12 inches on either side of the pipe.

3. Excavation for utility vaults and other structures shall be wide enough to provide 18 inches between the structure surface and the sides of the excavation.

4. For pipe or utility vaults to have bedding material, excavate to a depth of 6 inches below the bottom of the pipe or utility vault. Care shall be taken not to excavate below depths required.

5. If over digging occurs, the trench bottom shall be filled to grade with compacted bedding material.

G. Remove water or materials that interfere with Work.

1. The trench at all times shall be kept free from water to facilitate fine grading, the proper laying and joining of pipe, and prevention of damage to completed joints.

2. Adequate pumping equipment shall be provided to handle and dispose of the water without damage to adjacent property.

3. Water in the trench shall not be allowed to flow through the pipe while construction work is in progress unless special permission to do so has been given by the Engineer.

4. An adequate screen shall be provided to prevent the entrance of objectionable material into the pipe.

5. Remove and dispose of existing abandoned sewer pipe, structures, and other facilities as necessary to construct the improvements.

   a. Where the excavation activities require the removal of portions of an abandoned pipeline, masonry plugs shall be installed in the open ends of the pipe, unless otherwise noted in the Drawings or by the Engineer.

   b. Coordinate with Engineer prior to plugging.

   c. For plugs less than 36 inches in diameter, 8-inch deep masonry units shall be used. For plugs in larger pipelines, 12-inch deep masonry units shall be used.

6. The costs associated with the removal of water and materials noted above will be considered incidental to trench excavation and backfill.

H. Do not interfere with 45 degree bearing splay of foundations.

I. Over-excavation for Unsuitable Trench Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.

2. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.

3. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2-inch – 0 gradation, as specified in Table 31 05 16-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

4. Install nonwoven geotextile under trench stabilization material, over the soft or yielding excavated surface.

    a. Install the nonwoven geotextile ahead of placement of the trench stabilization material, continuously along the excavation bottom and centered on the pipe centerline.

    b. Use nonwoven geotextile width equal to the pipe diameter plus 2 feet.

    c. Place laps or splices in the geotextile in the direction of the pipe laying.

J. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

K. Excavated material shall be placed at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic or interfere with the function of existing drainage facilities or system operation.

L. Remove excess subsoil not intended for reuse from site.

M. Stockpile excavated material in area designated on site in accordance with Section 31 05 13, Soils for Earthwork.

3.8 TUNNELING

A. In lieu of open cut trenching as specified above, the Contractor may utilize tunnel methods for installation of pipe where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks and other structures.

    1. The Engineer must approve tunneling methods prior to utility installation.

    2. Tunneling will be per the most current ODOT Standard Specifications.

    3. Where tunneling is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks, and other surface improvements whose replacement is avoided by the tunneling method.

3.9 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, new and existing structures, and adjacent and neighboring properties and to prevent caving, erosion, settlement, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

D. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

E. Design sheeting and shoring to be removed at completion of excavation work, unless shown otherwise in the Drawings.

F. Construction Sheeting Left in Place:

1. Furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.

2. Construction sheeting and bracing originally intended for temporary installation, placed by the Contractor to protect adjacent and neighboring structures, may be left in place if desired by the Contractor and approved by the Engineer. All such sheeting and bracing left in place shall be included in the cost for excavation.

3. Any construction sheeting and bracing which the Contractor has placed to facilitate its work may be ordered in writing by the Engineer to be left in place. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating an obligation on its part to issue such orders. Failure of the Engineer to order sheeting and bracing left in place shall not relieve the Contractor of its responsibility under the contract.

4. For sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade.

3.10 COMPACTION

A. Testing will be required to show specified densities of compacted backfill are being achieved by the Contractor’s compaction methods.

B. Moisture Control:

1. Moisture condition backfill material to within 2 percent of optimum moisture content required for compaction throughout each lift of the fill.

2. Add moisture to granular backfill by sprinkling during compaction operation.

3. Compaction by ponding or jetting is not permitted.

C. Compact all materials and areas that are not accessible for in-place density testing, as determined by the Engineer, in place by whatever equipment and method is practicable or specified, and as approved by the Engineer.

1. Perform compaction at such moisture content as is required to produce well-filled, dense, and firm material in place that will show no appreciable deflection or reaction under the compacting equipment.

3.11 BEDDING

A. All utility vaults, potable water pipe 4-inch nominal diameter and over, all steel pipe, all concrete sewer pipe, all plastic pipe, all pipe under existing or future structures or roadways, and any and all utilities at a depth greater than 6 feet shall be laid in pipe bedding material.

B. Unless otherwise noted in the Drawings, pipe or conduit of less than 4-inch diameter, outside structure lines and at a depth of less than 6 feet shall be bedded in native material properly shaped as specified below, all as detailed on the Drawings.

C. Compacted bedding material shall be placed the full width of the excavated trench to a depth as shown on the trench detail included in the Drawings.

1. In lieu of a detail, the depth shall be 6 inches.

D. Spread the bedding smoothly over entire width of trench to the proper grade so that the pipe is uniformly supported along the barrel.

E. Hand grade and compact each lift to provide a firm, unyielding surface along the entire pipe length. For rigid pipe, compact to at least 90 percent relative compaction in unpaved areas and 95 percent relative compaction in paved areas.

F. Excavate bell holes at each joint to permit proper assembly and inspection of the joint.

G. Check grade and correct irregularities in bedding material.

H. Center pipes horizontally in trench width.

3.12 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Maintain optimum moisture content of fill materials to attain required compaction density.

D. Place fill material, with the exception of CLSM, in continuous layers and compact in 6- to 8-inch lifts.

1. Prevent pipe from moving either horizontally or vertically during placement and compaction of pipe zone material.

2. Where trenches are under existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on the Drawings or specified elsewhere in these specifications, the trench backfill shall be Class B or Class E and pipe zone backfill shall be Class B or Class E. Class B backfill shall be compacted to 95 percent of maximum density at optimum moisture content.

3. Where trenches are outside existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on plans or specified elsewhere, the trench backfill shall be Class A and pipe zone backfill in these areas shall be Class B. For these locations, compaction of Class B backfill shall be to not less than 90 percent of maximum density at optimum moisture content. Class B backfill shall be compacted to not less than 95 percent of maximum density at optimum moisture content.

E. Employ placement method that does not disturb or damage nearby or adjacent foundation perimeter drainage or utilities in trench.

F. Do not use power-driven impact compactors to compact pipe zone material.

G. Backfill Immediately: All trenches and excavations shall be backfilled immediately after pipe or conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible, unless otherwise directed by the Engineer.

H. Under no circumstances shall water be permitted to rise in open trenches after pipe has been placed.

I. Do not allow backfill material to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.

J. Use hand compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

K. Placement of Sand:

1. Place medium sand in lifts not exceeding 8 inches in uncompacted thickness.

2. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

L. Placement of CLSM:

1. Discharge from truck-mounted drum-type mixer into trench.

2. Place in lifts not exceeding 2 feet in thickness.

3. No compaction of CLSM is allowed.

4. Use steel plates to protect the CLSM from traffic a minimum of 24 hours. After 24 hours, the CLSM may be paved, or opened to traffic until permanent surface restoration is completed, if it has hardened sufficiently to prevent rutting.

M. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

N. Do not leave trench open at end of working day.

3.13 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, install 24 inches below finished grade. Coordinate with piping installation drawings.

3.14 ELECTRONIC LOCATING FACILITY INSTALLATION

A. Marker Balls:

1. Install according to manufacturer's recommendations and as shown or directed and according to the following requirements:

a. Install marker balls directly above the pipe alignment at a depth no less than 3 feet and no more than 4-1/2 feet below final surface grade.

b. Install marker balls during trench backfill operations by placing the marker ball in compacted backfill.

c. Cover marker ball with a minimum of 6 inches of backfill and compact backfill before continuing trench backfill operations.

d. Install markers balls with trenchless pipe installations by core-drilling hole of a minimal diameter needed to allow clearance for placement of marker ball. Backfill with approved trench backfill, pavement base and pavement, as applicable.

2. Water Marker Ball Locations: Install at locations as required by Sewer Marker Ball Locations specified herein.

3. Sewer Marker Ball Locations:

   a. Install marker balls directly above connection points, termination points and all fitting locations, and at a minimum spacing of 50 linear feet on sewers with a straight horizontal alignment.

   b. Install marker balls at a minimum spacing of 25 lineal feet directly above sewer mains installed on a radius.

   c. Install marker balls on new or reconstructed sewer service laterals, directly above the centerline of the end of the lateral at the curb, property line or other end of lateral location, as directed.

   d. Install marker balls directly above every alignment change along sewer mains and service laterals.

   e. Install marker balls directly above manholes for manholes with buried covers.

B. Tracer Wire and Terminal Appurtenances:

1. Tracer Wire:

   a. Install as shown or directed directly over the pipe centerline and on top of the pipe zone in all sewer trenches, including mainline sewers, service laterals and storm sewer inlet leads.

   b. Connect mainline and service lateral tracer wires using either an approved direct-bury lug connector or direct-bury twist connector.

   c. Extend tracer wire to locator stations in manholes, locator boxes, storm inlets, or other visually identifiable terminal appurtenances, allowing for access with electronic locating equipment, as shown or directed and according to the following requirements:

2. Locator Stations:

   a. Install locator stations as shown within manholes.

   b. Mount locator station to manhole wall within 18 inches of manhole rim with two stainless steel expansion anchors.

   c. Drill a minimum 3/8-inch diameter hole through the manhole wall within 18 inches of the finish grade of the manhole rim.

d. Extend the tracer wire from the pipe trench in one continuous piece up the outside of the manhole and through the hole and into a locator station and attach to one of the lugs in the locator station.

e. When multiple tracer wires are terminated in manhole install a multi-lead locator station.

f. Extend a ground wire from the locator station through a minimum 3/8-inch diameter hole in the manhole wall.

g. Install ground wire approximately 3 feet deep and extend from the outside manhole wall a minimum of 3 feet horizontally in any direction.

h. Seal all holes drilled in manhole walls with silicone sealant.

3. Storm Inlet Tracer Wire Termination: Terminate tracer wire inside inlet and directly over storm outlet pipe by placing tracer wire as follows:

a. Drill a minimum 3/8-inch diameter hole through inlet wall to pass tracer wire through to inside inlet wall.

b. Seal hole with silicon sealer or material approved by Engineer.

c. Leave 6 inches of coiled tracer wire along inside of inlet wall approximately 3 inches below the inlet frame and grate or as directed by Engineer.

4. Service Lateral Tracer Wire Termination: Terminate tracer wire at ends of service laterals as shown or directed, as follows:

a. Termination in Tracer Wire Locate Boxes: Extend the tracer wire in one continuous piece up vertically from the pipe trench and into the bottom of the locate box. Leave 18 inches of coiled tracer wire inside locate box.

b. Termination at 2-inch by 4-inch Markers: Extend tracer wire in one continuous piece directly up service lateral 2-inch by 4-inch markers and leave 18 inches of tracer wire wrapped around the exposed top end of 2-inch by 4-inch marker.

3.15 VISUAL IDENTIFICATION FACILITIES

A. Tracer Wire Locate Boxes: Install tracer wire locate boxes directly over service laterals at property line, service boundary, or other location as shown or directed by the Engineer.

B. Service Lateral Plastic or Copper Markers:

1. Install plastic or copper markers in the concrete curb directly over the centerline of the service lateral, as shown or directed by the Engineer.

2. Either plastic or copper markers may be used.

3. If there is not suitable concrete curb for marker placement, then install a lateral cleanout as close to property line as practical at location approved by Engineer.

C. Service Lateral 2-inch by 4-inch Markers:

1. Place a 2-inch by 4-inch marker at the end of each new service lateral not connected to a building sewer.

2. Omit markers only as approved.

3. Block the capped or plugged service lateral end with a wood block against undisturbed earth and install the marker.

4. Extend the marker from the blocked service lateral invert to at least 12 inches above the existing or proposed finish ground surface.

5. Install marker in one piece. No splicing will be accepted.

6. Paint the exposed portion of the marker after its installation with quality quick drying enamel white paint for a storm only sewer and green paint for a sanitary or combined sewer.

7. After the paint has dried, use black, quick drying enamel, and neatly indicate the distance from the ground surface to the top of the service lateral in feet and inches.

8. Do not disturb the position and location of the marker during the backfilling operation.

9. If the marker is broken, moved out of location, or vertical alignment is changed during the backfilling operation, reopen the trench and replace the marker.

3.16 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the Owner. Initial testing will be paid for by the Owner. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with the most current ODOT Laboratory Manual of Test Procedures.

C. In-place compaction testing of pipeline backfill materials shall be performed at 2-foot elevation increments, one test per 200 lineal feet of pipeline trench as measured along pipe centerline.

1. The Engineer may reduce the frequency when satisfied with method of compaction.

2. The Engineer may direct testing at a higher frequency at no additional cost to the Owner upon failure to obtain specified densities or if the Contractor changes compaction equipment or methods of compaction.

3. The Engineer shall determine all test locations.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922
2. Moisture Tests: ASTM D3017

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

3.17 SURFACE RESTORATION AND CLEANUP

A. Open Trenches: At the end of each workday, all open trenches shall be backfilled and all trenches within streets shall be temporarily paved or covered to the satisfaction of the Engineer and the local permitting agency.

1. Temporary paving shall be replaced with permanent street paving at the completion of construction within street rights-of-way, or sooner, if deemed necessary by the ENGINEER.

2. No gravel-filled trenches shall be left open within the street right-of-way at the end of the workday.

B. Topsoil:

1. Where trenches cross lawns, garden areas, pastures, cultivated fields, or other areas on which reasonable topsoil conditions exist, remove the topsoil to the specified depth and place the material in a stockpile.

2. Topsoil shall not be mixed with other excavated material.

3. After the trench has been backfilled, the topsoil shall be replaced.

C. Clean up and remove all excess materials, construction materials, debris from construction, etc. Replace or repair any fences, mailboxes, signs, landscaping, or other facilities removed or damaged during construction. Replace all lawns, topsoil, shrubbery, flowers, etc., damaged or removed during construction. The Contractor shall be responsible for seeing that lawns, shrubs, etc. remain alive and leave premises in condition equal to original condition before construction.

3.18 SCHEDULE

A. Storm and Sanitary Piping:

1. Cover pipe and bedding with Fill Type Class B to finish grade or base rock grade just below asphalt or concrete finish grade.

2. Compact uniformly to minimum 95 percent relative maximum density as determined by AASHTO T-180.

B. Duct Bank:

1. Cover duct and bedding with Fill Type Class B to finish grade or base rock grade just below asphalt or concrete finish grade.

2. Compact uniformly to minimum 95 percent relative maximum density as determined by AASHTO T-180.

END OF SECTION

SECTION 31 23 19 - DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes temporary dewatering and surface water control systems for open excavations and utility trenches.

B. Section includes:

1. Dewatering systems.
2. Surface water control systems.
3. System operation and maintenance.
4. Water disposal.

1.2 RELATED SECTIONS

A. Section 31 05 16 - Aggregates for Earthwork
B. Section 31 23 16 - Excavation
C. Section 31 23 17 - Trenching

1.3 SUBMITTALS

A. Dewatering Plan:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply; pollution control facilities; discharge locations to be utilized; and provisions for immediate temporary water supply as required by this Section.

2. Plan to be reviewed by the Engineer prior to the beginning of construction activities requiring dewatering. Review by the Engineer of the design shall not be construed as a detailed analysis of the adequacy of the dewatering system, nor shall any provisions of the above requirements be construed as relieving the Contractor of its overall responsibility and liability for the work.

1.4 DEFINITIONS

A. Dewatering includes the following:

1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations, trenches, tunnels, and /or shafts.

2. Reducing piezometric pressure within strata to prevent failure or heaving of excavations, trenches, tunnels, and /or shafts.

3. Disposing of removed water.

B. Surface Water Control: Removal of surface water within open excavations.

1.5 QUALITY CONTROL

A. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

B. Provide all labor, materials, and equipment necessary to dewater trench and structure excavations, in accordance with the requirements of the Contract Documents.

C. Secure all necessary permits to complete the requirements of this Section.

D. Control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

E. Where the critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop.

1. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor.

2. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 EQUIPMENT

Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 DEWATERING

A. Provide all equipment necessary for dewatering.

1. Have on hand, at all times, sufficient pumping equipment and machinery in good working condition.

2. Have available, at all times, competent workers for the operation of the pumping equipment.

3. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for structures and pipelines shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. Site Grading:

1. At all times, site grading shall promote drainage.

2. Surface runoff shall be diverted from excavations.

3. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

F. Maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

G. Flotation shall be prevented by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

I. Dispose of water from the work in a suitable manner without damage to the environment or adjacent property. No water shall be drained into work built or under construction without prior consent of the Engineer. Water shall be filtered using an approved method to remove sand and fine sized soil particles before disposal into any drainage system.

J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

K. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the work and all costs thereof shall be included in the various contract prices in the bid forms.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes backfilling required at building perimeter and site structures to subgrade elevations, fill under interior and exterior slabs-on-grade or pavement, and fill under landscaped areas. Backfilling for utilities within building proper is included within this section; backfilling for utilities outside building is included in Section 31 23 17, Trenching.

B. Section includes:

1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 23 16 - Excavation
E. Section 31 23 17 - Trenching
F. Section 33 11 10 - Water Utility Distribution and Transmission Piping
G. Section 33 31 13 – Public Sanitary Utility Sewerage Piping
H. Section 33 41 10 - Storm Utility Drainage Piping
I. Supplemental Information: Geotechnical report; bore hole locations and findings of subsurface materials.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

5. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.4 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill elsewhere in these Specifications. A self-compacted, cementitious material.

B. Imported Material: Materials obtained from sources offsite, suitable for specified use.

C. Lift: Loose (uncompacted) layer of material.

D. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

1.5 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

1.6 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S2, Imported Fill Material as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Lean concrete with compressive strength of 100 pounds per square inch (psi).

2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete. Compressive strength as required by the application or as noted in the Drawings.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Foundation Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to Work in this Section, become familiar with Site conditions. In the event discrepancies are found, notify Engineer as to the nature and extent of the differing conditions.

B. Verify sub-drainage, damp-proofing, or waterproofing installation has been inspected.

C. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

D. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Control of Water:

1. Excavated areas shall be kept free of water and frost.
2. Bearing surfaces which become softened by water or frost shall be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.
3. See Section 31 23 19, Dewatering for additional details.

C. Compact subgrade to density requirements for subsequent backfill materials.

D. Cut out soft areas of subgrade not capable of compaction in place and replace with specified granular fill material. See Article 3.5, Over-excavation for Unsuitable Foundation Conditions in Section 31 23 16, Excavation for additional details.

E. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

F. Subgrade to be approved by Engineer prior to placement of structures and commencement of backfill activities.

G. Do not allow or cause any work performed or installed to be covered up or enclosed prior to required tests and approvals. Should any Work be enclosed or covered up, uncover at Contractor's expense.

3.4 BACKFILLING

A. Backfill areas to contours and elevations shown in the Drawings with unfrozen materials.

B. Do not place materials when weather conditions and/or moisture content prevent attainment of specified density.

C. Maintain optimum moisture content of backfill materials to attain required compaction density.

D. Employ placement method that does not disturb or damage other work.

E. Mechanical tampers permitted in confined areas.

F. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

G. For areas receiving surface structures or existing paved areas to be constructed or replaced, such as, roadways, driveways, parking lots, and sidewalks:

1. Place Coarse Aggregate Type A1, Dense-Graded Aggregate, 1-1/2-inch-0 gradation in 6-inch lifts.

2. Compact with vibratory equipment to 95 percent maximum density, unless otherwise specified or shown in the Drawings.

3.5 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the Owner. Initial testing will be paid for by the Owner. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with ASTM C136.

C. In-place compaction testing for structural fill material shall be performed at 2-foot elevation increments in the fill material with at a minimum of one test per each 2,500 square feet of material placed. The Engineer shall be provided with the results of each compaction test at the time of testing.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

F. When testing of subgrade is not possible or feasible as detailed above, proof roll compacted fill surfaces under slabs-on-grade, pavers, paving, and as may be otherwise required by the Engineer.

3.6 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION

SECTION 32 11 23 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes construction of an aggregate subbase and base course for placement under asphalt or concrete paving, unit paving, or placed and left exposed.

B. Section Includes:

1. Aggregate subbase
2. Aggregate base course

1.2 RELATED REQUIREMENTS:

A. Section 31 23 17 - Trenching
B. Section 31 23 23 - Fill
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 32 12 16 - Asphalt Paving

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications

2. T11, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing

3. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

4. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

B. ASTM International (ASTM):

1. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

2. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

4. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports

5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities and standing water, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Keystone: Fine aggregate used to aid in binding of loose surface stone.

1.5 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data:

1. Submit data for geotextile fabric and herbicide.

C. Materials Source: Submit name of aggregate materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

PART 2 PRODUCTS

2.1 SHOULDER AGGREGATE

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.2 DENSE-GRADED BASE AGGREGATES

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.3 OPEN-GRADED BASE AGGREGATES

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A2, Granular Drain Backfill Material as specified in Section 32 05 16, Aggregates for Earthwork.

2.4 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

2.5 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

2.6 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; woven, polypropylene.

1. Geotextile Fabric: Propex Geo-Solutions Geotex 200ST

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Obtain Engineer’s acceptance of subgrade before placing base course or surfacing material.

B. Verify compacted substrate is dry and ready to support paving and imposed loads.

1. Proof roll substrate with equipment approved by the Engineer in minimum two perpendicular passes to identify soft spots.

2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.3 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.

2. Loads: Of uniform capacity.

3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.

2. Produce even distribution of material on prepared surface without segregation.

3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

4. Maintain consistent gradation of material. Widely varying gradation will be cause for rejection.

3.4 CONSTRUCTION OF COURSES

A. Untreated Aggregate Base Course:

1. If the required compacted depth of the base course exceeds 6 inches, construct it in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.

2. Completed Course Total Thickness: As shown on the Plans, 8-inch minimum.

3. Spread lift on preceding course to required cross-section. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.

4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:

    a. Use 3/4-inch leveling course or surfacing material as keystone.

    b. Spread evenly on top of base course, using spreader boxes or chip spreaders.

    c. Roll surface until keystone is worked into interstices of base course without excessive displacement.

    d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.

6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing and Leveling Course:

1. Place shoulder aggregates in a single layer, or two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 9 inches.

2. Spread on preceding course in accordance with cross-section shown.

3. Blade lightly and roll surface until material is thoroughly compacted.

4. Complete Total Thickness: As shown on the Plans, 8-inch minimum.

3.5 ROLLING AND COMPACTION

A. Commence compaction of each layer of base immediately after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by AASHTO T-180.

B. Roll each layer of material until there is no appreciable reaction or yielding under the compactor before succeeding layer is applied.

C. Shape and maintain the surface of each layer during compaction operations. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to the required density before succeeding lift is placed.

F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate: Within plus or minus 0.04-foot of grade shown at any individual point.

C. Overall Average: Within plus or minus 0.04-foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

A. Quality control testing shall be performed by an independent testing laboratory provided by the Owner.

B. Refer to table below for minimum sampling and testing requirements for aggregate base course and surfacing. The OWNER reserves the right to complete additional testing.

Property	Test Method	Frequency	Sampling Point
Gradation	AASHTO T11 and AASHTO T27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T180	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	AASHTO T310	One for each 500 ton but at least every 10,000 square feet of area	In-place completed, compacted area

3.8 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate. Restore per Specifications as applicable.

END OF SECTION

SECTION 32 12 16 - ASPHALT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SCOPE

This section includes the construction of asphalt concrete pavement.

1.2 REFERENCE STANDARDS

A. References herein to “AASHTO” shall mean Association of American State Highway Transportation Officials.

B. Standard Specifications: Where the term “Standard Specifications” is used, such reference shall mean the current edition of the Oregon Department of Transportation (ODOT) Standard Specifications for Highway Construction. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.3 DEFINITIONS

A. Maximum Density Test (MDT): Theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041 (Rice), by 62.4 pounds per cubic foot.

1.4 SUBMITTALS

A. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00640 for aggregate used in aggregate base.

B. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00745 for aggregate used in asphalt concrete.

C. Job mix formula shall be an approved job mix formula. Submit formula, supplier, and product identification to the Engineer 30 days prior to start.

1. Definite percentage for:

   a. Each sieve fraction.
   b. New asphalt cement.
   c. Recycled asphalt pavement.

2. Temperature of completed mix when discharged from mixer.

3. Character and quantity of anti-strip and recycling agents.

1.5 QUALITY ASSURANCE

A. All testing to determine compliance with the specifications shall be performed by an independent testing laboratory contracted by the Contractor and approved by the Engineer. All testing costs shall be borne by the Contractor.

B. A minimum of five nuclear densometer readings shall be taken in random locations within every test area. Each test area shall not exceed 200 tons of asphalt; however, smaller areas may be designated by the Engineer.

C. The surface smoothness of the new asphalt concrete pavement shall be such that when a 10-foot straightedge is laid longitudinally across the paved area in any direction, the new pavement shall not deviate from the straightedge more than 1/8-inch. Surface drainage shall be maintained. Additionally, paving must conform to the design grade and crown and contain no abrupt edges, low or high areas or any other imperfections as determined by the Engineer. Pavement construction not meeting these requirements will be repaired by grinding the existing pavement to a 1-1/2-inch depth and replacing with Level 2, 1/2-inch dense graded Asphaltic Concrete the full width at no cost to Owner.

1.6 PRE-PAVING CONFERENCE

A. Any supervisory personnel of the Contractor and any subcontractors who are to be involved in the paving work shall meet with the Engineer, at a time mutually agreed upon, to discuss methods of accomplishing all phases of the paving work.

B. The Contractor shall be prepared to review the size and type of equipment to be used and the anticipated rate of placement to determine equipment needs.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIAL

A. Aggregate Base for Dense Graded Asphalt Concrete: The aggregate material shall be a clean, well-graded crushed base aggregate conforming to the Standard Specifications. Base course shall be 3/4-inch minus aggregate.

2.2 ASPHALT CONCRETE PAVEMENT

A. Dense Graded Hot Mix Asphalt Concrete

1. Use Level 2, 1/2-inch-dense graded, PG 70-22 HMAC. Conform to the requirements as specified in Section 00745 of the Standard Specifications. Conform to the requirements as specified in Section 00745 of the Standard Specification.

2. Asphaltic concrete pavement delivered to the site shall be accompanied by a ticket with the approved "job mix formula" number shown. Loads without tickets identifying the job mix formula will not be accepted.

3. Percent of recycled asphalt pavement used in new asphalt pavement shall not exceed 30 percent. Recycled asphalt pavement may not be used in top wearing course unless otherwise approved by the Engineer.

B. Tack Coat

In accordance with Standard Specifications. Use AR 4000, AC-20 asphalt or CSS-1 emulsified asphalt C.

C. Seal and Cover Coat

Asphalt material shall be CRS-2 cationic emulsified asphalt. Cover stone shall conform to size 1/4-inch #10 aggregate in the Standard Specifications.

D. Subgrade Geotextile

1. Dense Graded AC Mix-For subgrade separation using dense graded asphalt concrete, use subgrade geotextile with Certification Level B as specified in Section 02320 of the Standard Specifications.

E. Subgrade Stabilization

In the event that unstable materials are encountered during excavation, the additional excavation and installation of geotextile fabric and 12 inches of rock substructure will be required, as directed. Conform to the requirements as specified in Section 00331 of the Standard Specifications. For subgrade separation, use subgrade geotextile with Certification Level B as specified in Section 02320 of the Standard Specifications.

PART 3 EXECUTION

3.1 AGGREGATE PAVEMENT BASE

A. Place pavement base to the depth shown on the plans or as specified in all cases, pavement base shall be compacted to a minimum depth of 6 inches. Bring the top of the pavement base to a smooth, even grade at a distance below finished grade equivalent to the required pavement depth.

B. Compact the pavement base with mechanical vibratory or impact tampers to a density of not less than 91 percent of the maximum density, as determined by AASHTO T-180.

C. Obtain the Engineer's acceptance of the subgrade before beginning construction of the aggregate base course.

D. When, in the judgment of the Engineer, the weather is such that satisfactory results cannot be secured, suspend operations. Place no aggregate base course in snow or in soft, muddy, or frozen subgrade.

E. If the required compacted depth of aggregate base course exceeds 6 inches, construct in two or more lifts of approximately equal thickness. Maximum compacted thickness of any one lift shall not exceed 6 inches. Compact each layer to the specified density before a succeeding lift is placed.

3.2 ASPHALT CONCRETE PAVEMENT

A. Construct asphalt concrete pavement in accordance with Section 00745 of the Standard Specifications.

B. Conform to the requirements for prime coat and tack coat in the Standard Specifications. Tack coat all edges of existing pavement, manhole and clean out frames, inlet boxes, and like items. When rate is not specified, asphalt will be applied at the rate of 0.1-gallon per square yard.

C. Obtain the Engineer's acceptance of the aggregate base course before beginning construction of the asphalt concrete wearing course.

D. Hot mix asphalt shall be placed on dry, prepared surfaces, when air temperature in the shade of 40 degrees Fahrenheit (F) or warmer, unless otherwise authorized by the Engineer.

E. Placing asphalt pavement during rain or other adverse weather conditions will not be permitted unless otherwise authorized by the Engineer, except that asphalt mix in transit at the time these adverse conditions occur may be placed provided it is of proper temperature, the mix has been covered during transit, and it is placed on a foundation free from mud or free-standing water.

F. Correct any defects in material and workmanship, as directed, when determined detrimental by the Engineer. These include segregation of materials, non-uniform texture, and fouled surfaces preventing full bond between successive spreads of mixture. The corrections or replacement of defective material or workmanship shall be at the Contractor's expense.

G. Compact the bituminous mixture to at least 91 percent of the Theoretical Maximum Density.

H. The finished surface of each course of layer of mixture shall be of uniform texture, smooth, and free of defects and shall closely parallel that specified for the top surface finished grade. Remove and replace boils and slicks immediately with suitable materials.

I. The surface of each layer when tested with a Contractor-furnished 10-foot straightedge shall not vary from the testing edge by more than 0.02-foot for underlying courses of pavements and 0.015-foot for finished top courses or wearing courses of pavements. At no point shall the finished top of the wearing course vary more than 0.03-foot from the specified finished grade.

J. Lift thickness shall be as shown on the drawings or specified, but not to exceed 3 inches.

K. Do not place asphalt concrete pavement on emulsified asphalt (tack coat) until the asphalt separates from the water (breaks) but before it loses its tackiness.

L. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

3.3 FIELD QUALITY CONTROL

A. Job mix will be sampled immediately behind the paving machine.

B. Temperature of the mix will be measured immediately behind the paver.

C. The theoretical maximum specific gravity of the bituminous mixture will be determined in accordance with ASTM D2041.

D. Properties of the job mix will be measured using ASTM D2041.

E. Density of the compacted job mix will be measured in accordance with ASTM D2922.

3.4 ADJUSTMENT OF EXISTING MANHOLE COVERS AND VALVE BOXES

Prior to placing asphalt concrete pavement, the CONTRACTOR shall make all necessary adjustments to existing manhole frames and covers and valve box covers to ensure that the tops of the manhole covers or valve box lids are flush with the finished grade of the adjoining pavement or ground surface, and that valve boxes and PVC pipes are centered and plumb over operating nut valve.

END OF SECTION

SECTION 32 31 13 - CHAIN LINK FENCING AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes chain link steel fencing and gates as shown on the Drawings or specified elsewhere. All fences and gates shall be furnished with top rails and knuckled periphery edges.

B. Section includes:

1. Chain link fabric
2. Posts
3. Rails
4. Tension wires
5. Braces
6. Fittings
7. Gates
8. Lock assemblies and gate stops

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Chain Link Fence Manufacturer's Institute:

1. Galvanized Steel Chain Link Fence Fabric
2. Industrial Steel Specifications for Fence-Posts, Gates and Accessories

B. ASTM International (ASTM):

1. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

2. A313, Standard Specification for Stainless Steel Spring Wire

3. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric

4. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric

5. A497, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete

6. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

7. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

8. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence

9. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

10. C94, Standard Specification for Ready-Mixed Concrete

11. C150, Standard Specification for Portland Cement

12. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete

13. F552, Standard Terminology Relating to Chain Link Fencing

14. F567, Standard Practice for Installation of Chain-Link Fence

15. F626, Standard Specification for Fence Fittings

16. F900, Standard Specification for Industrial and Commercial Swing Gates

17. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework

18. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

19. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric

20. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates

21. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications

C. Conflicts in requirements shall use this Section to take precedence.

1.3 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Shop Drawings:

1. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.

2. Fence, gate posts, rails, and fittings.

3. Chain link fabric.

4. Gates and hardware.

C. Manufacturer's recommended installation instructions.

D. Evidence of Supplier and installer qualifications.

1.4 QUALITY ASSURANCE

A. Use skilled workers thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Provide each type of steel fence and gate as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings, and fastenings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition.

B. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fabric

1. Continuous chain link fence.

2. Height: As shown on the Drawings.

3. Mesh: 2-inch. All mesh shall have knuckled periphery to eliminate sharp appendages.

4. #9-gauge steel core wire.

5. Top and bottom selvage: Knuckled finish.

6. Galvanized after weaving.

7. Zinc coating shall not be less than 0.9 ounces per square foot.

B. Line Posts

Line posts shall be hot dipped galvanized 2.375-inch outside diameter hot dipped galvanized pipe, weighing 3.12 pounds per lineal foot.

C. Terminal Posts

End, corner, and pull posts shall be hot dipped galvanized pipe 2.875 inches outside diameter and weighing not less than 4.64 pounds per lineal foot.

D. Top Rail

1. Top rail shall be hot dipped galvanized 1.660-inch outside diameter pipe, weighing 1.83 pounds per lineal foot.

2. Furnish in random lengths of approximately 20 feet.

3. Jointed using a pressed steel or malleable sleeve, not only allowing for expansion and contraction, but also providing a continuous brace from end to end of each stretch of fence.

E. Tension Wire

Bottom tension wire shall be #6-gauge heavy galvanized high carbon steel coil spring wire, securely fixed to the fabric, line posts, and terminal posts.

F. Braces

1. All terminal posts shall be braced with 1.660-inch outside diameter. horizontal pipe bracing of the same material as the top rail, securely attached to the terminal and first line post with malleable iron fittings.

2. Braces shall be truss-braced from the first line post to the bottom of the terminal post, with a 3/8-inch galvanized truss rod assembly.

3. Corner posts shall be braced in both directions.

G. Fittings

1. Malleable, cast iron, or pressed steel.
2. Hot dip galvanized.

H. Fabric Ties

1. #11-gauge galvanized wire ties shall be used to tie the fabric to the line posts and rails.

I. Chain Link Gates

1. Frames:

   a. Made of heavy galvanized 1.90-inch outside diameter pipe, weighing 2.28 pounds per lineal foot.

   b. Welded or assembled with corner fittings.

2. Corner fittings, ball and socket hinges, catch stops, and center rest to be heavy galvanized malleable iron.

3. Hinges as required.

4. Provide diagonal cross-bracing.

J. Gate Posts

Posts shall be hot dipped galvanized pipe 2.875-inch outside diameter weighing 4.64 pounds per lineal foot.

K. Framework Material

All posts, rails, and braces to be heavy galvanized.

L. Lock Assembly and Gate Stop

1. Provide for each gate one double-hasp drive gate drop rod lock assembly set in concrete and one gate stop set in concrete.

2. All lock assemblies and gate stops shall be fabricated from heavy galvanized malleable iron.

3. Provide one vandal-proof keyed lock and three keys for each gate assembly.

PART 3 EXECUTION

3.1 INSTALLATION

A. All materials and workmanship shall be first class in all respects and shall be done in a neat and workmanlike manner.

B. Installation shall be conducted in accordance with the requirements of the Chain Link Fence Manufacturers Institute and these Drawings & Specifications.

C. All line, terminal, gate stops, gate drop, and gate posts shall be fixed with a minimum of 3-foot embedment in concrete poured into a 1-foot diameter hole and plumb upon curing of the concrete.

D. Line posts shall be spaced not further than 10-foot on-center.

E. Gates shall have 3-inch clearance above ground surface and sized for the application shown.

F. Space ties at 14 inches on center.

END OF SECTION

SECTION 32 91 21 - FINISH GRADING AND SEEDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil Preparation
2. Weed control
3. Fertilizing
4. Seeding
5. Mulching
6. Hydroseeding
7. Hydromulching
8. Erosion Control Blanket
9. Maintenance and Establishment Period

B. Related Sections:

1. Section 31 23 17 - Trenching

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Grassed Areas:

1. Basis of Measurement: Lump Sum.

2. Basis of Payment: Includes seeding, mulching, watering, weeds control and maintenance to specified 1 year.

1.3 REFERENCES

A. ASTM International (ASTM):

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.
2. 7 USC 1551-1611 - Federal Seed Act.

1.4 DEFINITIONS

A. Certified Seed: A grass or legume seed named variety that has been reviewed and accepted into the State Certified Seed program. Currently certified seed is individually sold in bags with a Certification Tag.

B. Pure Live Seed (PLS): Is a measure used to describe the percentage of a quantity of seed that will germinate. PLS is obtained by multiplying the purity percentage by the percentage of total viable seed, then dividing by 100.

C. Establishment Period: A period when planting work has been performed and initially accepted, and there is a contract requirement to care for the planted areas in some way until the period ends.

D. Sensitive Areas: Defined areas such as wetlands, natural water and riparian resources, special environmental zones, or where certain activities are restricted such as the use of chemicals.

E. Weeds: Vegetative species other than specified species to be established in given area.

F. Invasive Plants: Any species that appears on the Oregon State Weed Board and the Oregon Department of Agriculture current noxious weed list, plus known problem species including phalaris arundinacea, mentha pulegium, holcus lanatus, anthoxanthum odoratum odoratum. The last crop plants (if listed as non-native on United States Department of Agriculture (USDA) Plants Database) are considered invasive if it comprises more than 15 percent in any newly established vegetation.

G. Weed Control: Removal and prevent regrowth of specified weeds, weed parts, and weed seeds from area within the project limit.

1.5 SUBMITTALS

A. Product Data: Submit data for seed mix, mulch, tackifier, erosion control blanket, soil amendment materials, pesticides, herbicides, and other accessories. The product should meet or exceeds all product requirements specified herein.

B. Grass Seeds Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1. Certification of seed analysis, germination rate, and inoculation. Include the year of production and date of packaging. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing within 12 months of delivery date. Also include:

    a. Name and address of laboratory

    b. Date of test

    c. Lot number for each seed certified

    d. Test Results: Name, percentages of purity and of germination, and weed content for each seed mix.

C. Operation and Maintenance Data: Include maintenance instructions and weed control.

1.6 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

B. Pesticide shall not be used in this project.

1.7 QUALIFICATIONS

A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum 3 years documented experience.

B. Installer: Company specializing in performing work of this section with minimum 2 years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

C. Deliver tackifier sealed containers showing weight, chemical analysis, and name of manufacturer.

1.9 MAINTENANCE SERVICE

A. Maintain seeded areas immediately after placement for 12 months from Date of Substantial Completion. Grass shall be well established and exhibits vigorous growing condition.

PART 2 PRODUCTS

2.1 SEED MIXTURE

A. Suppliers:

1. Sunmark Seeds, Portland, OR
2. PT Lawn Seed, Portland, OR
3. NaturesSeed.com
4. Approved equal

B. Seed Mixes: The following are the functional categories of seed mixes that may be included on projects (a category may have multiple functions on a project site):

1. Temporary Seeding - To provide short-term erosion control of disturbed soils and slopes that are not at finished grade and which will be exposed for 2 months or longer before being disturbed again, until permanent seeding is performed, or all potential for erosion is removed.

2. Permanent Seeding - The final seeding or only seeding performed for erosion control.

3. Lawn Seeding - Seeding for areas where finished turf appearance is desired.

4. Wildflower Seeding - Seeding to develop growth of wildflowers. The seed mix will typically contain grass or other plant seed to provide erosion control.

5. Plant Seeding - Seeding which typically includes more than just grass species, such as seeds of woody or herbaceous plants.

6. Water Quality Seeding - For use in water quality facilities such as swales or settling basins.

7. Wetland Seeding - To vegetate existing or constructed wetlands.

8. Native Plant Seeding - Seeding to restore native vegetation.

C. Types of Seed Mixes: Seed mixes, quantities, standards, and other information

1. Erosion Control Seed Mix 1: Easy to establish, maintain, and drought-tolerant NW native grasses for erosion protection. Suitable for dry areas with minimum or no irrigation

Botanical Name	Common Name	PLS Lbs. per Acre
Elymus glaucus	Blue Wildrye	21.9
Festuca rubra rubra	Native Red Fescue	13.1
Bromus carnatius	California Brome	4.4
Agrostis exarata	Spike Bentgrass	4.4
TOTALS:		43.71

2. Erosion Control Seed Mix 2: Fast establishment NW native erosion control grass mix, low growing with good root masses for reduced erosion of soils. Mychorrhize may be added to enhance root system growth. Less than 24 inches in height with shade and drought tolerance. May work on wet and dry sites.

Botanical Name	Common Name	PLS Lbs. Per Acre
Hordeum brachyantherum	Meadow Barley	17.45
Bromus carinatus	California Brome	15.27
Festuca rubra rubra	Native Red Fescue	8.73
Deschampsia cespitosa	Tufted Hairgrass	1.31
Agrostis exerata	Spike Bentgrass	0.87
TOTALS:		43.63

3. Erosion Control Seed Mix 3: NW Native seed mix with low/no maintenance. It has a high percentage of wildflowers and legumes which provide excellent nitrogen fixation. It is drought tolerant low-growing native grasses and low-growing wildflowers.

Botanical Name	Common Name	PLS Lbs. Per Acre
Bromus carinatus	California Brome	16.26
Lupinus albaculus	Sicklekeel Lupine	16.26
Elymus elymodies	Squirreltail	12.36
Gailardia aristata	Blanketflower	7.8
Lotuspurshianus	Spanish Clover	5.2
Festuca occidentalis	Western Fescue	2.6
Eschscholzia californica	California Poppy	2.6
Koeleria macrantha	Prairie Junegrass	0.98
Clarkia unguiculata	Elegant Clarkia	0.65
Achillea millefolium	Common Yarrow	0.33

TOTALS:	65.04

4. **Swale Seed Mix**: NW Native species that establish quickly and provide phytoremediation of stormwater.

Botanical Name	Common Name	PLS Lbs. per Ac
Elymus glaucus	Blue Wildrye	21.74
Festuca rubra rubra	Native Red Fescue	6.52
Hordeum brachyantherum	Meadow Barley	4.35
Glyceria occidentallis	Northwestern Mannagrass	4.35
Beckmannia syzigachne	American Sloughgrass	4.35
Deschampsia caespitosa	Tufted Hairgrass	2.17
TOTAL:		43.48

5. **Water Quality Seed Mix**: Water quality facilities NW Native bio-filtration seed mix, salmon-friendly, will perform well in the bottom of drainage swales, storm water retention ponds, and bio-filtration swales. This mixture will range from the continuously wet lowlands, up into the riparian zone, offering erosion control and habitat development.

Botanical Name	Common Name	PLS Lbs. per Acr
Elymus glaucus	Blue Wildrye	20
Festuca rubra rubra	Native Red Fescue	16.5
Deschampsia caespitosa	Tufted Hairgrass	5.2
Glyceria occidentallis	Western Mannagrass	0.9
Beckmania syzigachne	American Sloughgrass	0.9
TOTALS:		43.38

6. **Roadside Seed Mix**: Erosion control mix for vegetation along roadsides. It is also salt tolerant.

Botanical Name	Common Name	PLS Lbs. per Acre

Hordeum vulgare var Poco	Poco Barley	52.24
Hordeum brachyantherum	Meadow Barley	36.57
Bromus carinatus	California Brome	23.51
Festuca idahoensis romerii	Roemer's Fescue	7.18
Trifolium fragiferum	Strawberry Clover	5.22
Clarkia amonea	Farewell to Spring	1.96
Oenothera elata hookeri	Hooker's Evening Primrose	1.96
Deschampsia cespitosa	Tufted Hairgrass	1.31
Agrostis exerata	Spike Bentgrass	0.65
TOTALS:		130.6

7. Wildflowers/Grasses Seed Mix: Low growing grass, wildflower, and ground cover mix with drought tolerant, soil stabilization, and aesthetically colors.

Botanical Name	Common Name	PLS Lbs. per Acre
Festuca brevipila	Spartan II Hard Fescue	34.4
Festuca ovina var covar	Covar Sheep Fescue	12.9
Dalea purpurea	Purple Prairie Clover	12.9
Centaurea cyanus, dwarf	Dwarf Bachlor Buttons	10.3
Poa sandbergii	Sandberg Bluegrass	5.2
Nemophilia menziesii	Baby Blue Eyes	4.3
Trifolium repens	White Clover	1.7
Lobularia maritium	Sweet Alyssum	1.7
Sphaeralcea coccinea	Scarlet Globemallow	1.7

Achillea millefolium	Common Yarrow	0.86
TOTALS:		86.12

2.2 ACCESSORIES

A. Straw Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

B. Wood and Bark Mulching Material: Chipped wood and bark, sawdust, and ground wood mulch should be free of growth or germination inhibiting ingredients.

C. Compost: Commercially manufactured fine and medium compost materials.

D. Tackifier: Commercial tackifier containing no agent toxic to plant life and exhibits no growth or germination inhibiting factors at one of the following forms:

1. Liquid Stabilizer Emulsion - Tackifier with a base material of liquid containing not less than 55 percent total solids by weight. It should allow exchange of air and moisture to the seeds and have an effective life of 1 year or more.

2. Dry Powder Tackifier - Tackifier base consisting of one or more active hydrocolloids from natural plant sources, which hydrates in water and blends with other slurry materials, and upon application tacks the slurry particles to the Soil surface.

E. Fertilizer: Commercial grade; recommended for grass to eliminate deficiencies of topsoil and suitable for application with equipment designed for that purpose.

1. Deliver fertilizers in separate or mixture containers that have the percentage of total nitrogen, available phosphoric acid, and water-soluble potash (NPK) in the amounts specified. Label each container with a quality compliance certificate.

2. Application rate shall be determined by the soil conditions, as indicated in analysis to determine the proportions of Nitrogen percent, phosphoric acid percent, soluble potash percent.

F. Lime: ASTM C602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.

G. Water: Clean, fresh, and free of substances or matter capable of inhibiting vigorous growth of grass.

H. Erosion Control Blanket shall be open, flexible, and dimensionally stable network of fully-biodegradable, bonded, interlocking fibers. The blanket shall have a functional longevity of up to 12 months. Blanket fibers shall be turf green color or natural wood/straw color.

I. Pesticides/Herbicide: Submit proposed pesticides and receive approval before using. Submit a copy of the manufacturer's federal registered label and, if requested, a Material Safety Data Sheet. The Agency reserves the right to restrict chemicals from being used on sensitive areas.

1. Pesticide registered and approved by the Environmental Protection Agency (EPA), acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application.

2. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

3. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the erosion control layer.

4. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.3 SOURCE QUALITY CONTROL

A. Analyze soil to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

B. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of soil testing.

C. Testing is not required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. See General Conditions, Volume 1, for verification of existing conditions before starting work.

B. Planting Season: Plant seeds when growing conditions are conducive to seed germination and quick but thorough establishment of seedlings.

1. Depending on latitude and elevation in the Pacific Northwest, these conditions occur either in mid-August through early October or mid-April to late May.

2. Avoid planting seed during the heat of summer or in late fall to avoid freezes that kill sprouting grass seeds.

C. Weed Control Coordinator - Submit certification at the preconstruction conference that the weed control coordinator meets the following minimum requirements:

1. Demonstrates ability to identify noxious and other weed species commonly seen in site location for at least 1 year conducting weed surveys.

2. Has successful weed control experience, with similar duties to those stated under typical duties below, on at least three construction or vegetation management projects. Certification of Pesticide Consultant License is preferred.

3. The weed control coordinator duties include:

a. Identify Specified Weeds.
b. Prepare and update the Weed Control Program.
c. Coordinate Contractor's weed removal Work and records.
d. Ensures the removed weeds are disposed of at an approved off-site facility.

D. Pesticide Applicator - Submit certification before application of pesticide Work begins, that when chemical weed control is used, that each applicator possesses a Commercial Pesticide Applicator's License held in the individual's name. Submit a certification each time a new applicator begins application Work on the Project.

E. Conduct soil analysis to determine soil fertility. The soil test should at least analyze the current nitrogen, phosphorus, potassium, and PH rates in the soil. Accordingly, the soil test result would suggest the proper soil amendment application including the rates of fertilizers and lime. Obtain the Engineer approval before applying soil amendment.

F. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

2. Uniformly moisten excessively dry soil that is not workable, and which is too dusty.

3. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3.2 SOIL PREPARATION

A. Prepare area for seeding while generally considering the following:

1. Remove any matter detrimental or toxic to the growth of plants, including weeds, clods, rocks, or debris.

2. Application rates of fertilizer or lime shall be based on soil testing results.

3. Prepare a tilled, fine, but firm seedbed.

4. The soil shall have a pH range of 5.5 to 8.0.

B. Refer to ODOT Standard Specifications Section 01040.48, for area preparation for the following kind of seeding:

1. Temporary Seeding - Method E
2. Permanent Seeding - Method D
3. Water Quality Seeding - Method B
4. Wetland Seeding - Method B
5. Lawn Seeding - Method C

3.3 WEED CONTROL

A. Do not harm or disturb any vegetation that was planted as proposed on the planting plans. Do not compact soil with heavy equipment.

B. Inspect the Project for new growth of specified weeds at least monthly during the plants growing season and apply weed control measures as appropriate.

1. Inspect the area at least every 30 days after growing season has begun or as directed for continuing control of all vegetation considered as weeds.

2. Provide schedule of weed control measures.

3. Request to use wheeled or tracked construction equipment in sensitive areas.

C. Remove and control weeds according to the following:

1. Verify the weed control methods before proceeding with weed control activities.

2. Remove all specified weeds and ensure that weed seeds or reproducing plant parts such as vines, runners, or rhizomes do not remain or become disbursed during control activities.

3. Place weeds and related materials in an approved container and transport to an approved offsite disposal facility according to applicable laws and regulations.

4. Keep the site weed free including weeds not initially documented.

D. Weed Control at Sensitive Areas - as determined by The Engineer:

1. Use only hand or light mechanical weed control methods within 50 feet of sensitive areas.

2. Hand methods include the use of hand tools. Light mechanical methods include the use of hand carried, motorized machinery.

E. Weed Control Corrective Work - If corrective work for areas identified as deficient by the Engineer, it should be completed within a 15 Calendar Day period,

3.4 SEEDING

A. Apply Owner Approved Seed mix per ODOT Standard Specifications Section 01040.14 and 0103.13 at areas according to the plans.

3.5 HYDROSEEDING & HYDROMULCHING

A. Mix seeds, fertilizers, mulch, and tackifier with water in specific tank as follows:

1. Hydraulic Equipment should continuously mix and agitates the slurry providing a continuous, non-fluctuating delivery.

2. Provide a uniform distribution of the slurry.

3. Place seed, fertilizer, mulch, and tackifier in the hydroseeder tank no more than 30 minutes prior to application.

B. Hydroseeding operation: Perform hydroseeding according to the following:

1. One-Step Operation - Apply materials in one step only for the following situations:

   a. When seeding in conjunction with erosion control matting. Apply seed, fertilizer, and tracer before installing matting.

   b. When treating small areas that are 1,500 square feet or less and totaling no more than 0.5 acre, double the amount of seed to compensate for seed suspended above Soil by the mulch.

2. Two-Step Operation – for areas over 0.5 acre, use the two-step method for all hydroseeding/hydromulching operations:

   a. Step 1 - Apply seed, fertilizer, and tracer.
   b. Step 2 - Apply mulch and tackifier.

C. Seed -Thoroughly mix seeds when more than one kind is to be used.

D. Mulch - Apply at the following rates based on dry fiber weight:

1. Slopes Flatter Than 1V:2H - Apply cellulose fiber that includes a tackifier at a rate of 2,000 pounds per acre.

2. Slopes 1V:2H or Steeper - Apply cellulose fiber that includes a tackifier at a rate of 3,000 pounds per acre.

E. Tackifier for Cellulose Fiber Applications – apply dry tackifier to water tank at the following rates unless the manufacture recommends a greater rate of application:

1. Slopes Flatter Than 1V:2H - 60 pounds per acre mixed with hydromulch fibers at the rate specified.

2. Slopes of 1V:2H or Steeper - 100 pounds per acre mixed with hydromulch fibers at the rate specified.

3.6 MECHANICAL SEEDING

A. Seeding, fertilizing, and covering: The following may be used to stabilize small disturbed areas that are 1,500 square feet or less and totaling no more than 0.5 acre:

1. Seeds and fertilizer - Seed the disturbed area with the seed mix at the specified rate by mechanical spreader.

2. Cover - Cover seeded areas with one of the following:

a. Straw mulch at a rate of 100 pounds per 1,000 square feet. Spread the mulch uniformly approximately 2 inches deep, in loose condition, which requires roughly 2-1/2 tons per acre of dry mulch. Do not use straw mulch on slopes of 1V:1.5H or steeper.

b. Bark mulch spread uniformly at an approximate depth of 1/2-inch. Use well-decomposed mulch for seed mulching. Do not use bark mulch on slopes of 1V:1.5H or steeper.

c. Suitable open-weave, biodegradable erosion control matting installed according to manufacturer’s instructions.

3.7 SEEDING OVER MULCHED AREAS

A. If an area has been previously mulched for erosion control or temporary seed and mulch is present on the soil surface, double the pound rate for each seed type used. Apply seed and fertilizer hydraulically or mechanically and add a green dye to the mixture to visibly aid uniform application. Upon approval, fertilizer and seed may only be applied after mulching if one of the following conditions apply:

1. Mulch is punched into the soil by mechanized means. Avoid heavy equipment that may compact the soil. Roll seeded area with roller not exceeding 112 pounds/linear foot.

2. Mulch that is held down with netting or like material

3. Mulch is removed prior to seeding.

3.8 WORK QUALITY

A. After application, apply water with fine spray immediately after each area has been hydroseeded Apply water with fine spray immediately after each area has been mulched.

B. Drift - Prevent drift and displacement of seed and fertilizer regardless of equipment and methods used.

C. Displacement - Prevent seed, fertilizer, and mulch from falling or drifting onto other areas where grass is detrimental. Remove material that falls on plants, roadways, gravel shoulders, structures, and other surfaces where material is not specified.

D. Damage - Prevent damage to prepared areas and to completed fertilizer, seed, and mulch work. Replace all material that becomes displaced before acceptance of the work.

3.9 MAINTENANCE

A. Control growth of weeds. Remedy damage resulting from improper use of herbicides.

B. Weed Control - Remove specified weeds prior to plants going to seed and keep weed control and seeded areas "Weed Free" throughout the Establishment Period.

C. Immediately reseed areas showing bare spots.

D. Repair washouts or gullies.

E. Protect seeded areas with warning signs during maintenance period.

F. Ensure that each seeded area has a uniform, healthy and weed-free stand of grass or other seeded plants growing at the end of the Establishment Period. The minimum living plant coverage standards for acceptance of seeding in a planted area are as follows:

1. Temporary Seeding:

a. West of the Cascades - 70 percent coverage of ground surface.
b. East of the Cascades - 30 percent coverage of ground surface.

2. Permanent Seeding:

   a. West of the Cascades - 90 percent coverage of ground surface.
   b. East of the Cascades - 30 percent coverage of ground surface.

3. Wetland Seeding - 70 percent coverage of ground surface.

4. Water Quality Seeding - 100 percent of ground surface.

G. Protection - Protect seeded areas from trespass and other hazards of damage. Use protective fences and signs at no additional cost to the Agency. Obtain approval of protective methods used.

H. Fertilizing and Watering - Apply fertilizer according to grass and soil requirements. Apply water according to good horticultural practice under the prevailing conditions, as required to promote a healthy stand of plants. Obtain water at no additional cost to the Agency.

I. Mowing – If mowing is required, do the first mowing of grass when soil is firm enough to prevent rutting and grass is about 3 inches tall. After mowing, leave grass that is approximately 2 inches tall. At each subsequent mowing, leave about 1-1/2 inches of growth. After the second mowing, grass clippings may be left in place upon written approval.

J. Repair and Restore - Repair and restore soil grades and re-seed damaged, settled, or unproductive areas to the specified conditions of this Section at no additional cost to the Agency.

K. Finishing and Cleaning Up Cleanup - Remove weeds, trash, debris, stones, and other extraneous matter from seeded areas as directed and dispose of.

END OF SECTION

SECTION 33 01 10.59 – DISINFECTION OF WATER UTILITY STORAGE TANKS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water tank disinfection
2. Bacteriological testing

B. Related Requirements:

1. Section 09 97 13.24 - Steel Water Storage Tank Painting: Paint curing requirements.
2. Section 33 01 10.58 - Disinfection of Water Utility Piping Systems: Disinfection of water mains and testing.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C652-19 - Disinfection of Water-Storage Facilities.

1.3 SUBMITTALS

A. Volume 1 – Section 400 General Conditions – 103.9.00 Shop Drawings and Sample Submittals.

B. Disinfection Procedure:

1. Submit description of procedure, including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration.
2. Comply with Sections 3 and 4 of AWWA C652-19
3. Submit plan for disposal of disinfection water.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements:

D. Certify that disinfectants meet or exceed AWWA C652-19 requirements:

E. Test and Evaluation Reports: Indicate results of bacteriological and residual chlorine laboratory test reports.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statement:

1. Submit qualifications for applicator.

1.4 QUALITY ASSURANCE

A. Perform Work in compliance with AWWA C652.

B. Maintain one copy of each standard affecting Work of this Section on Site.

1.5 QUALIFICATIONS

A. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store disinfectants according to manufacturer's recommendations and in a cool, dry place away from combustibles such as wood, rags, oils, and greases.

C. Handle disinfectants according to manufacturer's safety precautions.

PART 2 PRODUCTS

2.1 DISINFECTANTS

A. Provide Chlorine Forms: According to AWWA C652, Section 4.

PART 3 EXECUTION

3.1 EXAMINATION

A. Volume 1 – Section 400 General Conditions – 108.2.00 Samples, Testing and Inspection.

B. Inspection:

1. Conduct inspection of tank interior before beginning disinfection.

2. Verify that tank is clean and free of polluting materials.

3. Verify that tank pipe and vent connections are properly made and clear of obstructions.

4. Verify that paint is thoroughly cured according to paint manufacturer's instructions.

3.2 PREPARATION

A. Furnish personnel working inside tank during disinfection with equipment to comply with Federal and state regulations for Work conducted in a hazardous atmosphere.

B. Protect aquatic life and vegetation from damage from disinfectant solution purged from tank.

3.3 APPLICATION

A. Use any one or combination of the following three methods for disinfecting tank according to AWWA C652, Section 4.

1. Chlorination Method 1.

2. Chlorination Method 2.

3. Chlorination Method 3.

B. Disposal.

1. Neutralize disinfectant solution before disposal.

2. Legally dispose of disinfection solution off Project Site or as agreed with the Engineer. Owner will allow discharge into the adjacent storm system.

C. Repair damage caused by disinfectant solution and disinfection procedures.

3.4 QUALITY CONTROL

A. Volume 1 – Section 400 General Conditions – 108.2.00 Samples, Testing and Inspection.

B. Sampling

1. Collect samples of water from filled tank for bacteriological analysis according to AWWA C652, Section 5.

2. Take inlet and outlet water samples.

C. Test water samples for bacterial contamination, residual chlorine according to State of Oregon health standards for potable water.

D. If water samples fail to meet state health standards for potable water, perform the following corrective measures until water quality complies with state health standards:

1. Inlet and Outlet Water Sample Failure: Eliminate source of contamination in water supply, repeat disinfection, and retest water quality.

2. Outlet Water Sample Failure: Repeat disinfection and retest water quality.

END OF SECTION

SECTION 33 05 00 - PIPE, VALVES, AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

Section includes: All piping, including fittings, valves, supports, and accessories as shown on the Drawings, described in the Specifications, and as required to completely interconnect all equipment with piping for complete and operable systems, including equipment drains. Work also includes complete mechanical installation for all flow, level, and analytical instruments provided by the Owner.

1.2 SUBMITTALS

A. Product Review Shop Drawings:

1. Verify by excavation, inspection, and measurement all installation conditions for pipe before preparation of Shop Drawings. Submit field measurements and photographs with Shop Drawings where exposed conditions are significantly different than indicated on the Drawings.

2. Layouts and schematics: Submit detailed installation drawings of all piping. Schematics may be submitted for piping 4 inches and smaller. The drawings shall include pipe support locations and types, if different than shown on the Drawings and specified, all fittings, valves, and other appurtenances.

3. Submit pipe, fittings, and joint fabrication details for welded steel pipe.

4. Fabricated pipe supports and other pipe supports as required herein.

B. Product Information Submittals:

1. Submit data to show the following items conform to the specification requirements:

   a. Pipe, fittings, and accessories except welded steel pipe.

   b. Flexible couplings and flanged adapters.

   c. Valves and accessories, except valves 4 inches and larger, pressure control valves, and flow control valves.

   d. Submit certified test reports as required herein and by the referenced standard specifications.

2. Samples:

   Solder and flux for copper pipe.

1.3 QUALITY ASSURANCE

A. All materials and equipment furnished under this Section shall be of a manufacturer who has been regularly engaged in the design and manufacture of the materials and equipment for a period of at least 5 years. Demonstrate to the satisfaction of the Engineer that the quality is equal to the materials and equipment made by those manufacturers specifically named herein, if an alternate product manufacturer is proposed.

B. Factory Quality Control: The Contractor shall test all products as required herein and by the reference specifications.

C. Field Quality Control:

1. The Owner's representative will:

   a. Inspect field welds and test the welds if it is deemed necessary.

2. The Contractor will:

   a. Perform leakage tests
   b. Be responsible for the cost of additional inspection and retesting resulting from noncompliance.

1.4 APPURTENANCES

Furnish and install all necessary guides, inserts, anchors, and assembly bolts; washers and nuts, hangers, thrust blocks, supports, gaskets, and flanges; all other installation and operation of the piping; devices included or on the piping equipment; and piping accessories.

1.5 PIPE SUPPORTS

A. General:

1. Piping less than 6 inches: Pipe supports are generally not shown for piping less than 6 inches in diameter. Where supports are not shown, it shall be the Contractor's responsibility to support all such piping in accordance with the design criteria stated hereinafter and the support details shown on the Drawings. Piping 2-1/2 inches and larger and all piping for hazardous chemicals shall be supported with pipe supports designed to resist seismic loads, as indicated on the pipe support details listed below. Hazardous chemical piping includes chlorine gas, chlorine solution, polyphosphates, HMO and sodium fluoride. Piping smaller than 2-1/2 inches with non-hazardous contents may be supported with non-seismic resistant supports.

2. Shop drawings: Submit layout drawings, schematics, and design calculations to demonstrate that support systems that are not as shown on the Drawings are in accordance with the design criteria.

3. Where not detailed or otherwise indicated, pipe support types and spacing shall be in accordance with the Manufacturer's Standardization Society (MSS) Standard Practice No. SP-69, except as superseded by the requirements of these Specifications. Submit drawings of pipe supports that are not as detailed on the Drawings.

B. Pipe Support System Design:

1. Design loads: Pipe suspension shall be such as to prevent excessive stress or excessive variation in support force while system is in operation. Pipe supports shall support the sum of the weight of the pipe, fittings, appurtenances, and contents. In addition, the pipe shall be anchored to resist internal pressure forces tending to separate any unrestrained joint at pressures 1-1/2 times the maximum working pressure for the applicable service.

2. Seismic loads: Seismic loads, expressed as a percentage of the weight of the contributing length of pipe, fittings, appurtenances, and contents, are to be calculated in accordance with structural engineer's recommendations. Assume concurrent loading in 3 orthogonal directions.

3. Location: All piping shall be supported in a manner that will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, at all nonrigid joints, and where otherwise shown. Where piping connects to equipment, it shall be supported by a pipe support and not by the equipment.

   a. Maximum support spacing shall conform to the following table:

Pipe Size (Inches)	Pipe Material	Maximum Spacing (Feet)
¾ and smaller	Iron or Steel Copper Plastic Tubing	6 4 ½ continuous continuous
1	Iron or Steel Copper Plastic	6 4½ 2
1 ¼ to 2	Iron or Steel Copper or Plastic	8 5
2 ½ to 4	Iron or Steel Copper or Plastic	10 6

b. Piping penetrations through concrete walls and slabs are considered to resist seismic loading, provided penetrations for pipes 3 inches in diameter and larger are complete with wall flange.

c. Branch piping is not considered to provide resistance to seismic forces.

4. Anchors: Anchors for connecting pipe supports to concrete shall be in accordance with Section 05120.

5. Thermal expansion allowance:

a. Provide one rigid pipe support for each straight run of pipe between each pair of flexible couplings, flexible connectors, or expansion loops

b. Provide vertical support only, that is, no lateral support, within 4 feet of an angle or tee for pipes listed above.

PART 2 PRODUCTS

2.1 GENERAL

A. Pipe and valve sizes are nominal inside diameter unless otherwise noted.

B. Construct vents of materials specified for the pipe system for which they serve.

C. All materials delivered to the job site shall be new, free from defects, and marked to identify the material, class, and other appropriate data such as thickness for piping.

D. Acceptance of materials shall be subject to strength and quality testing in addition to inspection of the completed product. Acceptance of installed piping systems shall be based on inspection and leakage tests as specified hereinafter.

E. All materials coming into contact with potable water shall be NSF approved.

2.2 GENERAL MATERIAL REQUIREMENTS

A. Gaskets: Unless specifically specified otherwise, all gaskets shall be chlorine resistant neoprene.

B. Bolts and Tie Rods: Unless specifically specified otherwise herein, all T-head bolts and nuts, and Tie Rods supplied for mechanical joint fittings, valves, sleeves, couplings, hydrants, tapping sleeves, etc. shall be as follows:

1. Made of high-strength, low alloy steel, conforming to ANSI/AWWA C111 Corrosion-resistant steel (“Cor-Ten”) or

2. Ductile Iron of ASTM A536 specially alloyed and heat treated conforming to ANSI/AWWA Standard C111/A21.11.

3. The rods and nuts for hydrant laterals, etc., shall be made of high strength, low alloy steel conforming to ANSI/AWWA C111 ("Cor-Ten"), unless specified otherwise in the Drawings or Special Provisions.

C. Flexible Sealant: Flexible sealant for pipe joints, where shown on the Drawings, shall be a 2-component polysulfide, non-sag; Sikaflex 412, Dualthane, or equal.

D. Piping: unless specified otherwise, cement lined CL 52 DI with high solids epoxy coating applied to commercial blast prepared pipe. (i.e. Ameron Amerlock, Tnemec Series 66)

E. Flanged Flow meters:

1. Sparling Tiger Mag or approved equal

2.3 PIPING MATERIALS

A. Piping Identification Schedule: Piping systems and their corresponding piping and valve systems are listed below.

<u>Material</u>

Cu	Copper
DI	Ductile Iron
PVC	Polyvinyl Chloride
SS	Stainless Steel

<u>Service</u>

B	Buried	In contact with soil
C	Concrete	Encased in contact with concrete
E	Exposed	In contact with the atmosphere
S	Submerged	Continuously or intermittently in contact with water.

B. Pipe Schedule: Pipe material, joints, and fittings shall be as summarized below. A detailed Specification of each pipe type follows. (The detailed Specification supersedes the schedule in case of any conflicts.) For fire sprinkler piping requirements see Section 15330.

Pipe Type	Pipe Material	Field Joints	Fittings
Cu	Copper	Solder or Flare	Wrought Copper or Bronze
PVC-Process	PVC, Schedule 80	Solvent Weld	PVC
PVC-Drain	PVC Drain, Vent, and Waste		PVC
SS	Stainless Steel	Welded, flanged where shown	Stainless Steel
DI	Ductile Iron	Bell & Spigot (buried) Flanged or Victaulic (exposed)	DI or CI CI or CI

2.4 COPPER PIPE

A. Pipe: Copper, ASTM B 88.

1. Buried: Type K (soft drawn).
2. Exposed: Type L (hard drawn).

B. Joints:

1. Buried: Soldered or flared.
2. Exposed: Soldered.

C. Solder: ASTM B 32, alloy grade E or HB. Solder and flux shall contain less than 0.2 percent lead.

D. Fittings:

1. Soldered: Wrought copper, ANSI B16.22; or cast bronze, ANSI B16.18.
2. Flared: AWWA C800 and ANSI B16.26

2.5 PVC PIPE – PROCESS

A. Pipe: Schedule 80 polyvinyl chloride (PVC), gray, normal impact, Type 12454 B, ASTM D 1785. Pipe shall bear the National Sanitation Foundation (NSF) label.

B. Joints: Solvent weld, except flanged or threaded permitted where required at equipment connections and where required on the Drawings.

C. Fittings: Schedule 80, ASTM D 2467, solvent weld, socket type, of same material as the pipe.

D. Cement: Solvent weld, ASTM D 2564, as recommended by the pipe manufacturer for the schedule and size to be joined. Primer shall be listed by AIPMCO-UPC and NSF, and shall be recommended by the pipe manufacturer.

E. Pipe Cleaner: As recommended by the pipe manufacturer for the schedule and size to be joined.

2.6 PVC PIPE – DRAIN, WASTE, AND VENT

A. Pipe and Fittings: Polyvinyl chloride drain, waste and vent, ASTM D2665. Fitting patterns, ASTM D3311.

B. Joints: Solvent weld.

C. Cement: Solvent cement, ASTM D2564, as recommended by the manufacturer.

2.7 STAINLESS STEEL PIPE

A. Pipe: Stainless steel, ASTM A 312, TP 316L, Schedule 40S.

B. Joints: Butt welded except where flanges are required adjacent to valves or equipment.

C. Fittings: Wrought stainless steel, ASTM A 182, TP316L, ANSI B16.9 and B16.11 for dimensions.

D. Flanges: Welding neck or slip-on, raised face, ASTM A 182, WP316L. ANSI B16.5 for dimensions. Class 150, drilling to match adjacent accessories or valves.

E. Gaskets: Full-face gasket per ANSI B16.21, non-asbestos gasket.

2.8 DUCTILE IRON PIPE – PUSH-ON AND MECHANICAL JOINT

A. Pipe: Ductile iron, AWWA C151

1. Thickness:

Pipe Size (inches)	Thickness Class
3-12	52

B. Joints: Push-on or mechanical, AWWA C111.

C. Fittings: Ductile iron.

1. Push-on joints, AWWA C110.

2. Mechanical joints, AWWA C110 or AWWA C153.

3. Mechanical joint restraint shall be incorporated in the design of the follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Flexibility of the joint shall be maintained after burial. Glands shall be manufactured or ductile iron conforming to ASTM A536-80. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA C153/A21.53 or the latest revision. Twist-off nuts, sized same as tee-head bolts, shall be used to insure proper actuating of restraining devices. The mechanical joint restraint device shall have a working pressure of at least 250-psi with a minimum safety factor of 2:1 and shall be EBAA Iron, Inc., 1100 Series Retainer or approved equal.

4. All fittings shall have cement-mortar lining conforming to ANSI/AWWA C104.

D. Lining: Cement-mortar lined per AWWA C104.

E. Coating: Standard asphaltic coating. Aboveground pipe shall be painted in accordance with SECTION 09 90 00- PROTECTIVE COATINGS.

2.9 DUCTILE IRON PIPE – FLANGED

A. Pipe: Ductile iron.

   1. Flanged pipe: AWWA C115 including Appendix A, minimum thickness Class 53.

B. Joints: Flanged

C. Flanges: Ductile iron, plain faced, AWWA C115. Submit certification that flanges comply with AWWA C115.

D. Fittings:

   1. Flanged: Ductile iron, AWWA C110.

   2. Special fittings: Special fittings not available in ductile iron pipe may be fabricated of fusion epoxy lined and coated welded steel pipe with a design pressure of 450 psi. Submit design and wall thickness to the Engineer for review.

E. Lining: Cement mortar-lined per AWWA C104.

F. Coating:

   1. Exposed pipe: Provide coating of material and thickness compatible with topcoat of System 4 epoxy or remove asphaltic coating as specified in SECTION 09 90 00 – PROTECTIVE COATINGS.

   2. Buried pipe: Provide standard asphaltic coating.

G. Gaskets: Flanged: Full-face, 1/8-inch thick chloroprene, AWWA C115, Appendix A.

H. Pipe Taps:

   1. Direct threaded taps shall engage a minimum of four full threads. Ductile iron 6 inches and larger may be direct tapped with taps 1 inch and smaller. Use bossed fittings when tapping fittings with taps up to one inch in diameter. In other cases, use service saddles for tapping or use reducing flanges on tees, or by tapping blind flanges on tees.

   2. Service saddles:

      a. Materials: Ductile iron saddle with electro-galvanized straps and hardware, and neoprene gaskets.

      b. Type: For ductile iron pipe 4 inches and less, single-strap saddles may be used. For pipe greater than 4-inch, double-strap saddles shall be used.

      c. Manufacturers: Smith Blair Model 311 or 313; R. H. Baker and Company Series 180-0; or equal.

3. Corporation stops: ¾ and 1 inch, compression X Mueller thread. 1 ½ and 2 inch, AWWA X iron pipe thread, Jones J-45.

2.10 VALVES AND ACCESSORIES

A. Valve and Accessory System Designation: Most valves and accessories to be furnished and installed are identified by a model number and manufacturer on the drawings.

B. General Requirements for Valves:

1. All valves of each type shall be the product of one manufacturer.

2. All valves shall be furnished with operators, handwheels, levers, or other suitable type wrench including handles as specified herein or as shown on the Drawings. Valves 4 inches and larger located more than 7 feet above the floor level shall be furnished with chain operators. Chains shall be galvanized and shall extend to within 2 feet of the floor.

3. All threaded stem valves shall open by turning the valve stem counter-clockwise.

4. All exposed valves and valve operators shall have a non-bleeding shop coat, unless otherwise specified. Buried valves and operators shall be painted as specified in Section 09 90 00.

C. General Requirements for Accessories:

Pressure gauges: Provide shutoff valves for all pressure gauges. Conform to additional requirements in this Section below.

D. Gate Valves

All Gate Valves shall conform to ANSI/AWWA Standard C509 or latest revision, Gate Valves for Ordinary Water Service.

1. All gate valves shall be non-rising stems, furnished with O-Ring stem seals. Number, size and design shall conform to Section 3.12 of the AWWA Standards for gate valves.

2. All gates shall have square operating nut that operates left (counter clockwise) to open.

3. All gates, 20-inch or larger, shall be horizontal stem, equipped with machine cut cast steel gears, extended type grease case, position indicators and bypass, all in accordance with the AWWA Specifications.

E. Butterfly Valves

All butterfly valves shall conform to AWWA C504-80 for Rubber Seated Butterfly Valves, Class 150B.

F. Pressure Relief and Pressure Sustaining Valves

1. The valve shall maintain a maximum upstream pressure by opening to relieve high pressure. Pilot control system shall operate such that as excess line pressure is dissipated, the valve shall slowly close. The pressure-relief pilot control shall be adjustable over a range of 20 to 200 psi. Provide strainer, three isolation valves, and opening speed control in the pilot control piping and tubing. Flanges shall be Class 250, ASME B16.1. The valve shall be globe angle pattern. Valves shall be Cla-Val Series 50-01, Cla-Val 50-90, Bermad Model 730, Ross Model 50-RWR, Watts 116, or equal.

G. Check Valves

1. For pump check valves, provide restrained dismantling joint (ROMAC DJ400 or approved equal) at pump base.

2. Check Valve for Booster Pump 1 and Booster Pump 2 shall be:

   a. Flanged end, cast-iron body, bronze mounted swing type, solid bronze or cast-iron disc, bronze seat ring, rated 125-pound SWG, 200-pound WOG.

   b. Manufacturers and Products:

      1) Stockham G-931; List 37, Clearway Check Valve

      2) Crane Co.; Cat No. 373

3. Check Valves for Fire Pumps shall be:

   a. Cast iron swing check valves 2 1/2 inches and larger for Fire Protection Service:

      1) Swing check valves of sizes 2 1/2 through 12 inches for fire protection service shall be UL listed, FM approved, rated for at least 175 psi nonshock, cold water.

      2) Ends shall be flanged, Class 125 ASME B16.1. Materials of construction shall be as follows:

Description	Material	Standards
Body and cap	Cast iron	ASTM A126, Class B
Disc	Bronze or cast iron	ASTM B62; ASTM B584, Alloy C83600; or ASTM A126, Class B
Disc bushing, disc ring, and seat ring	Bronze	ASTM B62; or ASTM B584, Alloy C83600
Hinge pin	Brass	ASTM B16 or ASTM B21

3) Valves shall be Stockham G-939, Walworth Figure 8883F, Nbco F-908, or approved equal.

H. Combination Air/Vacuum Valves:

1. Combination air/vac valves for pumping stations shall be:

a. 1/2-inch through 3-inch NPT inlets and outlets, 4-inch and larger ASME B16.1 Class 125 flanged inlet with plain outlet and protective hood.

b. Rated 150 psi working pressure, cast iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.

c. Manufacturers and Products:

1) APCO Valve and Primer Corp.; Series 140 or 150

2) Val-matic Valve; Series 100

2. Degas Relief Valve:

a. Degas separators shall include degas relief valve as recommended by the manufacturer.

2.11 MISCELLANEOUS ACCESSORIES

A. Valve Boxes for Buried Valves: Cast Iron valve boxes and lids shall be as indicated on the drawings. All buried valves shall be provided with a valve box and lid with an extension of cast iron soil pipe as necessary. The Contractor shall maintain the location and provide access to all valves within the project. No valve shall remain buried during construction.

B. Valve Tags: Plastic, fiberglass, or plastic material, 2-inch square with grommeted hole. The tags shall be attached to valves with a brass jack chain. For buried installations use a nylon strap. Lettering shall be the P&ID Tag number and shall be stamped or cut into the tag at least 3/16-inch high.

2.12 PIPE SUPPORTS

A. Manufacture and Design: Pipe supports shall to the maximum extent possible be standard factory fabricated units conforming to the typical supports and braces shown in the Drawings and as specified below. Where required support cannot be provided by standard factory fabricated units, and are not detailed on the Drawings, the Contractor shall provide special pipe supports. For all pipe supports which are not defined by specific designs shown on the Drawings, the Contractor shall provide design calculations for favorable review. These design calculations shall justify the selection and confirm the design adequacy. Supports shall be manufactured or special fabrications or combination as shown on the Drawings or specified. Special fabrications shall be in conformance with Section. Provide ¾-inch chamfer on corners of all support elements and file or grind smooth. Supports designated to allow axial pipe movement shall have smooth and even contact surfaces.

B. Materials: All support systems shall be galvanized steel except those that are submerged or located within a tank, channel, or other structure designed to hold water, below the surrounding walkway elevation or tank wall top, or otherwise called out on the Drawings, shall be Type 304 stainless steel. Trays for continuous support of plastic pipe or tubing shall be made of 20 gauge galvanized steel.

C. Plastic Piping Support Saddles: Provide a one-half section of the next larger plastic pipe under the plastic pipe where it bears on a pipe support six inches each side of the support. Take a section of the next pipe size and split it in half lengthwise. Solvent weld one of the sections to the plastic pipe where it bears on the support.

PART 3 EXECUTION

3.1 PIPING INSTALLATON

A. General Handling and Placing:

1. Exercise great care to prevent injury to or scoring the pipe lining and coating, as applicable, during handling, transportation or storage. Do not store pipe on rough ground and do not roll the pipe on the coating. Any damaged pipe sections, specials, or fittings shall be repaired or replaced at the expense of the Contractor as satisfactory to the Engineer.

2. Carefully inspect each pipe fitting, valve and accessory before installation. Inspect the interior and exterior protective coatings and patch all damaged areas in the field or replace to the satisfaction of the Engineer.

3. Place or erect all piping to accurate line and grade and backfill, support, hang, or brace against movement as specified or shown on the Drawings, or as required for proper installation. Remove all dirt and foreign matter from the pipe interior prior to installation and thoroughly clean all joints before joining.

4. Use reducing fittings where any change in pipe size occurs. Do not use bushings unless specifically noted on the Drawings. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and floors.

5. Cast pipes penetrating new concrete wall into the wall without blockout. Pipes may be cast-in-place or blocked out at the Contractor’s option. Maintain at least ½-inch clearance between reinforcing steel and metal pipe in penetrations.

6. Cover polyvinyl chloride pipe stored outside for more than six months with canvas or other opaque material. Provide for air circulation under the covering.

7. See Section 15400 for additional requirements.

8. Make connections between ferrous and nonferrous piping and accessories with a dielectric coupling, union, or flange.

B. General Buried Piping Installation

1. Trenching, bedding, and backfill for buried piping shall be as written below and as specified on Drawings.

   Backfill shall be selected excavated material free of rocks over six inches, wood, trash, concrete, asphalt, or other unsuitable material. Excavated material, which will not readily compact to form solid, dense backfill, will be rejected by the inspector. Surplus suitable material from other parts of the job can be used as backfill when available. Bankrun sand and gravel shall be furnished to make up any deficiency in the available excavated material. Backfill between bellholes or joints may be started as soon as the joints are made up, but all joints shall be left exposed until after the inspection and pressure test or approved by Inspector.

2. Where pipe grade elevations are shown on the Drawings, install the pipe with straight grades between the indicated elevations.

3. Where no pipe grade elevations are shown on the Drawings, install buried piping with at least 3 feet of cover to finished grade. Where piping crosses under buried electrical ducts, provide at least 4 feet 6 inches of cover. Provide 12 inches minimum separation between the buried pipes and ducts.

4. Provide each pipe with a firm, uniform bearing for its full length in the trench except at field joints. Do not lay pipe in water or when trench conditions or weather are unsuitable for such work

5. Protect buried piping against thrust by use of restrained pipe joints and/or thrust blocks. All exposed free pipe ends shall be securely braced. Cap or plug pipe ends that are left for future connections as shown on the Drawings and in a manner favorably reviewed by the Engineer.

6. Where piping leaves a structure or concrete encasement, provide a joint capable of angular deflection within 36 inches of the structure.

7. Concrete Encasement: All piping and conduits installed under slabs or footings on earth or crushed rock shall be encased in concrete not less than 6-inch thickness on all sides and extending up to the bottom of the slab or footing, unless otherwise specifically noted on the Drawings. Encasement shall extend to within 6 inches of

the first pipe joint beyond the slab or footing. This requirement for concrete encasement applies to all piping (including tubing, plumbing, and drains) and to all electrical conduits and ducts. Provide concrete encasement whether or not the encasement is shown on the Drawings. Provide encasement under slabs on earth or crushed rock even if the structure is supported on piles, caissons, or footings. Provide continuous concrete cradles where shown.

8. Do not pull bell and spigot, gasketed joints more than 50 percent of the maximum deflection permitted by the pipe manufacturer.

9. Snake buried PVC pressure pipe from side to side of the trench in long sweeps.

C. General Exposed Piping Installation

1. Unless shown otherwise, install piping parallel to building lines, plumb and level.

2. Install piping without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.

3. Set all pipe flanges level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipe. All bolt holes in flanges shall straddle vertical centerline of pipes.

4. Flexibility and Expansion: Provide flexible couplings, flexible hose, or flexible spools for all piping connections to motor driven equipment and where otherwise shown. The Contractor may install additional flexible couplings at favorably reviewed locations to facilitate piping installation, provided that he submits complete details describing location, pipe supports, and hydraulic thrust protection.

5. Install unions or flexible connections where shown on the Drawings, and at all non-motor-driven equipment to facilitate removal of the equipment.

6. Provide valves where ever equipment drain connections are furnished and carry the discharge pipe to the nearest floor drain, drain trench or sump. Where no receptacle for drain exists, install drain piping to one inch above the floor. Drain piping and valve materials shall conform to the requirements of the system served.

7. Where piping conveying liquids passes over motor control centers, electrical panels and other electrical panels, install a protective drainage tray below the piping.

D. Pipe Welding:

1. General: Unless specified otherwise, shop and field welding of pipe shall conform to ANSI B31.1 as amended by this paragraph.

2. All field and shop welding shall be done by the electric arc process unless otherwise specified. All field welding shall be done in passes not thicker than ¼-inch. Size and type of electrodes, and current and voltages used, shall be subject to the favorable review of the Engineer. Give particular attention to the alignment of edges to be joined, so that complete fusion and penetration will be effected throughout the bottom of the weld. Welds shall contain no valleys or undercuts in the center or edges of the weld. Thoroughly clean each pass, except the final one, of dirt, slag, and flux before the succeeding bead is applied.

3. Clean completed field welds of pipe joints of dirt, slag and flux, and then visually inspect. Completely chip out all defects in welds discovered during field inspection in a manner which will permit proper and complete repair by welding subject to the favorable review of the Engineer. Under no circumstances will caulking of defective welds be permitted.

4. All welding shall be done by experienced, skilled operators familiar with the methods and materials to be used. Hand welding will be done only by welders qualified under the standard qualification procedure of Section IX of the ASME Boiler and Pressure Vessel Code. The Contractor shall conduct tests of his welders, when required by the Engineer, in accordance with that code and in the presence of the Engineer. An independent testing laboratory, favorably reviewed by the Engineer, shall supervise the testing and determine the quality of the test work. Weld specimens in the same positions as those in which the welder is to qualify his work. The Engineer may require test specimens at any time. Any welder whose work is found unsatisfactory shall not remain employed on this contract, regardless of the quality of his earlier work. Each hand weld specimen shall be plainly marked with the welder's identifying symbol. The Contractor shall furnish all materials required and pay all costs for qualifying welders.

5. Field welds shall follow as closely as possible to the laying operation. All field welds shall be complete before lining or coating of the joints in steel pipe is begun.

6. A single, continuous, watertight, full fillet weld shall be the minimum required at all field joints. Double weld joints will be required on all piping specifically noted to be double welded.

E. Copper Pipe:

1. Except as modified below, install per the International Association of Plumbing and Mechanical Officials (IAPMO) Standard IS 3-89.

2. Bends shall be made in a manner that does not crimp or flatten pipe.

3. Dielectric unions shall be installed at connections with ferrous piping.

4. Pipe shall have joints squarely cut clean, soldered joints shall be properly fluxed and heated before solder is placed in the joint. Joints must be driven up tight before the solder is added. Compression and flared joints shall be made up in accordance with the fitting manufacturer's installation instructions. Brazing shall be in accordance with ANSI B31.1.

5. Install so tubing is free to expand. Provide for all necessary expansion with offsets, loops, or expansion fittings where necessary.

6. All changes in direction shall be made with fittings. All radii shall be long radii.

7. Arrange tubing so as not to interfere with access or removal of equipment or devices, block access to doors, windows, or other access openings.

8. Arrange tubing so as to facilitate the removal of fixtures and equipment. Provide unions ahead of screwed valves, strainers, and on each side of each piece of equipment, and wherever needed to dismantle tubing.

9. Grade all tubing to drain to a low point.

10. Provide an accessible blind flange or screwed plug to cap at each low point.

11. Install tubing in a neat and workmanlike manner, in accordance with the best trade practice. Install to conserve headroom and interfere as little as possible with use of space. Run exposed tubing parallel to wall unless otherwise shown. Where possible group runs and risers.

12. Install concealed pipes in wall with clearance around piping to prevent contact with structure.

F. PVC Pipe:

1. Place PVC pipe and CPVC pipe within the installation areas at least 24 hours prior to installation to permit temperature equalization.

2. Cut pipe ends squarely, ream and deburr inside and out.

3. Installation standard: Install PVC and CPVC pipe in conformance with IAPMO IS 8-89. Install PVC drain, waste, and vent piping in conformance with IAPMO IS 9-90.

4. Solvent weld joints: Pipe ends and sockets shall be cleaned and joined in strict conformance with ASTM D 2855 and the pipe manufacturer's instructions. Handle solvents and primers in accordance with ASTM F 402.

5. Screwed joints: Screwed connection shall use a short nipple, threaded at one end, socket at the other. Teflon tape shall be wrapped around the threads.

6. Grade condensate drain piping at ¼ inch per foot.

G. Stainless Steel Pipe: Install and weld in accordance with ANSI B31.1

H. Ductile Iron Pipe, Push-on or Mechanical Joint:

1. Install buried pipe in accordance with AWWA C600.

2. Support and brace encased pipe to support the pie and to prevent movement during testing and placement of the concrete encasement. The braces and supports shall be erected of materials and by methods which will prevent any future contact of the pipe with the environment surrounding the encasement.

3. Install restrained joints in accordance with the manufacturer's instructions.

I. Ductile Iron Pipe, Flanged:

1. Flanged joints: Flanged joints shall be made up tight with care being taken to avoid undue strain in the flanges, fittings, and other accessories. Bolt holes shall be aligned for each flanged joint. Bolts shall be full size for bolt holes; use of undersize bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted.

2. Adjoining flange faces shall not be out of parallel such a degree that the flanged joint cannot be made watertight without overstraining the flange.

3. Any flange pipe or fitting whose dimensions do not allow the making of a proper flanged joint as specified herein shall be replaced by one with the proper dimensions.

4. Clean flanges before jointing is started.

5. Buried flanged pipe connections shall be made with the smallest practical "bell" hole. After the joint is completed take special care to completely fill the "bell" hole under and around pipe with compacted backfill.

6. All flanged fittings will have 1/8" thick drop in gaskets.

3.2 INSTALLATION OF VALVES AND ACCESSORIES

A. Install valves in accordance with the manufacturer's recommendations and details shown on the Drawings. Install valves and accessories such that all parts are easily accessible for maintenance and operation.

B. The valve stem orientation shall be as approved by the Engineer for accessibility, but no valve shall have the stem in the downward direction. In general, orient the valve shaft in the same plane as the upstream elbow's radius. Where valve handwheels are shown on the Drawings, valve orientation shall be as shown. Where valve handwheels are not shown, orient valves to permit easy access to the handwheels or handles and to avoid interferences.

C. Install pressure gauges and thermometers in a position to permit reading them from a point approximately 5 feet above floor level.

D. Rigidly support pressure switches and connect them to piping and equipment using a suitable flexible linkage that will not permit transmission of vibrations from the piping or equipment to the pressure switches.

E. Install a union adjacent to each screwed end valve and accessory with additional unions as necessary to facilitate removal.

F. Install a valve below each pressure gauge or protective devices unless otherwise specified.

G. Wherever a solenoid valve or modernized ball valve is shown on the Drawings or required by the Equipment supplied, it shall be electrified as required at no additional cost. Minimum conduit size shall be ¾-inch with flexible connector at valve, and minimum wire size shall be 2-#12 with ground.

H. Connections between ferrous and non-ferrous piping, valves, accessories or pipe supports shall be made using a dielectric coupling, union, or flange.

I. All insulated piping passing through walls or slabs shall be sleeved and insulation shall run continuously through the sleeves and shall allow for 1/8-inch annular clearance between outside of insulation and sleeve wall.

J. Install a suitable chrome plated escutcheon on pipes passing through slabs or walls in finished areas.

K. Use reducing fittings where any change in pipe size occurs. Do not use bushings unless specifically noted on the Drawings. Use eccentric reducing fittings wherever necessary to provide free drainage of lines. Each piece of pipe and each fitting shall be carefully inspected to see that there is no defective workmanship on pipe, or obstructions in pipes and fittings. Anchor piping subject to expansion or contraction in a manner permitting strains to be evenly distributed. Sleeves for branches through wall from adjacent mains shall be of sufficient size to allow for free side motion of covered pipe in sleeves.

L. Install butterfly valves in accordance with AWWA C504, Appendix B, Sections B.2 thorough D.5, inclusive.

M. Aboveground valves shall be rigidly held in place using supports and hangers as shown on the Drawings and as specified.

N. Buried piping shall be firmly supported in place by the foundations to preclude strain on the pipe connections. Valve boxes shall be checked for countering plumb over the wrench nut to ensure that the box will not transfer any shock or stress to the valve and to ensure that the box cover is flush with finish grade. Earth backfill shall be carefully tamped around each valve box to a distance of four feet on all sides of the box, or to undisturbed trench face if less than four feet. Valves shall have their interiors cleaned of all foreign matter before installation. The valves shall be inspected in opened and closed positions to ensure that all parts are in working condition.

3.3 INSTALLATION OF PIPE SUPPORTS

A. General

1. Install and adjust supports for each pipeline such that the pipeline is true to the indicated line and grade.

2. Locate anchors and braces for any single support on a continuous structure; that is, not on two sides of a structural expansion joint.

B. Electrolytic Protection: Pipe supports serving copper pipe or tubing shall be dielectrically insulated from the pipe by dielectric sleeves of plastic pipe wrap at the point of contact.

3.4 PIPE AND VALVE IDENTIFICATION

A. General: Identify all exposed piping in this project by painting, banding, system name labels, and direction arrows. The color and banding shall be per Sections 09 90 00 and 10 40 00. Identify all buried valves with tags as specified below.

B. Exposed Pipe Identification: Before paining, banding and labeling, pipes shall be identified by the Contractor with temporary wired-on cardboard tags showing the proposed marking for review by the Engineer.

C. Piping: Paint all exposed pipes (except plastic and stainless steel) with the appropriate paint system as specified in Section 09 90 00.

D. Valves: Provide each buried valve with a valve tag identifying the pipeline contents, valve number, and the area or item served by the valve. Contents shall be as designated in the Piping Schedule.

3.5 CLEANING

Prior to testing, thoroughly clean the inside of each completed piping system of all dirt, loose scale, sand and other foreign material. Cleaning shall be by sweeping, flushing with water or blowing with compressed air, as appropriate for the size and type of pipe. Flushing shall achieve a velocity of at least 3 feet per second. The Contractor shall install temporary strainers, temporarily disconnect equipment or take other appropriate measure to protect equipment while cleaning piping.

3.6 FIELD TESTING

A. General: Perform leakage tests on all pipe installed in this project. Furnish all equipment, material, personnel and supplies to perform the tests and shall make all taps and other necessary temporary connections. The test pressure, allowable leakage and test medium shall be as specified and as shown in the following Schedule. Test pressure shall be measured at the highest point on the line unless specifically noted otherwise. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Engineer.

B. Buried Piping: The leakage test for buried piping shall be made after all pipe is installed and backfilled. However, the Contractor may conduct preliminary tests prior to backfill. If the contractor elects to conduct preliminary tests, provide any necessary temporary thrust restraint.

C. Exposed Piping: All supports, anchors and blocks shall be installed prior to the leakage test. No temporary supports or blocking shall be installed for the final test.

D. Encased Piping: The leakage test for encased piping shall be made after all pipe is installed and encased, and before any structures are constructed above it. However, the Contractor may conduct preliminary tests prior to encasement. If the Contractor elects to conduct preliminary tests, provide any necessary temporary thrust restraint.

E. Accessories: It shall be the responsibility of the Contractor to block off or remove equipment, valves, gauges, etc., which are not designed to withstand the full test pressure.

F. Testing Apparatus: Provide pipe taps, nozzles and connections as necessary in piping to permit testing including valves to isolate the new system, addition of test media, and draining lines and disposal of water, as is necessary. These openings shall be plugged in a manner favorably reviewed by the Engineer after use. Provide all required temporary bulkheads.

G. Pneumatic Testing: Piping tested by air or another gas shall show no reduction of pressure during the test period after corrections have been made for changes in temperature in conformance with the following relationship:

$$\frac{{}_{1}}{T_1} = \frac{P_2}{T_2}$$

H. Precautions for Pneumatic Testing: Where gas is called for as the test medium, the Contractor shall take special precautions to protect personnel. During the initial pressurization of a pipeline to the specified test pressure, personnel shall be protected by suitable barricades or shall remove themselves to locations where portions of the concrete structure itself are between them and the pipeline under test.

I. Correction of Defects: If leakage exceeds the allowable, the installation shall be repaired or replaced and leakage tests shall be repeated as necessary until conformance to the leakage test requirements specified herein have been fulfilled. All visible leaks shall be repaired even if the pipeline passes the allowable leakage test.

J. Drying: Gas lines tested with water shall be drained and blown dry.

K. Reports: The Contractor shall keep records of each piping test, including: Description and identification of piping tested

1. Test Pressure
2. Date of test
3. Witnessing by Contractor and Engineer
4. Test evaluation
5. Remarks, to include such items as:
    a. Leaks (type, location)
    b. Repairs made on leaks

    Test reports shall be submitted to the Engineer.

L. Venting: Where not shown on the Drawings, the Contractor may install valved “tees” at high points on piping to permit venting of air. Valves shall be capped after testing is completed.

M. Hydrostatic Pressure Testing Specifics: This includes testing under a hydrostatic pressure 150 psi in excess of operation pressure or 200 psi whichever is greater. Leakage is not allowed.

3.7 DISINFECTION OF WATERLINES AND FILTERS

Disinfection of the lines and filters shall be done in accordance with AWWA C651-99 and C652-99.

Before disinfection, the facilities shall be cleaned and flushed with potable water.

For wells, valves, pumps, water mains and service connection, a chlorine solution with a free chlorine residual of 25 mg/l shall be introduced into the system in a manner that will result in a thorough wetting of all surfaces and discharge of all trapped air. The solution shall remain in place for 24 hours. After the 24-hour period, the free chlorine residual shall be checked, and if it is found to be 10 mg/l or more, the chlorine solution shall be drained, the facility flushed with potable water and a minimum of one sample shall be collected from the facility for microbiological analysis. If the results of the analysis indicate that the water is free of coliform organisms, the facility may be put into service. If the check measurement taken after the 24-hour contact period indicates a free chlorine residual of less than 10 mg/l, the facilities shall be flushed, rechlorinated and rechecked until a final residual of 10 mg/l or more is achieved. Likewise, if the microbiological analysis indicates the presence of coliform organisms, the flushing and disinfection must be repeated until a sample free of coliform organisms is obtained.

The chlorinated solution shall be disposed of in a manner approved by the City of Harrisburg.

END OF SECTION

SECTION 33 05 13 - MANHOLES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes cast-in-place and precast concrete manholes and covers for access to subsurface drainage piping or utilities.

B. Section Includes:

1. Cast-in-place concrete manholes with transition to cover frame, covers, anchorage, and accessories.

2. Modular precast concrete manhole with tongue-and-groove joints with precast transition to cover frame, covers, anchorage, and accessories.

3. Bedding and cover materials.

1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Work
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 23 16 - Excavation
E. Section 31 23 23 - Fill
F. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M-198B – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

B. American Concrete Institute (ACI):

1. ACI 301 – Building Code Requirements for Structural Concrete
2. ACI 315 – Details and Detailing of Concrete Reinforcement
3. ACI 318 – Building Code Requirements for Structural Concrete

C. ASTM International (ASTM):

1. ASTM A48 - Standard Specification for Gray Iron Castings

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

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

4. ASTM C55 - Standard Specification for Concrete Building Brick

5. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)

6. ASTM C150 - Specifications for Portland Cement

7. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

8. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile

11. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

12. ASTM C913 - Standard Specification for Precast Concrete Stormwater and Wastewater Structures

13. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

14. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

D. Federal Specifications:

1. SS-S-00210 (210-A) – Specification for Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

E. US Army Corp of Engineers:

1. CRD-C 621 – Specifications for Non-Shrink Grout

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data:

1. Pre-cast concrete manholes:

   a. Design criteria and calculations.
   b. Details of reinforcement.

2. Steps.

3. Cover and frame construction, features, configuration, dimensions and material specifications.

4. Rubber gaskets.

5. Grout and mortar.

C. Shop Drawings:

1. Indicate manhole by location.

2. Provide dimensions, elevations, joints, location, and type of lifting inserts.

3. Indicate connecting piping material, piping size, piping connection angles and offsets, and sizes of penetrations.

D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

B. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

C. Storage:

1. Store precast concrete manholes as to prevent damage to Owner's property or other public or private property.

2. Repair property damaged from materials storage.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA FOR MANHOLES

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: According to ASTM C913.

C. Design of Joints for Precast Components:

1. According to ASTM C913.
2. Lipped male/female joints.
3. Maximum Leakage: 0.025 gallons per hour per foot of joint at 3 feet of head.

D. Shaft Construction:

1. Reinforced concrete.
2. Cone top section per Drawings.
3. Sleeved to receive pipe connections.

E. Wall Thickness:

1. Minimum wall thickness shall be 6 inches.
2. Cones shall have the same wall thickness and reinforcement as riser sections.

F. Shape: Cylindrical.

G. Clear Inside Dimensions:

1. As indicated on Drawings.

2. Sections shall consist of circular sections in standard nominal inside diameters of 42, 48, 54, 60, 72, 84, 96, 108, 120, 132, or 144 inches.

H. Design Depth:

1. As indicated on Drawings.

I. Clear Cover Opening: As indicated on Drawings, minimum of 30 inches.

J. Pipe Entry: Furnish openings as required and as indicated on the Drawings.

K. Steps:

1. Rungs:

   a. Material: Formed polypropylene with 1/2-inch diameter, Grade 60 reinforcing bar.

   b. Comply with ASTM C478.

   c. Reinforcing bar to comply with ASTM A615.

2. Formed integral with manhole sections.

3. Width: Minimum 12 inches.

4. Spacing: 12 inches on center vertically.

2.2 MANHOLES

A. Precast Concrete Manholes:

1. Sections:

   a. Description: Reinforced precast concrete according to ASTM C478.
   b. Gaskets: According to ASTM C923.
   c. Heights: Multiples of 6 inches.

2. Bases:

   a. Base slab integral with sidewalls.
   b. Monolithic construction, conforming to ASTM C478.

B. Cast-in-Place Concrete Manholes:

1. Sections: Reinforced cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.

C. Joint Materials:

1. Mortar:

   a. Conform to ASTM C387.

   b. Admixtures

      1) Allowable, not exceeding the following percentages of weight of cement:

a) Hydrated lime, 10 percent
b) Diatomaceous earth or other inert materials, 5 percent

c. Consistency: Shall be such that it will readily adhere to the precast concrete if using the standard tongue and groove type joint.

d. Mortar not used within 30 minutes of initial mixing shall be discarded and not be used.

2. Non-Shrink Grout:

a. Description: Non-metallic, cementitious, commercial grout exhibiting zero shrinkage per ASTM C827 and CRD-C-621.

b. Manufacturers:

1) Preco-Patch
2) Sika 212
3) Euco N-S
4) Five-Star
5) Approved equal

3. Grout shall not be amended with water after initial mixing.

4. Grout not used within 20 minutes of initial mixing shall be discarded and not be used.

5. Commercial Concrete Bonding Agent:

a. Non-shrink grout shall be placed or packed only with the use of an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted.

b. Bonding agent shall be compatible with the brand of grout used.

c. Water shall not be used as a substitute for the commercial bonding agent.

D. Preformed mastic gaskets for manhole joints shall meet Federal Specifications SS-S-00210 (210-A), AASHTO M-198B and ASTM C990.

E. Reinforcement:

1. Formed steel wire.

2.3 FRAMES AND COVERS

A. Description:

1. Construction: ASTM A48, Class 30B cast iron.

2. Lid:

   a. Machined flat bearing surface.
   b. Removable.

   c. Lockable at locations shown on the Drawings.

3. Cover Design: Closed.

4. Live Load Rating: AASHTO H20 loading.

5. Cover: Molded with “S” cast in.

6. Coefficient of Friction on Outside Face: Minimum of 0.60.

2.4 RISER RINGS

A. Description:

1. Four inches to 6 inches Thick:

   a. Material: Precast concrete.
   b. Comply with ASTM C478.

2. Less than 4 inches Thick:

   a. Material: Cast iron.
   b. Comply with AASHTO M306.

3. Rubber Seal Wraps:

   a. Wraps and Band Widths: Conform to ASTM C877, Type III.
   b. Cone/Riser Ring Joint: Minimum 3 inches overlap.
   c. Frame/Riser Ring Joint: 2 inches overlap.
   d. Additional Bands: Overlap upper band by 2 inches.

2.5 MATERIALS

A. Bedding and Cover:

1. Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Backfill Around Structure: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Soil Backfill from Above Pipe to Finish Grade:

    a. In existing or future roadways, right-of-way:

        1) Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

    b. In non-paved areas outside of footprint of existing or future structures, outside of right-of-way:

        1) Soil Type S2, as specified in Section 31 05 13, Soils for Earthwork.
        2) Subsoil: No rocks over 6 inches in diameter, frozen earth, or foreign matter.

2.6 FINISHES

A. Steel:

1. Galvanizing:

    a. ASTM A123.
    b. Hot dip galvanize after fabrication.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items provided by other Sections of Work are properly sized and located.
B. Verify built-in items are in proper location and ready for roughing into Work.
C. Verify correct size of manhole excavation.

3.2 PREPARATION

A. Design the method of placement for all precast items and add all reinforcing steel, embeds, bracing, and other items necessary for placement. All portions of embeds which remain embedded in the concrete shall be made of stainless steel.

B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

D. Do not install manholes where site conditions induce loads exceeding structural capacity of manhole components.

E. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage; remove and replace damaged units.

F. Subgrade

1. Subgrade shall be compacted to 95 percent of maximum density.

2. Compacted subgrade shall be covered with a minimum of 6 inches of aggregate base compacted to 95 percent of maximum density, extending a minimum of 6 inches beyond the outside limits of the manhole, unless otherwise indicated on Drawings.

3. Grade the aggregate base to a uniform, level surface which will fully support the structure and to an elevation that will ensure proper positioning of the top slab or lid.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate manholes as specified in Section 31 23 16, Excavation in location and to indicated depth.

2. Provide 12 inches of clearance around sidewalls of structure for construction operations.

3. When groundwater is encountered, prevent accumulation of water in excavations and place manholes in dry trench.

B. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation as approved by Engineer.

C. Base Pad:

1. Place base pad.
2. Trowel top surface level.

D. Backfill excavations for manholes as specified in Section 31 23 23, Fill.

E. Form and place manhole cylinder plumb and level and to correct dimensions and elevations.

F. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.

G. Set cover frames and covers level without tipping and to correct elevations.

H. Coordinate with other Sections of Work to provide correct size, shape, and location.

I. Precast Concrete Manholes:

1. Assembly:

   a. Install precast structures in accordance with the manufacturer's recommendations unless otherwise required by the Contract Documents.

   b. Verify installed manholes meet required alignment and grade.

   c. Lift precast components at lifting points designated by manufacturer.

   d. When lowering manholes into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.

   e. Set precast structures bearing firmly and fully on crushed stone bedding, compacted as specified in Section 31 23 23, Fill or on other support system as indicated on Drawings.

   f. Assemble multi-section structures by lowering each section into excavation; set level and firmly position base section before placing additional sections.

   g. Place manhole sections plumb and level, trim to correct elevations, and anchor to base pad.

   h. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.

   i. Maintain alignment between sections by using guide devices affixed to lower section.

2. Joints:

   a. Sealing materials may be installed onsite or at manufacturers plant.

   b. All joints shall be sealed watertight by the use of rubber gaskets or other approved preformed sealant.

   c. All joints shall then be filled with non-shrink grout on both the inside and outside surfaces to produce smooth interior and exterior surfaces.

3. Concrete Base Installation:

    a. Bases shall be set at the proper grade to allow pipe openings to match the grades for connecting pipes.

    b. Invert shall be constructed to a section identical with that of the sewer pipe.

    c. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces.

    d. Prevent sewage or water from contacting the new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

    e. Manhole bases shall be set level so base gravel fully and uniformly supports them in true alignment with uniform bearing throughout full circumference.

    f. Do not level the base sections by wedging gravel, or other material, under the edges.

    g. Flexible connectors shall be installed in the base section to form a permanently watertight seal.

4. Manhole Riser Sections:

    a. Precast manhole components may be used to construct standard, drop and carry-through manholes. Manholes less than 4 feet in depth measured from the spring line of the pipe to the bottom of the lower riser ring shall be flat-top manholes.

    b. Install manhole riser sections at the location shown on the plans. All sanitary sewer and pollution control manholes joints shall be watertight and shall use rubber gaskets or a preformed sealant. All joints shall then be filled with non-shrink grout inside and out so as to produce smooth interior and exterior surfaces. All manhole penetrations shall be watertight. Complete manholes shall be rigid. Compact backfill in accordance with the provisions stated elsewhere in this document.

    c. All lift holes shall be thoroughly wetted, completely filled with mortar, and smoothed and pointed both inside and out to ensure watertightness.

    d. The shortest length of riser section to be incorporated into the manhole shall be installed immediately below the flat slab top or cone.

    e. Properly locate and plumb each manhole riser section.

f. Install manhole extensions and top slabs in accordance with manufacturer's specifications and as shown on the plans. Lay section risers with the sides plumb and the tops level. Make joints and penetrations watertight.

g. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.

5. Entrances/Exits:

a. Cut pipe flush with interior of structure.

b. Shape inverts through manhole as indicated on Drawings.

c. All rigid non-reinforced pipe entering or leaving the manhole (new or existing manhole) shall be provided with flexible joints within 1-foot of the structure and shall be placed on compacted bedding.

d. Ribbed HDPE pipe connections shall be grouted watertight with non-shrink grout.

e. PVC pipe shall be connected to manholes using an approved adapter specifically manufactured for the intended service.

1) Adapters shall be Fernco, Kor-N-Seal, or approved equal.

6. Grates, Frames, and Covers:

a. Manhole frames, grates, and covers shall be installed in such a manner as to prevent infiltration of surface or groundwater between the frame and the concrete of the manhole section. Use preformed rubber ring to form a watertight seal.

b. Manhole frames and covers shall be installed to grades shown on the drawings or as directed.

c. Adjustment of manhole castings shall be made using specified precast grade rings and approved rubber ring joints.

d. The maximum depth of adjustment below any manhole casting shall be 16 inches, and a minimum depth of adjustment shall be 4 inches.

J. Cast-in-Place Concrete Manholes:

1. Prepare crushed stone bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.

2. Erect and brace forms against movement as specified in Section 03 30 00, Cast-in-Place Concrete.

3. Install reinforcing steel as indicated on Drawings and as specified in Section 03 30 00, Cast-in-Place Concrete.

4. Place and cure concrete as specified in Section 03 30 00, Cast-in-Place Concrete.

5. Frames and Covers:

    a. Set frames using mortar and masonry.

    b. Install radially laid concrete brick with 1/4-inch thick vertical joints at inside perimeter.

    c. Lay concrete brick in full bed of mortar and completely fill joints.

    d. If more than one course of concrete brick is required, stagger vertical joints.

    e. Set frame and cover as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

A. Test concrete manhole and structure sections according to ASTM C497.

B. Perform manhole testing according to ODOT Standard Specifications Section 470.

C. Test cast-in-place concrete as specified in Section 03 30 00, Cast-in-Place Concrete.

D. Vertical Adjustment of Existing Manholes:

1. If required, adjust top elevation of existing manholes to finished grades as indicated on Drawings.

2. Reset existing frames, grates, and covers that were carefully removed and cleaned of mortar fragments to required elevation according to requirements specified for installation of castings.

3. When removal of existing concrete wall is required, remove concrete without damaging existing vertical reinforcing bars, clean concrete from vertical bars, and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 03 30 00, Cast-in-Place Concrete.

END OF SECTION

SECTION 33 11 10 - WATER UTILITY DISTRIBUTION AND TRANSMISSION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Work under this Section applies to furnishing and installation of pipe materials, fittings, and appurtenances normally encountered with water distribution and transmission systems, including potable water and fire water systems.

B. Section includes:

1. Pipe and fittings
2. Flanged coupling adapters
3. Insulating flanged joints
4. Tapping sleeves and valves
5. Flexible expansion joints
6. Bedding and cover materials

C. Related Requirements:

1. General

    a. Furnish and install all piping systems shown and specified in accordance with the requirements of the Contract Documents.

    b. Each buried piping system shall be complete, with all necessary fittings, valves, accessories, lining and coating, testing, excavation, backfill and encasement, to provide a functional installation.

    c. Piping layouts shown in the Drawings are intended to define the general layout, configuration, and routing for pipe, as well as the size and type of piping to be installed. The piping plans are not pipe construction or fabrication drawings.

    d. The Contractor shall cause the Supplier of pipes, valves, fittings, and appurtenances to coordinate piping installation such that all equipment is compatible and is capable of achieving the performance requirements specified in the Contract Documents.

    e. It is the Contractor's responsibility to develop the details necessary to construct all piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, valves, gaskets, fittings, appurtenances etc., for a complete and functional system.

1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Work
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 23 16 - Excavation
E. Section 31 23 17 - Trenching
F. Section 31 23 23 – Fill
G. Section 33 05 00 – Pipe, Valves, and Accessories
H. Section 33 12 13 - Water Service Connections
I. Section 33 12 16 - Water Utility Distribution Valves
J. Section 33 13 00 - Testing & Disinfecting of Water Utility Piping

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

B. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys

3. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges

4. ASME B31.10 - Standards of Pressure Piping

C. ASTM International (ASTM):

1. ASTM A36 - Standard Specification for Carbon Structural Steel

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

4. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

5. ASTM A536, Standard Specification for Ductile Iron Castings.

6. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

7. ASTM D1598 - Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

8. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

9. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

10. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

13. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

D. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems

3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings

4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

5. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast

7. AWWA C153 - Ductile-Iron Compact Fittings

8. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe

9. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances

10. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

11. AWWA C606 - Grooved and Shouldered Joints

12. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 48 In. (100 mm Through 300 mm), for Water Transmission and Distribution

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joints between Tapping Sleeves and Tapping Valves

F. NSF International (NSF):

1. NSF Standard 61 - Drinking Water System Components – Health Effects
2. NSF Standard 372 - Drinking Water System Components – Lead Content

G. SUBMITTALS

H. See General Conditions, Volume 1, for requirements for submittals.

I. Product Data: Submit data on pipe materials, pipe fittings, restrained joint systems, and accessories.

J. Shop Drawings: Indicate piping layout, including piping specialties.

1. Layout Schedule for applicable segments of proposed transmission main alignment. Schedule shall include layout plan and dimensions, schedule of pipe fittings and specials, materials and class for each size and type of pipe, joint details, pipe supports, and any special provisions required for assembly.

K. Lining and coating data.

L. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

M. Manufacturer’s handling, delivery, storage, and installation requirements.

N. Field Quality-Control Submittals:

1. Pipeline hydrostatic testing plan.
2. Indicate results of Contractor-furnished tests and inspections.

O. Preconstruction Photographs:

1. Submit digital files of colored photographs of Work areas and material storage areas.

1.4 CLOSEOUT SUBMITTALS

A. As-Built Drawings:

1. Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Materials:

1. Unless otherwise noted, all water works materials provided for the project shall be new, of first-class quality and shall be made by reputable manufacturers.

2. All material of a like kind shall be provided from a single manufacturer unless otherwise approved by the Owner's Representative.

3. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage, and handling.

4. All pipe and fittings shall be manufactured in the United States of America, unless otherwise approved by the Owner.

B. Markings:

1. Pipes and Fittings: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, inside diameter of pipe, dimension ratio as applicable, pipe class as applicable, pipe number for laying purposes as applicable, and other information required for type of pipe.

2. Bolting materials (washers, nuts, and bolts) shall be marked with material type.

C. Testing:

1. Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards.

1.6 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer's written recommendations and as specified in these Contract Documents.

B. Pipe, specials, and fittings delivered to Project Site in damaged condition will not be accepted.

C. Storage:

1. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

2. Pipe and fittings shall not be stored on rocks, gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

3. Do not store materials in direct sunlight.

4. Gaskets: Do not allow contact with oils, fuels, petroleum, or solvents.

D. Handling:

1. Pipe and appurtenances shall be handled in accordance with manufacturer's recommendations or requirements contained in this section or subsequent sections dealing with the specific pipe material, whichever is more stringent.

2. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.

3. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.

4. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.

PART 2 PRODUCTS

2.1 WATER PIPING

A. General

1. All piping materials and specials shall meet the specifications of this Section and of the appropriate AWWA Standard Specifications. In the case of conflict, the more stringent specifications shall apply.

2. All coatings and materials specified herein which may come in contact with potable water shall conform to National Sanitation Foundation (NSF) Standard 61 and 372.

3. Minimum Pressure Ratings: Unless otherwise specified herein or shown in the Drawings, the minimum working pressure rating of all water works materials

specified herein shall be 1-1/2 times the operating pressure or 150 pounds per square inch (psi) minimum.

4. Gaskets:

    a. Material: Styrene Butadiene Rubber (SBR) or approved equal.

B. PVC:

1. All PVC pressure pipe shall be manufactured with an integral bell design capable of receiving an elastomeric gasket.

2. All PVC pressure pipe shall be dimensionally compatible with standard cast/ductile iron fittings produced according to AWWA C110 or AWWA C153, as applicable.

3. Deflection:

    a. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly.

    b. Deflection by bending of the pipe rather than at the joints is not allowed.

    c. The maximum pipe deflection shall not exceed one half of the manufacturer's stated joint deflection allowance.

4. Joints:

    a. Solvent-cement couplings are not permitted.

5. Gaskets: Comply with ASTM F477.

6. Size: 4-inch through 48-inch diameter

    a. Comply with AWWA C900, DR 18, Class 305, unless shown otherwise in the Drawings or specified elsewhere.

7. Restrained Joints:

    a. For push-on pipe joint at pipe bells:

        1) Material:

            a) Body: Ductile iron. Comply with ASTM A536.
            b) Bell Restraint Systems: Corten steel tie rods.

        2) Coatings: Shop-applied liquid epoxy.

3) Construction:

a) A split serrated ring shall be used behind the pipe bell. A split serrated ring shall also be used to grip the pipe and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring.

b) System shall be designed for a minimum 2 to 1 safety factor.

4) Manufacturers:

a) 4-inch through 12-inch diameter: EBAA Iron, Inc. - Series 1900 Bell Restraint Harness.

b) 14-inch through 48-inch diameter: EBAA Iron, Inc. - Series 2800 Bell Restraint Harness.

b. At mechanical joint fittings:

1) Material: Ductile iron. Comply with ASTM A536.

2) Coatings: Shop-applied liquid epoxy.

3) Construction:

a) Restraint accomplished by a restraint device consisting of a follower gland utilizing multiple gripping wedges.

b) The restraint system shall have a sufficient number of fastening bolts to connect the ring to the mechanical joint.

c) System shall be designed for a minimum 2 to 1 safety factor.

4) Fasteners:

a) T-bolts and nuts: High strength, low alloy steel.
b) Comply with AWWA C111.

5) Manufacturers:

a) EBAA Iron, Inc. - MEGALUG, Series 2000PV
b) Romac Industries, Inc. – 470 Series Pipe Restraining System

2.2 FITTINGS:

A. Material: Ductile iron, complying with AWWA Standard C110.

1. Fittings conforming to AWWA C153 may be substituted in lieu of AWWA C110 fittings.

B. Fittings used for joining ductile iron and PVC pipe shall be of the type, size, and strength designated on the Plans, elsewhere in the specifications.

1. Fittings shall be mechanical joint, push-on type, flanged or plain-end as required and shown on the Drawings.

2. All restraint systems and flanged fittings shall be provided with bolts and gaskets as specified herein.

C. Pressure ratings: As specified for joining pipe above and as shown on the Drawings.

D. Coating and Lining:

1. Asphaltic exterior coating in accordance with AWWA Standard C110.

2. Cement Mortar Lining: Comply with AWWA C104.

E. Following information cast upon fittings:

1. Manufacturer's identification.
2. Country of manufacture.
3. Pressure rating.
4. For bends, number of degrees and/or fractions of a circle.

F. Owner may require additional metallurgical documentation or other certifications.

2.3 NUTS, BOLTS, AND WASHERS:

A. All bolts shall have heavy hex head with heavy hex nuts.

B. For operating pressures greater than 150 psi:

1. Bolts: Steel alloy composition. Comply with ASTM A193.
2. Nuts: Comply with ASTM A194, Grade 2H.
3. Washers: Comply with ASTM F436.

C. For operation pressures of 150 psi or less:

1. Bolts: Low-carbon steel composition. Comply with ASTM A307, Grade B.
2. Nuts: Comply with ASTM A563A, Heavy Hex.
3. Washers: Comply with ASTM F844.

D. Higher-strength bolts with higher torque values as specified above for operation pressures greater than 150 psi shall not be used for assembly of flange joints including gray-iron flanges.

2.4 FLANGED COUPLING ADAPTERS

A. Flanged Coupling Adapters:

1. All flanged coupling adapters shall be constructed to diameters that properly fit the connecting plain end pipe and the flanged fitting.

2. Description:

    a. Comply with AWWA C219.

    b. Flange: AWWA Class E Steel Ring Flange, compatible with ANSI Class 125 and 150 bolt circles.

    c. End ring and body:

        1) Steel. Comply with ASTM A36.
        2) Ductile iron. Comply with ASTM A536, Grade 65-45-12.

    d. Flange: Compatible with ANSI Class 125 and 150 bolt circles.

    e. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

    f. Bolts and nuts: High strength low alloy steel bolts and nuts. Comply with AWWA C111 composition requirements.

    g. Lining and coating: Factory-applied fusion bonded epoxy.

    h. Working pressure rating: Equal to the maximum rating of the flange.

3. Manufacturers:

    a. Romac Industries, Inc.

        1) Style FCA501

            a) For 3-inch to 16-inch diameter.

        2) Style FC400.

            a) For 12-inch to 96-inch diameter.

B. Restrained Flanged Coupling Adapters:

1. Description:

   a. Gland and flange body: Ductile iron. Comply with ASTM A536.

   b. Flange: Compatible with ANSI Class 125 and 150 bolt circles.

   c. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

   d. Restraining bolts and lugs: Ductile iron. Comply with ASTM A536.

   e. T-bolts, Bolts, and nuts: High strength low alloy steel. Comply with AWWA C111 composition requirements.

   f. Lining and coating: Factory-applied fusion bonded epoxy.

2. Manufacturers:

   a. Romac Industries, Inc. – RFCA Restrained Flanged Coupling Adapters.

   b. EBAA Iron – MEGAFLANGE Restrained Flange Adapter.

2.5 TAPPING SLEEVES AND VALVES

A. Tapping Sleeves:

1. Description:

   a. Type: Tapping & Cut-In Sleeve Assemblies.

   b. Material:

      1) Body: Ductile Iron.
      2) Flanged outlet: Ductile Iron.

   c. Outlet Flange Dimensions and Drilling: Comply with ASME/ANSI B16.1, B16.42 class 150 and MSS SP-60.

   d. Outlet Gasket:

   e. Provide with ¾” NPT test plug.

   f. Pip Gland Bolts & Nuts: 588-88 OR A242-91A

   g. Side Bolt & Nuts: Steel Zinc Plated.

2. Manufacturers:

    a. Mueller Co.
    b. Romac Industries, Inc. – Model STS 420
    c. JMC Industries, Inc.

B. Tapping Valves:

1. Resilient wedge gate valves. Comply with AWWA C500 and NSF 61 and 372.
2. Minimum Pressure Rating:

    a. Twelve-inch Diameter and Smaller: 200 psig.
    b. Sixteen-inch Diameter and Larger: 150 psig.

3. End Connections: As shown in the Drawings.

    a. Standard mechanical joint ends comply with ANSI/AWWA C111.

    b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125. Comply with AWWA C115 and ASME 16.5.

        1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.

4. Gear actuators: Conforming to AWWA C509 for manual valves.

5. Linings and Coatings:

    a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

    b. All internal and external ferrous surfaces.

    c. Do not coat flange faces of valves.

6. Bi-directional flow.

7. Buried Service Operation:

    a. Non-rising stem (NRS).
    b. Two-inch square operating nut.

8. Interior and Exposed Service Operation:

    a. Outside screw and yoke (OS&Y).
    b. Provide NRS valves with position indicators.

9. Open counterclockwise when viewing the valve from above, unless otherwise indicated in the Drawings.

10. Manufacturers:

    a. Mueller Co. or approved equal.

2.6 FLEXIBLE EXPANSION JOINTS

A. Description

1. Installed at locations indicated in the Drawings.

2. End connections: As shown in the Drawings.

3. Material: Ductile iron, AWWA C153.

4. Working pressure: 350 psi, minimum.

5. Construction:

    a. An expansion joint designed and cast as an integral part of a double ball and socket type flexible joint.

    b. Manufactured of ductile iron, conforming to requirements of AWWA C153 and ASTM A536.

    c. Deflection: Minimum of 15 degrees deflection per ball.

    d. Expansion:

        1) 12-inch diameter and under: 8-inch.
        2) Greater than 12-inch diameter: 16 inches.

    e. Each flexible expansion joint shall be hydrostatically tested to the manufacturer's published pressure rating prior to shipment.

    f. Lining: All interior "wetted" parts shall be shop-lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213 and shall be holiday tested with a 1500-volt spark test conforming to said specification.

    g. Coating: Coal tar epoxy.

6. Quality Assurance: Hydrostatically tested to manufacturer's published pressure rating prior to shipment.

7. Appropriately sized polyethylene sleeves, meeting AWWA C105 requirements, shall be included for direct bury applications.

B. Manufacturers

1. Mueller Co. or approved equal.

2.7 UNDERGROUND PIPE MARKERS

A. As specified in Section 31 23 17, Trenching.

2.8 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 30 00 - Cast-in-Place Concrete.
2. Type: reinforced, air entrained as shown in the Drawings.
3. Compressive Strength: Minimum 3,000 psi at 28 days.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 20 00 - Concrete Reinforcing.

2.9 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

   a. Material type varies by location, as shown in the Drawings.

   b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

   c. Subsoil Type S2, as specified in Section 31 05 13, Soils for Earthwork.

2.10 ACCESSORIES

A. Concrete for Thrust Restraints: As specified in Section 03 30 00 - Cast-in-Place Concrete.

B. Manhole and Cover: As specified in Section 33 05 13- Manholes.

C. Miscellaneous Steel Rods, Bolt, Lugs, and Brackets:

1. Comply with ASTM A36 or ASTM A307.
2. Grade A carbon steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing utility water main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

A. Preconstruction Site Photos:

1. Take photographs along centerline of proposed pipe trench; minimum one photograph for each 50 feet of pipe trench.

2. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.

3. Include Project name, date taken, and sequential number of each photograph in physical log or CD.

B. Inspection:

1. All pipe sections, specials, and jointing materials shall be carefully examined for defects.

2. No piping or related materials shall be laid that is known to be defective. Any defective piece installed shall be removed and replaced with a new pipe section in a manner satisfactory to the Engineer at the Contractor's expense.

3. Defective material shall be marked and removed from the job site before the end of the day.

C. Pipe Cutting:

1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.

3. Grind edges smooth with beveled end for push-on connections.

4. Prior to assembly of field cut pipe, the reference mark shall be re-established with a pencil or crayon. The location of the reference mark at the proper distance from the bevel end shall be in accordance with the manufacturer’s recommendations.

D. Remove scale and dirt on inside and outside before assembly. Cleaning of each pipe or fitting shall be accomplished by swabbing out, brushing out, blowing out with compressed air, or washing to remove all foreign matter.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Bedding:

1. Excavation:

a. Excavate pipe trench as specified in Section 31 23 17, Trenching for Work of this Section.

b. All pipe trenches shall be excavated below the proposed pipe invert as required to accommodate the depths of pipe bedding material as scheduled on the Drawings.

c. Remove large stones or other hard matter which could damage pipe or impede consistent pipe bedding backfilling or compaction.

d. Trench base shall be inspected prior to placement of pipe.

e. Hand trim excavation for accurate placement of pipe to elevations as indicated on Drawings.

2. Dewater excavation as specified in Section 31 23 19, Dewatering to maintain dry conditions and to preserve final grades at bottom of excavation.

3. Provide sheeting and shoring as specified in Section 31 23 17, Trenching.

4. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth and compact to 95 percent of maximum density.

B. Piping:

1. Install pipe according to AWWA Standards.

2. Handle and assemble pipe according to manufacturer instructions and as indicated on Drawings.

3. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

4. Steel Rods, Bolt, Lugs, and Brackets: Coat buried steel with one coat of coal tar coating before backfilling.

5. Sanitary Sewer Separation:

    a. Install new water lines and appurtenances in compliance with local and state regulations governing the horizontal and vertical separations between water and sewer facilities.

    b. Variance:

        1) If a variance is proposed due to requested design revisions or if an existing facility has been installed at a different location or elevation than indicated on the Plans, submit written proposal for review and approval by the Engineer.

        2) Include the reason for the variance, type of material and condition of the sewer line, location of the water and sewer facilities, horizontal and vertical skin-to-skin clearances and corrective measures proposed.

        3) Each variance will be considered on a case-by-case basis.

        4) Review Time: Allow a minimum of 5 working days review and response to each proposal.

6. Install ductile iron fittings according to AWWA C600.

7. Joints:

    a. Pipe jointing surfaces shall be clean and dry when preparing surfaces for joining.

    b. Lubricants, primers, adhesives, etc. shall be used as recommended by the pipe or joint manufacturer's specifications.

    c. The jointing materials or factory-fabricated joints shall then be placed, fitted, joined, and adjusted in such a manner as to obtain a watertight joint.

    d. Trenches shall be kept water-free and as dry as possible during bedding, laying and jointing.

    e. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to prevent movement of the pipe from any cause.

8. Flanged Joints: Not to be used in underground installations except within structures, unless shown otherwise in the Drawings.

9. Deflection:

    a. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly.

    b. Deflection by bending of the pipe rather than at the joints is not allowed.

    c. The maximum pipe deflection shall not exceed one-half of the manufacturer's stated joint deflection allowance.

    d. Set a laser, string line, or other approved alignment guide along the centerline of previously installed pipe to the point where pipe joint deflection is required. The approved alignment guide shall extend to the end of the proposed subsequent pipe length. A measurement will be taken from the alignment guide to the centerline of the subsequent pipe length to determine the amount of pipe joint deflection proposed. Measured deflection shall not exceed the specified allowable deflection for the purposes of aligning the pipe.

10. Install pipe and fittings to the line and grade specified on the Drawings, with joints centered, pipe properly supported and restrained against movement, and all valve stems plumb. Re-lay pipe that is out of alignment or grade.

11. High Points:

    a. Install pipe with no high points, unless otherwise shown in the Drawings.

    b. If unforeseen field conditions arise that necessitate high points, install air release valves as directed by Engineer.

12. Bearing:

    a. Install pipe to have bearing along entire length of pipe.

    b. Excavate bell holes to permit proper joint installation where necessary or as directed by Engineer.

    c. Do not lay pipe in wet or frozen trench.

13. Prevent foreign material from entering pipe during placement.

14. Install pipe to allow for expansion and contraction without stressing pipe or joints.

15. Close pipe openings with watertight plugs during Work stoppages.

16. All pipe ends which are to be permanently closed shall be plugged or capped and restrained against internal pressure.

17. Install access fittings to permit disinfection of water system performed under Section 33 13 00 – Testing and Disinfecting of Water Utility Piping.

18. Cover:

    a. Establish elevations of buried piping with not less than 36 inches of cover.
    b. Measure depth of cover from final surface grade to top of pipe barrel.

19. Pipe Markers:

    a. Install as specified in Section 31 23 17, Trenching.

C. Tapping Sleeves and Valves:

1. As indicated on Drawings and according to manufacturer instructions.

D. Thrust Restraints:

1. Provide valves, tees, bends, caps, and plugs with concrete thrust blocks at locations shown in the Drawings and as required to facilitate testing of lines.

2. Pour concrete thrust blocks against undisturbed earth.

3. Locate thrust blocks to ensure that pipe and fitting joints will be accessible for repair.

4. Provide thrust restraint bearing area on subsoil as shown in details within the Drawings.

5. Install tie rods, clamps, setscrew retainer glands, or restrained joints.

6. Protect metal-restrained joint components against corrosion with polyethylene film as specified herein.

7. Do not encase pipe and fitting joints to flanges.

E. Backfilling:

1. Backfill of piping systems shall be as specified in Section 31 23 17, Trenching.

F. Testing and Disinfection of Potable Water Piping System:

1. In accordance with AWWA C600, AWWA C651 and as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Piping.

2. All chlorinated water used in disinfection of the water main shall either be discharged through an approved connection to a public sanitary sewer system or shall be dechlorinated to limits acceptable by the Oregon State Department of Environmental Quality (DEQ) prior to discharge into any storm drainage system or open drainage way.

3. No chlorinated water shall be discharged into a storm drainage system or open drainage way without a dechlorination under a plan meeting DEQ’s requirements.

3.4 FIELD QUALITY CONTROL

A. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

END OF SECTION

SECTION 33 12 16 - WATER UTILITY DISTRIBUTION VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes valves and valve boxes for installation with buried water distribution and transmission main, including fire hydrants and tapping sleeves.

B. Section Includes:

1. Valves.
2. Valve boxes.
3. Valve operator extensions.

C. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete: Concrete for thrust restraints.
2. Section 33 11 10 - Water Utility Distribution and Transmission Piping: Piping trenching, backfilling, and compaction requirements.
3. Section 33 12 13 - Water Service Connections: Pipe materials, fittings, and service connection appurtenances and installation requirements.
4. Section 33 13 00 - Testing and Disinfecting of Water Utility Distribution: Flushing and disinfection requirements.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
3. ASME 1.20.1 - General Purpose Pipe Threads (Inch)

B. American Water Works Association (AWWA):

1. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service
2. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants

C. ASTM International (ASTM):

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications

D. NSF International (NSF):

1. NSF 61 - Drinking Water System Components - Health Effects
2. NSF 372 - Drinking Water System Components - Lead Content

1.3 COORDINATION

A. The Contractor shall cause the Supplier of valves to coordinate installation such that all pipes, valves, fittings, appurtenances, and equipment are compatible and capable of achieving the performance requirements specified in the Contract Documents.

B. Coordinate Work of this Section with Owner and utilities within construction area.

1.4 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling: Schedule of valves to be labeled indicating in each case the valve location and the proposed labeling for the valve.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves.
B. Operation and Maintenance Data: Submit information for valves.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Tools: Furnish one tee wrench of required length to Owner.

1.7 QUALITY ASSURANCE

A. Cast manufacturer's name, maximum working pressure, size of valve, and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, American National Standards Institute (ANSI), ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.

E. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves and accessories for shipment according to applicable AWWA standards.

B. Seal valve and ends to prevent entry of foreign matter.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Storage:

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

E. Handle products carefully to prevent damage to interior or exterior surfaces.

F. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RESILIENT WEDGE GATE VALVES

A. As specified in Section 33 05 00, Pipes, Valves, and Accessories and in Drawings.

B. Connecting Hardware:

1. As specified in Article 2.3, Nuts, Bolts and Washers of Section 33 11 10, Water Utility Distribution and Transmission Piping.

C. Gaskets:

1. As required for the end connection types specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

2.3 SOLID WEDGE, METAL-SEATED GATE VALVES

A. As specified in Section 33 05 00, Pipes, Valves, and Accessories and in Drawings.

B. Connecting Hardware:

1. As specified in Article 2.3, Nuts, Bolts and Washers of Section 33 11 10, Water Utility Distribution and Transmission Piping.

C. Gaskets:

1. As required for the end connection types specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

2.4 ACTUATORS

A. Unless otherwise indicated, all valves shall be furnished with manual actuators.

B. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

C. All gear-assisted valves that are buried and submerged shall have the actuators hermetically sealed and grease-packed.

D. All valves 6 inches to 30 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

2.5 VALVE BOXES

A. Provide all buried valves with valve boxes, covers and risers.

B. Valve Boxes:

1. Materials: Cast iron.

2. Construction:

    a. Walls not less than 3/16-inch thick at any point.
    b. Internal diameter not less than 5 inches.

3. Type: Two-piece extension.

4. Manufacturers:

    a. Olympic Foundry.
    b. Brooks Products.
    c. PROSELECT.

C. Covers:

1. Construction:

    a. Prevents dislodging and rotation from traffic.
    b. Allows a hand-held pry bar to be applied for easy removal.

2. Materials: Cast iron.

3. Lid Inscription: W.

4. Manufacturers: Matching that of valve box.

D. Riser:

1. Polyvinyl Chloride (PVC) Pipe:

    a. ASTM D3034, SDR 35 PVC.
    b. White, Schedule 40, 8-inch diameter.
    c. Length as shown on details in the Drawings.

2.6 VALVE OPERATOR EXTENSIONS

A. As shown in the Drawings.

B. Provide operator extensions to a maximum of 12 inches below grade where depth to valve exceeds 36 inches.

2.7 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 03 30 00 - Cast-in-Place Concrete.

PART 3 EXECUTION

3.1 PREPARATION

A. Conduct operations to not interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures, utilities, and landscape in immediate or adjacent areas.

B. Identify required lines, levels, contours, and datum locations.

C. Locate, identify, and protect from damage utilities to remain.

D. Access:

1. All valves shall be installed to provide easy access for operation, removal, and maintenance.

2. Avoid conflicts between valve operators and above grade construction such as structural members or handrails.

E. Valve Accessories:

1. Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly.

2. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.2 INSTALLATION

A. General:

1. All valves, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as shown in the Drawings and as specified herein.

2. Valves shall be firmly supported to avoid undue stresses on the pipe.

3. Stem extensions shall be braced at no greater than 10 feet intervals and be provided with double universal joints to allow for misalignment, where applicable.

B. Perform trench excavation, backfilling, and compaction as specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

C. Install valves in conjunction with pipe laying.

D. Set valves plumb.

E. Provide buried valves with valve boxes installed flush with finished grade.

1. Valves installed out of paved or otherwise hard-surfaced areas shall be set in a concrete pad at finished grade.

2. Concrete valve box pads shall be 18 inches square and be not less than 6 inches thick.

F. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

3.3 FIELD QUALITY CONTROL

A. Pressure test valving for water distribution system according to AWWA C600 and in accordance with Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

B. Field Testing of Valves:

1. All valves 24-inch diameter or larger, and all in-line transmission main valves, shall be pressure and leakage tested at the Site and shall pass the field testing prior to installation.

2. Valves shall be tested at 1.5 times normal operating pressure, 150 pounds per square inch (psi) minimum.

3. No valve shall be accepted for installation that fails to pass the field pressure test. Any valves failing field pressure tests shall be replaced by the Contractor at no additional cost to the Owner.

4. Engineer shall witness field testing.

END OF SECTION

SECTION 33 13 00 - TESTING AND DISINFECTING OF WATER UTILITY PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hydrostatic pressure testing, disinfection, and purity testing of potable water systems piping, fittings, valves, and domestic water services.

B. Section Includes:

1. Pressure testing and disinfection of potable water distribution and transmission piping systems and appurtenances.

2. Testing and reporting of results.

C. Related Requirements:

1. Section 33 11 10 - Water Utility Distribution and Transmission Piping
2. Section 33 12 16 - Water Utility Distribution Valves

1.2 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

1. AWWA B300 - Hypochlorites
2. AWWA B301 - Liquid Chlorine
3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances
4. AWWA C605 - Underground Installation of PVC and PVCO Pressure Pipe and Fittings
5. AWWA C651 - Disinfecting Water Mains
6. AWWA C655 - Field Dechlorination

1.3 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Pipeline Testing and Disinfection Plan: To be submitted for review and approval by the Engineer a minimum of 1 month before testing is to start. As a minimum, the plan shall include the following:

1. Testing schedule.

2. Hydrostatic Testing Plan:

    a. Narrative of the proposed process.
    b. Proposed equipment to be used.
    c. Disposal location for excess water used to fill mains.

3. Disinfection Plan:

    a. Narrative of the proposed process.

    b. Proposed chemicals and equipment (including list of all pumps and meters) to be used.

    c. Calculations for the amount of chlorine required to achieve required chlorine residual levels.

    d. Proposed method of mixing, injecting, and distributing of chlorine solution throughout all portions of the new water system facilities.

    e. Proposed plan for testing chlorine levels throughout the length of pipeline.

4. Proposed testing locations.

5. Proposed plan for water conveyance, including flow rates.

6. Proposed plan for water control.

7. Proposed plan for water disposal, including flow rates. Include proposed plan for dechlorination of disinfection water, including discharge points.

8. Proposed measures to be incorporated in the project to minimize erosion while discharging water from the pipeline.

1.4 CLOSEOUT SUBMITTALS

A. Disinfection Report:

1. Type and form of disinfectant used.

2. Date and time of disinfectant injection start and time of completion.

3. Test locations.

4. Name of person collecting samples.

5. Initial and 24-hour disinfectant residuals in treated water in parts-per million (ppm) for each outlet tested.

6. Date and time of flushing start and completion.

7. Disinfectant residual after flushing in ppm for each outlet tested.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future functions.

B. All temporary thrust restraint and equipment and facilities required for hydrostatic testing will be considered incidental.

C. As a minimum, furnish the following equipment and materials for the testing:

Amount	Description
2	Graduated containers approved by the Engineer.
1	Hydraulic pump approved by the Engineer with hoses, valves, and fittings as needed and required for the testing and disinfection of the facilities.
1	High range chlorine test kit, as approved by Engineer, with digital readout. Range of detection shall be between 5 and 200 ppm. Accuracy of 3 percent.
2	Pressure gauges with pressure range at least 120 percent greater than the required maximum test pressure with graduations in 2 pounds per square inch (psi) increments. Gauges shall have been calibrated with 90 days of pressure testing.

2.2 DISINFECTION CHEMICALS

A. Chemicals:

1. Hypochlorite: Comply with AWWA B300.
2. Liquid chlorine: Comply with AWWA B301.

2.3 DECHLORINATION CHEMICALS

A. Chemicals:

1. Comply with AWWA C655.

PART 3 EXECUTION

3.1 HYDROSTATIC TESTING OF WATER PIPING

A. Make all necessary provisions for conveying water to the points of use and for the disposal of test water.

B. No section of the pipeline shall be hydrostatically tested until backfill has been placed, compacted, and passed required density testing and all field-placed concrete or mortar has attained full strength.

1. At the Contractor’s option, early strength concrete may be used when the full-strength requirements conflict with schedule requirements.

2. All such substitutions and installations shall be approved by the Engineer prior to installation.

C. Provide 72-hour notification to the Engineer and Owner prior to conducting hydrostatic testing.

1. Provide coordination and scheduling required for the Owner and Engineer to witness and provide necessary labor for operating Owner’s existing system during hydrostatic testing and disinfecting procedures.

2. The Contractor shall not operate any part of the existing water systems.

D. Pipe Filling:

1. Fill pipes slowly from the lowest elevation to highest point along test section with potable water.

2. Take all required precautions to prevent entrapping air in the pipes.

3. Allow for natural absorption of water by the lining of the pipe to occur.

4. Apply specified test pressure by pumping.

E. Testing of Mains:

1. Ductile Iron: In accordance with AWWA C600.

2. Polyvinyl chloride (PVC): In accordance with AWWA C605.

3. General:

a. Tests shall be conducted under a hydrostatic test pressure not less than 1.25 times the stated anticipated maximum sustained working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section, minimum 150 psi, unless otherwise shown in the Drawings.

b. In no case shall the test pressure exceed the rated working pressure for any joint, thrust restraint, valve, fitting, or other connected appurtenance of the test section.

c. Testing shall be performed by applying the specified test pressure by pumping.

d. Once the test pressure has been attained, the pump shall be valved off.

e. The test will be conducted for a 2-hour period with the allowable leakage not to exceed the value as calculated per the Allowable Leakage formula below.

f. During the test period, there shall be no appreciable or abrupt loss in pressure.

4. Allowable Leakage:

a. Flanged Joints: Pipe, fittings, and valves with flanged joints shall be completely watertight. No leakage allowed.

b. Mechanical or Push-on Joints: Pipe, fittings and valves with rubber gasketed joints shall have a measured loss not to exceed the rate given in the following Allowable Leakage formula:

$$AL = \frac{LD(P)^{1/2}}{148{,}000}$$

In the above formula:

AL = Allowable leakage, in gallons per hour
L = Length of pipe tested, in feet
D = Nominal diameter of pipe, in inches
P = Average test pressure during the leakage test, in pounds per square inch.

5. Maintaining Pressure:

a. During the test period, operate the pump as required to maintain pressure in the pipe within 5 psi of the specified test pressure at all times.

b. At the end of test period, operate the pump until the specified test pressure is again obtained.

1) The pump suction shall be in a clean, graduated barrel, or similar device or metered so that the amount of water required to restore the test pressure may be accurately measured.

2) Sterilize this makeup water by adding chlorine to a concentration of 25 milligrams per liter (mg/L).

c. The Engineer will determine the quantity of water required to maintain and restore the required pressure at the end of the test period.

d. Each hour’s loss stands on its own and will not be averaged.

6. Defects, Leakage, Failure:

a. If the test reveals any defects, leakage in excess of the allowable, or failure, furnish all labor, equipment, and materials required to locate and make necessary repairs.

b. Correct any visible leakage regardless of the allowable leakage specified above.

c. All leaks shall be repaired in a manner acceptable to the Engineer.

d. The testing of the line shall be repeated until a test satisfactory to the Engineer has been achieved.

3.2 DISINFECTION OF WATER PIPING

A. Disinfection shall be in accordance with the latest version of AWWA C651 following Engineer’s acceptance of hydrostatic testing.

B. Chlorination by means of tablets or powders (calcium hypochlorite) placed in each length of pipe during installation is specifically prohibited.

C. Flush all foreign matter from the pipeline, branches and services.

1. Provide at no additional cost to the Owner, hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties.

2. Flushing velocities shall be at least 2.5 feet per second (fps).

3. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipe in place from the inside by brushing and sweeping, then flush the line at a lower velocity.

D. Chlorine Application:

1. Fill the test section of main from the lowest elevation and maintain a steady flow rate while injecting the water main with chlorinated water.

2. Flow (bleed) a blow-off, standpipe or hydrant at the water main's high point(s) to allow air to escape and ensure all interior pipe surfaces are wetted.

E. Chlorine Residual:

1. Measure chlorine residual with a high-range chlorine test kit at a point near to the injection point while filling the main.

2. Adjust the dose rate as necessary to maintain the target dose rate.

F. Potable water piping shall be disinfected with a solution containing a minimum 25 ppm and a maximum 50 ppm chlorine.

1. Once the main is completely filled with super-chlorinated water, measure the chlorine residual a minimum of once every 200 feet of main and once for each main branch, 2-inch service, or as directed by the Engineer.

2. The chlorine solution shall remain in the piping system for a period of 24 hours, after which time the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.

3. If check samples fail to produce acceptable results, the disinfection procedure shall be repeated at the expense of the Contractor until satisfactory results are obtained.

G. Flush piping, branches, and services with municipal potable water until the chlorine residual is below 1.5 ppm and approximately the same as the source water.

1. There is no minimum flushing velocity for this step.

H. Disposal of any water containing chlorine shall be performed in accordance with the latest edition of AWWA C651 and C655, and all state or local requirements.

1. Disposal may be made into existing sanitary sewer systems providing approvals are obtained from the respective system owners.

2. Any chlorinated water discharged to open stream channels must be dechlorinated prior to discharge to levels acceptable by DEQ.

3.3 DISINFECTION AND TESTING OF WATER MAIN END CONNECTIONS AND TIE-INS

A. Disinfection of potable water piping and appurtenances at end connections and tie-ins to the existing system which are required to remain in service due to restrictions in allowable shutdown time shall be disinfected as described below.

B. Prior to connecting new potable water piping and appurtenances with existing piping and appurtenances, the interior of all new pipe, fittings, valves and appurtenances shall be swabbed or sprayed with a 1 percent to 5 percent calcium hypochlorite solution.

C. In accordance with AWWA C651, swabbing or spraying of connection piping is allowed only if the total length of piping is equal to or less than one pipe length (18 feet). All runs of new piping over 18 feet in total length will require hydrostatic pressure testing, flushing and disinfection as detailed elsewhere in this Section.

D. Following the disinfection procedures described above, connection of the new piping and appurtenances to the existing water system shall be made.

1. During the system startup, the Engineer and Contractor shall visually inspect all new fittings, piping, valves and appurtenances for evidence of leakage.

2. Any leakage observed during this period shall be promptly repaired by the Contractor, at Contractor's expense, as required by the Engineer.

3.4 FIELD QUALITY CONTROL

A. Bacteriological Sampling and Testing:

1. The Owner will collect samples after the line is flushed in accordance with the latest edition of AWWA C651.

a. The locations for sample collection shall be at the sole discretion of the Owner and Engineer.

b. The chlorine residual must be below 1.5 ppm or restored to the level maintained in the Owner's distribution system, when the sample is taken.

2. Bacterial Testing: After completing the chlorination procedure, test the main according to the following:

a. Bacterial Sampling

1) Option A:

a) Take an initial set of samples using sampling site procedures outlined herein.

b) Resample after a minimum of 24 hours' time has elapsed using sampling site procedures outlined herein.

c) Both sets of successive samples must pass for the main to be approved for service.

2) Option B:

a) Allow main to sit for a minimum of 24 hours without any water use.

b) Using sampling site procedures outlined herein, collect two sets of samples a minimum of 15 minutes apart while the sampling taps are left running.

c) Both sets of samples must pass for the main to be approved for service.

3) Allow 24 hours for the test results for each sample set.

b. Sampling Locations

1) The Owner will take one bacteriological sample from the end of the main and on each branch.

2) For long runs of main, at least one sample will be taken for every 1,200 feet of new main and as directed.

c. Sample Testing

1) The Owner will test the sample set for coliform bacteria and publish the test results within 24 hours.

d. Evaluating the Test Results

1) If one or more of the sample set tests positive for coliforms (fails), repeat chlorination and sampling processes specified herein after correcting the cause of the failure and as directed by the Engineer.

2) When two consecutive sample sets test negative (passing)for coliform bacteria, the bacterial testing is complete.

e. Completion of Bacterial Testing

1) Upon completion of bacterial testing, notify the Owner shall notify the Engineer and Contractor in writing that the testing is complete and the main is ready for tie-in.

f. Multiple Positive (Failing) Test Results

1) If sample sets continue to test positive for coliforms, the Engineer will determine how to proceed, up to and including repeating the chlorination procedure or rejecting the pipe.

3. Results of the bacteriological testing shall be satisfactory with the Oregon Health Authority and/or other appropriate regulatory agencies, or disinfection shall be repeated by the Contractor.

B. Optional Sampling and Testing

1. If a pipeline is not promptly returned to service, the situation will be evaluated by the Owner to determine if the water quality may have been impacted and if additional testing as specified herein is warranted.

END OF SECTION

SECTION 33 31 10 - SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials, manholes, and accessories normally used with gravity sanitary sewers.

B. Section includes:

1. Sanitary sewerage pipe and fittings.
2. Pipe markers.
3. Connection to existing manholes.
4. Manholes.
5. Wye branches and tees.
6. Sanitary laterals.
7. Bedding and cover materials.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 23 16 - Excavation
E. Section 31 23 17 - Trenching
F. Section 31 23 23 - Fill
G. Section 33 05 13 - Manholes

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International (ASTM):

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

5. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

6. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

8. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

9. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

10. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

11. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

13. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

15. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

16. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

17. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.

4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.

6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

7. AWWA C153 - Ductile-Iron Compact Fittings.

8. 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.

1.4 COORDINATION

A. Notify affected utility companies at least 72 hours prior to construction.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

B. Shop Drawings:

1. Indicate layout of sewer system and appurtenances.
2. Show size, materials, components of system, and burial depth.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:

1. Indicate special procedures required to install specified products.

2. Submit detailed description of procedures for connecting new sewer to existing sewer line.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Materials:

1. Unless otherwise noted, all water works materials provided for the project shall be new, of first-class quality and shall be made by reputable manufacturers.

2. All material of a like kind shall be provided from a single manufacturer unless otherwise approved by the Owner's Representative.

3. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage, and handling.

4. All pipe and fittings shall be manufactured in the United States of America, unless otherwise approved by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture, dust, and direct sunlight by storing in clean, dry location remote from construction operations areas.

2. Block individual and stockpiled pipe lengths to prevent moving.

3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 SANITARY SEWERAGE PIPE AND FITTINGS

A. Plastic Pipe:

1. Material:

a. Polyvinyl chloride (PVC), manufactured from rigid polyvinyl chloride compounds conforming to ASTM D1784, Class 12454-B.

b. At locations indicated in the Drawings, pipe shall conform to AWWA C900.

2. Fittings: PVC.

3. Pipe and fittings 4 inches to 15 inches in diameter:

a. Comply with ASTM D3034, SDR 35.

4. Pipe and fittings 18 inches and larger in diameter:

a. Comply with ASTM F679, PS46.
b. Pipe shall have a minimum stiffness of 46 pounds per square inch (psi).

5. AWWA C900 Pipe:

a. 4 inches to 12 inches in diameter.
b. DR 25.
c. Pipe shall have minimum stiffness of 149 psi.

6. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.

7. Joints:

a. Integral bell push-on type: Comply with ASTM D3212.

b. For use with AWWA C900 pipe: Integral bell push-on type: Comply with ASTM D3139.

8. Gaskets:

a. Factory installed.
b. Elastomeric gaskets: Comply with ASTM F477.

2.2 FLEXIBLE COUPLINGS

A. Description:

1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
2. Attachment: Two [Series 300] stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Ethylene propylene rubber (EPDM).
2. Comply with ASTM C923.
3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 30 00, Cast-in-Place Concrete.
2. Strength: Minimum 3,000 psi at 28 days.
3. Air entrained.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 20 00 - Concrete Reinforcing.

2.5 MANHOLES

A. Description:

1. As specified in Section 33 05 13 - Manholes.
2. Material: Precast concrete.
3. Diameter: As shown in the Drawings.
4. Top: Eccentric cone.
5. Frames and Covers: Watertight cast iron.
6. Cover Inscription: S

2.6 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

    a. Material type varies by location, as shown in the Drawings.

    b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

    c. Subsoil Type S1, as specified in Section 31 05 13, Soils for Earthwork.

2.7 ACCESSORIES

A. Underground Pipe Markers: As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut, or excavation base is ready to receive Work.

B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation in accordance with Section 31 23 17, Trenching.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.

2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.

3. Pipe base shall be observed by Engineer prior to placement of the pipe.

4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.

5. Provide sheeting and shoring as specified in Section 31 23 17, Trenching.

6. Placement:

   a. Place bedding material at trench bottom.
   b. Level materials in continuous layer not exceeding 6 inches compacted depth.
   c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.

   a. PVC: Comply with ASTM D2321.
   b. Ductile Iron: Comply with AWWA C600.
   c. Reinforced Concrete: Comply with ASTM C1479.

2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

3. Lay pipe to slope gradients and line as indicated in Drawings.

4. Variations:

   a. Maximum Variation from Indicated Line: 1/32-inch per inch of pipe diameter, but no more than 1/2-inch, providing that such variation does not result in a level or reverse-sloping invert.

   b. Maximum Variation from Indicated Grade: 1/32-inch per inch of pipe diameter, but no more than1/4-inch.

   c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64-inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.

6. Assemble and handle pipe according to manufacturer’s instructions, except as may be modified on Drawings or by Engineer.

7. Make straight field cuts without chipping or cracking pipe.

8. Keep pipe and fittings clean until Work has been completed and accepted by Engineer.

9. Assemble pipe joints in accordance with manufacturer's recommendations/specifications.

10. Cap open ends during periods of Work stoppage.

11. Lay bell and spigot pipe with bells upstream.

12. Polyethylene Pipe Encasement: Conform to AWWA C105.

13. Backfill and compact as specified in Section 31 23 17, Trenching.

14. Do not displace or damage pipe when compacting.

15. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.

2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.

3. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.

4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.

5. The pipe is then forced "home" firmly and fully.

6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Connection to Existing Manholes:

1. Drilling:

   a. Core drill existing manhole to clean opening.

b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.

2. Install watertight neoprene gasket and seal with non-shrink concrete grout.

3. Encasement:

   a. Concrete encase new sewer pipe minimum of 24 inches to nearest pipe joint.

   b. Use epoxy binder between new and existing concrete.

4. Prevent construction debris from entering existing sewer line when making connection.

E. Manholes:

1. Install manholes as specified in Section 33 05 13, Manholes and Structures.

F. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.

2. Use standard fittings of same material and joint type as sewer main.

3. Maintain minimum 5-foot separation distance between wye connection and manhole.

4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.

5. Mount saddles with solvent cement or gasket and secure with metal bands.

6. Lay out holes with template and cut holes with mechanical cutter.

G. Sanitary Laterals:

1. Construct laterals from wye branch to terminal point at right-of-way or where otherwise shown in the Drawings.

2. Where depth of main pipeline warrants, construct riser-type laterals from wye branch.

3. Minimum Depth of Cover over Piping: 2 feet.

4. Minimum Separation Distance between Laterals: 5 feet.

5. Install watertight plug, braced to withstand pipeline test pressure thrust, at termination of lateral.

6. Marker Stake:

    a. Install temporary marker stake extending from end of lateral to 12 inches above finished grade.

    b. Paint top 6 inches of stake with fluorescent orange paint.

H. Backfilling:

1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.

2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

A. Request inspection by Engineer prior to and immediately after placing bedding.

B. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

2. Pipe Testing: Per ODOT Standard Specifications.

3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 41 10 - STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials and accessories normally used with gravity storm drainage sewers.

B. Section includes:

1. Storm drainage piping
2. Piping accessories
3. Connection to existing manholes
4. Catch basins and area drains
5. Cleanouts
6. Bedding and cover materials

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 23 16 - Excavation
E. Section 31 23 17 - Trenching
F. Section 31 23 23 - Fill
G. Section 33 05 13 - Manholes

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International (ASTM):

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

5. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.

6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

7. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

10. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

11. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

12. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

13. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

14. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

15. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

16. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

17. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

18. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.

5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

6. 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.

1.4 COORDINATION

A. Notify affected utility companies at least 72 hours prior to construction.

1.5 SUBMITTALS

A. See General Conditions (Volume 1) for submittal procedures.

B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:

1. Indicate special procedures required to install specified products.

2. Submit detailed description of procedures for connecting new storm sewer to existing storm sewer line.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture, dust, and direct sunlight by storing in clean, dry location remote from construction operations areas.

2. Block individual and stockpiled pipe lengths to prevent moving.

3. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Polyvinyl Chloride (PVC) Pipe:

1. Material:

a. Manufactured from rigid polyvinyl chloride compounds conforming to ASTM D1784, Class 12454-B.

b. At locations indicated in the Drawings, pipe shall conform to AWWA C900.

2. Pipe and fittings 4 inches to 15 inches in diameter, non-pressurized:

a. Comply with ASTM D3034, SDR 35.

3. Pipe and fittings 18 inches and larger in diameter, non-pressurized:

a. Comply with ASTM F679, PS46.
b. Pipe shall have a minimum stiffness of 46 pounds per square inch (psi).

4. AWWA C900 Pipe:

   a. At locations shown in the Drawings.
   b. Four inches to 12 inches in diameter.
   c. DR 25.
   d. Pipe shall have minimum stiffness of 149 psi.

5. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.

6. Joints:

   a. Integral bell push-on type: Comply with ASTM D3212.

   b. For use with AWWA C900 pipe: Integral bell push-on type comply with ASTM D3139.

7. Gaskets:

   a. Factory installed.

   b. Elastomeric gaskets: Comply with ASTM F477.

B. High Density Polyethylene (HDPE) Pipe:

1. Double wall, ribbed pipe with smooth interior.

2. Solid pipe, perforated pipe, and fittings shall meet the requirements of ASTM F-405 and F-667

3. Pipe 3 inches to 10 inches in diameter: Comply with AASHTO M-252.

4. Pipe 12 inches to 36 inches in diameter: Comply with AASHTO M-294.

5. Joints: Integral bell push-on type.

6. Manufacturers:

   a. ADS, N-12 with Pro Link joints, or approved equal.

C. Acrylonitrile-Butadiene-Styrene (ABS) Pipe:

1. Single walled. Comply with ASTM D2680, SDR 23.5.

2. Perforated.

a. Three-eighths-inch diameter holes, 3 inches on center.

3. Inside Nominal Diameter: 4 inches.

   a. Minimum Wall Thickness: 0.140 inches.

   b. One row of perforations on each side of pipe, approximately 45 degrees above bottom centerline of pipe.

4. Inside Nominal Diameter: 6 inches.

   a. Minimum Wall Thickness: 0.200 inches.

   b. Two rows of perforations on each side of pipe, approximately 45 degrees above bottom centerline of pipe.

5. Ends:

   a. Style: Bell and spigot.
   b. Type: Solvent sealed.

6. Fittings: ABS.

7. Joints:

   a. Type: Solvent weld.
   b. Comply with ASTM D2235.

2.2 FLEXIBLE COUPLINGS

A. Description:

1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
2. Attachment: Two Series 300 stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Ethylene propylene rubber (EPDM).
2. Comply with ASTM C923.
3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 30 00, Cast-in-Place Concrete.
2. Strength: Minimum 3,000 psi at 28 days.
3. Air entrained.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.5 MANHOLES

A. Description:

1. As specified in Section 33 05 13 - Manholes and Structures.
2. Material: Reinforced precast or cast-in-place concrete.
3. Diameter: As shown in the Drawings.
4. Top: As shown in the Drawings
5. Frames and Covers: Watertight cast iron.
6. Cover Inscription: “S”.

2.6 CATCH BASINS AND AREA DRAINS

A. Construction:

1. Material: Reinforced concrete pipe sections.

   a. Minimum compressive strength of 3,000 psi at 28 days.
   b. Precast concrete inlets shall conform to ASTM C913.

2. Joints: Lipped male/female.

3. Nominal Interior Dimensions: As shown in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron.

2. Lid:

   a. Removable.
   b. Design: Linear grill.

3. Nominal Lid and Frame Size: As shown in the Drawings.

2.7 CLEANOUTS

A. Construction:

1. Per details provided in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron. Meet H20 load requirement.

2.8 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

c. Subsoil Type S2**,** as specified in Section 31 05 13, Soils for Earthwork.

2.9 ACCESSORIES

A. Underground Pipe Markers: As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut, or excavation base is ready to receive Work.

B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation in accordance with Section 31 23 17, Trenching.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.

2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.

2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.

3. Pipe base shall be observed by Engineer prior to placement of the pipe.

4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.

5. Provide sheeting and shoring as specified in Section 31 23 17 Trenching.

6. Placement:

   a. Place bedding material at trench bottom.
   b. Level materials in continuous layer not exceeding 6 inches compacted depth.
   c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.

   a. PVC, HDPE, ABS: Comply with ASTM D2321.
   b. Ductile Iron: Comply with AWWA C600.
   c. Reinforced Concrete: Comply with ASTM C1479.

2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

3. Lay pipe to slope gradients and line as indicated on Drawings.

4. Variations:

   a. Maximum Variation from Indicated Line: 1/32-inch per inch of pipe diameter, but no more than 1/2-inch, providing that such variation does not result in a level or reverse-sloping invert.

   b. Maximum Variation from Indicated Grade: 1/32-inch per inch of pipe diameter, but no more than1/4-inch.

c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64-inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.

6. Assemble and handle pipe according to manufacturer's instructions, except as may be modified on Drawings or by Engineer.

7. Make straight field cuts without chipping or cracking pipe.

8. Keep pipe and fittings clean until Work has been completed and accepted by Engineer.

9. Assemble pipe joints in accordance with manufacturer's recommendations/specifications.

10. Cap open ends during periods of Work stoppage.

11. Lay bell and spigot pipe with bells upstream.

12. Backfill and compact as specified in Section 31 23 17, Trenching.

13. Do not displace or damage pipe when compacting.

14. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.

2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.

3. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.

4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.

5. The pipe is then forced "home" firmly and fully.

6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Connection to Existing Manholes:

1. Drilling:

   a. Core drill existing manhole to clean opening.

   b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.

2. Install watertight neoprene gasket and seal with non-shrink concrete grout.

3. Encasement:

   a. Concrete encase new sewer pipe minimum of 24 inches to nearest pipe joint.

   b. Use epoxy binder between new and existing concrete.

4. Prevent construction debris from entering existing sewer line when making connection.

E. Manholes:

1. Install manholes as specified in Section 33 05 13, Manholes.

F. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.

2. Use standard fittings of same material and joint type as sewer main.

3. Maintain minimum 5-foot separation distance between wye connection and manhole.

4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.

5. Mount saddles with solvent cement or gasket and secure with metal bands.

6. Lay out holes with template and cut holes with mechanical cutter.

G. Catch Basins

1. Form bottom of excavation clean and smooth, and to indicated elevation.

2. Cast-in-place Concrete Construction:

   a. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe end sections.

b. Level top surface of base pad.

c. Sleeve concrete shaft sections to receive storm sewer pipe sections.

d. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.

3. Mount lid and frame level in grout, secured to top cone section to indicated elevation.

H. Backfilling:

1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.

2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

A. Request inspection by Engineer prior to and immediately after placing bedding.

B. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

2. Pipe Testing: Per ODOT Standard Specifications.

3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 40 46 42 - CATHODIC PROCESS CORROSION PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies a galvanic-anode type cathodic protection system to protect water reservoirs. The cathodic protection system consists of magnesium anodes, test stations, and all associated wiring and hardware as required for a complete and operable system.

B. The Tank supplier shall provide Drawings that show all fittings, wiring or wiring devices required by code. Contractor shall include in its bid these and related items and the work associated with their installation.

1.2 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ASTM B843	Magnesium Alloy Anodes for Cathodic Protection
ASTM G97	Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications
UL 44	Rubber Insulated Wires and Cables
UL 467	Grounding and Bonding Equipment
UL 486	Wire Connectors and Soldering Lugs
UL 510	Insulating Tape

B. Qualifications:

1. Performed work of this Section with a firm regularly engaged in the design, repair, and maintenance of cathodic protection systems. Have a traceable, verifiable record of continuous, relevant work and performance for a minimum of three years.

2. All work shall be accomplished by qualified and experienced personnel working under continuous competent supervision.

1.3 SUBMITTALS

A. Procedures: General Conditions (Volume 1)

B. Manufacturer's product data showing conformance to the specifications for anodes, test station, splice materials, wire, wire connectors and coating materials of:

1. Anodes.
2. Reference cells.
3. Stations.
4. Wires.
5. Thermite weld materials (if applicable).
6. Coating.

C. Provide Operation and Maintenance manual for Owner use.

PART 2 EXECUTION

2.1 GENERAL

A. Materials shall be a standard product of a manufacturer regularly engaged in their production.

B. All components of the following materials shall be products of the same manufacturer to ensure compatibility and continuity.

1. Prepackaged anodes.

C. No splices shall be permitted in wires other than at locations specified on the Drawings.

2.2 MATERIALS

A. Prepackaged Anodes:

1. Weight: 20 lbs. (19.5 lbs. min.).

2. Cross section: 2 inches by 2 inches, nominal.

3. Minimum length: 60 inches.

4. Steel wire core.

5. 50 percent efficient based on their dielectric consumption rate.

6. Classified as high potential magnesium, Grade MIC, anode alloy per ASTM B843.

7. Alloy: Open circuit potential of 1.70 -1.75 volts with respect to a saturated calomel electrode based on the test procedure established in ASTM G97.

8. Chemical composition as follows:

    a. Aluminum: 0.010 percent maximum
    b. Manganese: 0. 5 to 1.3 percent
    c. Zinc: 0.004 percent maximum
    d. Silicon: 0.05 percent maximum
    e. Copper: 0.02 percent maximum
    f. Nickel: 0.001 percent maximum
    g. Iron: 0.03 percent maximum
    h. Other Impurities, each: 0.05 percent maximum
    i. Other Impurities, total: 0.30 percent maximum
    j. Magnesium: Balance Dow Magnesium Galvomag or approved equal.

9. Lead wire: Each anode shall have a minimum 15-foot long lead wire of black, Type RHW, No. 12 AWG, solid copper wire connected to one end of the steel wire core by means of silver soldering. The connection shall be insulated by filling the anode's recess area with an electrical potting compound.

10. Bag and Backfill:

    a. Packaged in a permeable cloth bag containing a backfill mixture composed of:

        1) Hydrated Gypsum: 75 percent
        2) Bentonite Clay: 20 percent
        3) Sodium Sulfate: 5 percent

    b. The backfill mixture shall be firmly packaged around the magnesium anode within the cloth bag by means of adequate vibration, with at least two full inches of backfill mixture covering the entire surface of the anode.

    c. Each anode shall have a packaged weight of not less than 70 lbs.

B. Wire:

1. Type RHW, No. 10 AWG, single conductor, stranded copper.

2. Lead wire colors:

    a. Anode header: Black.
    b. Primary containment: Blue.
    c. Secondary containment: Red.

3. UL 44. Rome Cable, Spec 2150.

C. Wire-to-Wire Connectors:

1. Copper alloy split bolt connectors of the proper size to accommodate the wires being connected together.

2. UL 467. Thomas & Betts Co., Type 9H

D. Wire-to-Pipe Connectors:

1. Brass or bronze grounding clamp specifically designed for connecting ground wires to piping of the size and type of materials being connected.

2. UL 467. Thomas & Betts Co., Type J.

E. Wire-to-Terminal Board Connectors:

1. Non-insulated, ring type crimp connector properly sized for the appropriate wire and stud where indicated.

2. UL 486. Thomas & Betts Co., Type C10-14.

F. Insulated Splice Materials:

1. Mastic:

   a. Soft, tacky, moldable, un-backed elastomeric tape.
   b. The mastic shall not have a backing tape.
   c. Royston Laboratories, "Tac-Tape".

2. Rubber Tape:

   a. Self-fusing 25 mil minimum thickness, water resistant, highly conformable rubber tape.

   b. 3M, "Scotch 23 Tape”.

3. Vinyl Tape:

   a. 7 mil vinyl electrical tape that is conformable and adhesive-backed.
   b. UL 510. 3M, "Scotch 33+ Tape".

4. Electrical Coating:

   a. Moisture proof coating designed for electrical splices.
   b. 3M, "Scotchkote" (Part No. 14853).

G. Wire to Pipe Connector Coating:

1. Wax tape composed of a synthetic fabric, saturated with a blend of petroleum wax, plasticizers and corrosion inhibitors, forming a tape wrapper.

2. Designed as a pipe coating for below ground use and resistant to water, chemicals and bacteria.

3. Coating: Non-hardening and re-enterable.

4. Trenton Corp., "#1 Wax Tape"

H. Cable Warning Tape

1. Polyethylene tape, minimum 6 inches wide, red or yellow in color, and labeled "CAUTION - CATHODIC PROTECTION".

2. Reef Industries, "Terra Tape”.

2.3 TEST STATIONS

A. Junction Box:

1. Fiberglass.
2. Used as the termination point of the anode and test wires.
3. Provide with quick release latches and lockable hasp.

2.4 WIRE

A. Underground Wiring: Unless otherwise indicated, single conductor, stranded, copper per ASTM Specification B-3 and B-8.

B. Color-coded and/or labeled as shown on the drawings.

C. Wire Connectors: UL listed ring type crimp connectors properly sized for the appropriate wire and terminal where indicated per UL 486.

2.5 CONDUIT AND FITTINGS

A. 1-1/4-inch schedule 40 PVC.

2.6 ANODE METERING SHUNTS

A. 0.1 ohm, 2 ampere capacity, with 1 percent accuracy.

PART 3 EXECUTION

3.1 GENERAL

A. The exact locations and routing of cables and conduits shall be governed by structural conditions and physical interference. The final placement of the anodes and test station shall be at the locations approved by Engineer.

B. All materials, workmanship and installation shall conform with all requirements of the legally constituted authority having jurisdiction. These authorities include, but are not limited to, the National Electric Code, General Construction Safety Orders of the Industrial Accident Commission, and all other applicable State, County, or City codes and regulations.

C. Unless otherwise indicated, install all materials in accordance with the manufacturer's recommendations, safety procedures and as shown.

D. Where requirements of this section conflict with the manufacturer's recommendations, the manufacturer's recommendations shall take precedence.

E. Store all materials and equipment to be used in construction in such a manner as to be protected from detrimental effects from the elements. If actual storage is not available, stack materials and equipment well above ground level and protect from the elements as appropriate.

3.2 INSTALLATION

A. Inspection:

1. Inspect the anodes and materials to ensure that damage has not been incurred through shipping or through mishandling.

2. Handle anodes carefully at all times and do not drop or drag.

3. Do not handle, lift or lower anodes by means of the anode's lead wires.

4. Replace anodes that have been damaged to the extent that the permeable cloth bag has been torn and backfill material has been lost.

B. Prepackaged Anodes:

1. Remove all wrapping (not the cloth bag) and be place in the hole.

2. Take care to protect the anode lead wires.

3. Install by either of the following methods:

   a. Vertical Installation: Augur a 15-foot deep, 7-inch minimum diameter hole in which the anodes shall be placed as shown. Lower the anodes into the hole with a rope. DO NOT USE THE LEAD WIRE.

   b. Horizontal Installation: Place anodes in a ditch as indicated on the Drawings. Make the bottom of the ditch level before installing the anode.

4. Maintain the anodes free of oils, chemicals, paint, petroleum products and other foreign chemicals or coatings. Remove all coatings, wrapping and protective shipping material from the anode prior to installation.

5. Install the magnesium anodes as shown on the drawings. Magnesium anodes are required at all locations where the piping contacts concrete underground. Install 3 inches from the pipe and 3 inches maximum from the concrete interface.

6. Place soil that is free from rocks and debris around the anode. When soil has been placed to the top of the anode, pour water into the hole to saturate the anode backfill and adjacent soil as necessary. Continue backfilling with native soil to ground surface.

7. Each anode wire shall terminate in the corresponding test station and shall be connected to the appropriate terminal as designated on the drawings.

8. Damage to the canvas bag enclosing the anode and backfill material, anode to wire connection, copper wire, or wire insulation will require replacement of the entire assembly.

C. Backfill:

1. Comply with Section 31 20 20.

2. Place cable warning tape above the anodes and anode header cable located within the pump station at a depth of approximately 12 inches.

D. Anode Header Cable:

1. Route to the test station in a trench at least 24 inches deep.

2. Terminate in the test station as detailed on the Drawings.

3. Connect the prepackaged anode lead wires to the header cable with a copper split bolt at the locations designated.

4. Splice lead wire connections as detailed on the Drawings.

E. Wire Connections:

1. Leave at least 12 inches of slack in wires at splices and anodes to accommodate settling forces.

2. Connect the magnesium anode lead wires to the anode header cable by means of a split bolt connector.

3. Remove only enough insulation from the cables to allow sufficient copper wire contact inside the split bolt connector.

4. Do not cut through the header cable.

5. Take care to ensure that the copper cables/wires are not cut or damaged.

6. Make the connection using the proper torque on the split bolt connector to ensure a tight connection between the wires.

3.3 COPPER-COPPER SULFATE REFERENCE CELLS

A. Maintain free of oils, chemicals, paint, petroleum products and other foreign chemicals or coatings. Remove all coatings, wrapping and protective shipping material from the reference cell prior to installation.

B. Install as shown on the drawings. Place each cell approximately 4” inches from the pipe.

C. Do not handle or lower by the lead wire. Place soil that is free from rocks and debris around the reference cell. When soil has been placed to the top of the cell, pour water into the hole to saturate the cell and adjacent soil as necessary. Continue backfilling with native soil to ground surface.

D. Each reference cell wire shall terminate in the corresponding test station and shall be connected to the appropriate terminal as designated on the drawings.

E. Damage to the cell, cell to wire connection, copper wire, or wire insulation will require replacement of the entire assembly.

3.4 TEST STATIONS

A. Route test leads and anode header cable to the designated test station location.

B. Set flush to grade.

C. Cut wires to provide 18 to 24 inches of slack wire extending above grade.

D. Connect wires to the test board using ring style crimp connectors.

E. Install the test stations at the locations indicated on the drawings. Field locate the test stations on grade to avoid other structures and to allow for easy future access. Each test station is comprised of a fiberglass junction box and a vault to house the junction box.

F. Install the test station vault flush to finish grade with a concrete collar poured for support. Fill below the vault with Granular Drain Backfill Material as described in Oregon Department of Transportation Standard Specification Section 00430.11 for adequate drainage.

G. Place the fiberglass junction box in the vault where the test wires terminate. Provide approximately 18 inches of slack in the wires between the conduit and the junction box. Provide the entrance into the junction box for the wiring with a sealed watertight connection.

H. Route the test wires from the pipe, reference cells, and anodes to the test vault through schedule 40 PVC conduit.

I. Connect one #10 test wire and one #6 test wire to the piping at each test station. Route the structure wires into the junction box, but do not connect to their corresponding terminals. Connection of the structure wires will be completed by the Engineer during testing of the system after native potentials have been measured.

J. Install one reference cell for each test station.

3.5 COMPLETION

A. Upon completion of the cathodic protection system, notify the Project Representative that the system is ready for final checkout and testing.

3.6 TESTING

A. Test and adjust the cathodic protection system upon completion of work to ensure that the system is installed and functions properly.

END OF SECTION

SECTION 40 61 00 - PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies requirements for process instrumentation and control for Division 40, which consists of hardware, software, and services necessary to provide the control functions specified.

B. The required control system uses information and requirements in other Contract Drawings, Schedules and Narrative/Specifications. The Drawings and Schedules depict application dependent data while the Narrative/Specifications define broader requirements such as overall quality and performance.

C. The Process Control System (PCS) consists of the following:

1. Installation, commissioning and testing of all field instruments, new and existing, that will provide analog or discrete information to the new SCADA/PLC.

2. Manufacture, installation, commissioning and testing of all new Local Control Panels (LCP) at each well, new North & South buildings and the existing building at the South facility.

3. Manufacture, installation, commissioning and testing of all motor control panels for wells 4, 6, 7 and 9. Note: Well 8 has an existing VFD power panel requiring electrical modifications to conform to the process control format identified in the FVNR wiring diagram drawings.

4. Procurement, installation, configuration and testing of the SCADA hardware per the drawings and specifications including all Cyber Security devices, network equipment, PC workstations, Server(s), Mobile laptop, fiber/copper Ethernet communications, FirstNet cellular systems.

5. Hardware shall be fully commissioned by the Hardware System Integrator (HSI) to support the Software System Integrator’s (SSI) developed process control software. Software System Integrator’s responsibilities are under a separate contract.

6. Testing of the PLC I/O shall be coordinated by the HSI with the SSI and the Owner’s Construction Manager/Field representative. All testing submittals shall be approved by the engineer prior to testing. All testing and configuration documents shall be provided to the Owner in electronic pdf format for final review and system approval. In addition to other test documents, the contractor shall utilize 40 61 06 Instrument Loop Testing Forms for each device to be connected to the PLC systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. It is a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
API RP 551	Process Measurement Instrumentation
API RP 552	Transmission Systems - first Edition
ANSI/ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ANSI/ISA S5.1	Instrumentation symbols and Identification
ANSI/ISA S51.1	Process Instrumentation Terminology
ISA S5.3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer systems
ISA RP12.2.02	Recommendations for the Preparation, Content and Organization of Intrinsic Safety Control Drawings
NFPA 70	National Electric Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery
IEC 61131:2020 SER	Programmable Controllers – ALL PARTS
IBC 1632	International Building Code
UL 508	Industrial Control Equipment
UL 508A	Industrial Control Panels
UL 60947	Low Voltage Switchgear and Controlgear

B. Qualifications: The hardware systems integration company which constructs and installs the process instrumentation and control system shall have the following qualifications at a minimum:

1. A single systems integration company regularly engaged in the design and installation of systems of similar scope and complexity.

2. The systems integration company and its personnel shall have demonstrated a history of successful execution of the work commensurate with the scope of work of this Contract.

3. A minimum of three years in the business of providing system integration.

4. Completed the same type of work specified on at least five projects of equal or larger size.

5. Local support within 100 miles of the work site.

6. Has an electrical or controls engineer currently registered as a professional engineer in the state of Oregon to supervise the work.

7. The on-site project manager shall have a minimum of five years' experience installing water control systems of similar scope and complexity.

C. Labeling: all electrical control panels shall be manufactured in conformance with UL 508A and shall bear the UL label.

D. Perform detailed design for new facilities for all interconnected components. Interconnected components shall include new and existing mechanical and electrical equipment specified in other sections of the Contract Documents, as well as new and existing process control system equipment specified within Division 40.

E. Calibrate, test, and start up the complete process instrumentation and control system.

F. Place the completed system in operation including tuning loops and making final adjustments to instruments as required during the start-up.

G. Provide the services of skilled instrument technicians for testing, calibration, and adjustment activities under direct on-site supervision of the electrical or controls engineer.

1.3 SUBMITTALS

A. Procedures: General Conditions (Volume 1)

B. Catalog cuts of all furnished components and equipment.

C. Fabrication drawings with keyed Bills of Materials. Furnish hard copy as well as electronic format.

D. Seismic design information including a list of equipment weighing 400 pounds or more.

E. Certifications.

F. Factory test schedule and procedure including all test forms.

G. Field test schedule and procedure including all test forms.

H. Test Reports.

I. Operation and maintenance information.

J. Elementary Drawings and Loop Diagrams: Hard copy as well as electronic format.

K. Connection Diagrams. Furnish hard copy as well as electronic format.

L. Interconnection Diagrams. Furnish hard copy as well as electronic format.

1.4 DEFINITIONS

A. Unless otherwise specified, the definitions of terminology used in Division 40 shall be as defined in ISA S51.1.

B. Electronic Format:

1. Drawings shall be AutoCAD 2011 or newer ".dwg" format files based on the City's CAD standards.

2. Tabular data shall be submitted in electronic format compatible with Microsoft Excel 2010®.

3. Text data shall be submitted in electronic format compatible with Microsoft Word 2010®.

1.5 DESCRIPTION OF SYSTEM

A. Process Control System consists of the following, installed in accordance to NFPA 70:

1. A SCADA HMI and Historian based system.

2. Programmable Logic Controllers, (PLC).

3. Hardwired and ethernet based smart motor control panel(s) (MCP) including conventional panel-mounted switches, controllers, recorders, and indicators; specific purpose panels, local control panels for individual equipment manual control. Manufactured and including the requirements of UL 508A. Refer the wiring schematic diagram drawings.

4. Conventional field instrumentation including primary elements, indicating transmitters, level, and pressure switches.

5. Final control elements such as valve positioners, instrumentation and solenoids.

B. The process control system interfaces with variable frequency drives, motor control centers, and other auxiliary equipment.

C. Hierarchical Levels:

1. A description of how each unit process is controlled within this control hierarchy is shown in the control strategies as described in Section 40 61 96 and as shown on the Drawings.

2. In all cases, the control system shall be capable of controlling all processes as described in Division 40 and as shown on the Drawings.

3. Generally, the process control system consists of three levels of control

   a. The first level of control is local HOA HAND/OFF field control where the operator can start/stop or open/close the equipment without the interaction of a PLC.

   b. The second level is PLC based MANUAL control (Local HOA in AUTO) where the operator can select the equipment at the SCADA HMI and start/stop or open/close the equipment with the interaction of the PLC.

   c. The third level is AUTO control at the SCADA HMI where the operator selects AUTO control of the systems and inputs supervisor setpoints to automatically control the system based on the changing conditions of the process instrumentation. This includes all analog and discrete Flow, Pressure, Level and Analytical Chemical instruments connected to the SCADA/PLC system.

D. SCADA System: Included for telemetering alarms and status information. The SCADA system includes the PLC system and special communication and interface modules.

E. FIRSTNET: This is the cellular telemetry system that provides the PLC based SCADA system wide area critical alarms and important process variables. FirstNet modems shall be configured for continuous connected Ethernet operation. Refer to the Cradle Point Modem configuration documentation for details regarding this configuration.

1.6 EXISTING CONDITIONS

A. Examine the mechanical Drawings and Specifications to determine actual locations, sizes, materials and ratings of process connections.

B. Any "as-built" or record drawings of existing work presented in these Contract Documents are for information only and may not accurately represent existing conditions. Field-investigate all existing facilities modifications to ascertain the exact physical and electrical conditions in each case. After field investigation, revise as required installation and interface wiring drawings to conform with actual conditions and comply with codes and Contract requirements. Submit revisions to the Project Representative. Provide a detailed design and implement the proper method for physical installation and interface wiring for the required modifications.

1.7 DESIGN AND PERFORMANCE REQUIREMENTS

A. Catalog Cuts:

1. Include catalog information, technical specifications, and application information for each piece of equipment to be furnished.

2. Edit catalog cuts to indicate only those items, models, or series of equipment to be furnished. Cross out or otherwise obliterate all extraneous materials information. Clearly identify all configuration options for the equipment to be furnished.

3. Include data sheets in accordance with ISA S20 and a complete listing of all instruments to be furnished or modified, as well as any existing equipment that may be included in the work of this contract.

B. Drawings:

1. The Contract Drawings are functional in nature and do not show exact locations of equipment and may not show all necessary interconnections between equipment.

2. Fabrication drawings:

   a. Submit detailed interconnection diagrams, wiring diagrams, elementary diagrams, loop diagrams, and process and instrument diagrams with all electrical and electronic components clearly identified by equipment and/or loop tag number.

   b. Submit detailed construction drawings for all panel layouts and equipment enclosures with dimensions in inches. Show both exterior and interior views.

3. Wiring and loop diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with Divisions 26 and 40.

4. Each control circuit, control loop, control panel layout design, etc., shall be represented on a unique drawing. Control circuits, loop diagrams, and panel layouts referenced to typical diagrams are not acceptable.

5. Drawing symbol format shall comply with NFPA 79, ISA 5.1, ISA 5.3 and where appropriate, ISA RP 12.2.02.

6. Hardcopy plots shall be 11-inch by 17-inch (half-size) or 22 inch by 34 inch (full-size), as required.

7. Minimum Text size: 0.125 inch for 22 x 34 inch drawings, 0.063 inch for 11 x 17 inch drawings.

8. Drawings shall have borders and title blocks identifying the Contract, facility, system, and revisions to the drawing, and type of drawing. Borders and title blocks shall conform to current County drafting standards.

9. Each release of a drawing shall carry a revision number, date, and a brief description of the changes. All changes associated with a given release shall be indicated on the drawing by a revision flag. Changes on the latest revision shall be indicated by clouding.

10. Transfer record drawings per the General Conditions (Volume 1) to the City in electronic format on CD and hard copy when work is completed.

C. Elementary and Loop Diagrams:

1. Contract Drawings are functional in nature and may not show the exact wiring needed to achieve the required functions.

2. Provide complete elementary diagrams for equipment control.

3. Prepare loop diagrams in compliance with ISA S5.4 and provide for all analog loops.

4. Comply with NFPA 79.

5. Show circuits and devices of a system.

6. Arrange to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system.

7. Show wire numbers, signal polarities, and terminal block numbers. Tables for wire numbers, signal polarity, and terminal block numbers are not acceptable.

8. Wiring between circuit elements shall terminate on terminal blocks, and shall not be connected from element to element. Exceptions are: common wires among contacts on a single circuit element (e.g., switch or relay contacts, but NOT the relay coil).

D. Wiring Diagrams:

1. Panels: comply with NFPA79.

2. Show components of a control panel in an arrangement similar to the actual layout of the panel.

3. Show internal wiring between devices within the panel.

4. Show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such.

5. Wiring diagrams shall indicate insulation color code, signal polarities, and show wire numbers and terminal block numbers.

E. Interconnection Diagrams:

1. Submit complete interconnection diagrams for field wiring.

2. Show each panel and field devices.

3. Show wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers.

4. Comply with NFPA79.

F. Certifications:

1. Temperature: Test data certified by the manufacturer to demonstrate that field electronic devices are suitable for the specified ambient temperatures.

2. Corrosion: Test data showing design features of the electronic equipment provided to protect against damage by the specified atmospheric contaminants and specific evidence that similarly protected electronic equipment has operated in similar environments for a period of not less than five years without failure due to corrosion.

G. Seismic Design:

1. Procedure and submittals: per the General Conditions (Volume 1).

2. Structures and equipment shall be braced to prevent damage from specified forces.

3. Equipment shall not be required to function properly during periods of seismic disturbance but shall be capable of manual restart without repair or modification following a disturbance.

1.8 FACTORY TEST

A. Prior to factory test to be witnessed by the Project Representative, complete the following:

1. Inspect and test the process instrumentation and control system including the main control panel, PLC, local control panels, etc., to ensure they are operational.

2. Ensure that proper materials have been used during manufacture and assembly and parts and materials have been correctly assembled and wired.

3. Complete an integrated test:

   a. Interconnect and test the process control and instrumentation system, except for primary elements, final control elements, and small control stations.

   b. Exercise and test all functions to ensure proper manufacture and assembly of the completed panel and/or system.

   c. Test all panels.

   d. Simulate inputs and outputs for primary elements, final control elements, and small control stations excluded from the test.

B. Location: Test within Oregon State.

C. The Project Representative may elect to witness the factory test. Provide a written test schedule and notify the Project Representative no less than seven days prior to the test.

D. The factory test: Test and document the following functions:

1. Exercise and test all functions, including PLC software functions.

2. Provide test equipment to simulate discrete and analog inputs and outputs. All I/O shall be exercised.

3. Provide a testing simulation program to exercise all discrete and analog outputs to confirm proper loop operation.

4. Provide screens for the Operator Interface (OI), if provided, to display and alarm simulated statuses and confirm system response to operator inputs.

5. Demonstrate that all panels and subsystems have the required spare capacity for expansion. Include test for I/O storage capacity and program memory capacity.

E. At a minimum, have the following at the test available for review and use:

1. All applicable Drawings, Specifications, Addenda and Change Orders.
2. Factory test procedure including all test forms.
3. Shop drawings and hardware submittals for equipment being tested.
4. Software documentation.

F. Correct deficiencies and retest prior to shipment of the equipment to the work site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Ship as a single unit to work site.

2. Anchor and brace equipment weighing 400 pounds or more to resist seismic forces per UBC 1632. Seismic criteria for the work site are listed.

B. Delivery Inspection: Notify the Project Representative and provide access for inspection upon arrival of any material or equipment to be incorporated into the work. Remove protective covers when required.

C. Control Panels:

1. Completely wired and tested in the factory prior to being shipped to the job site.
2. Shipped as a single unit to job site after testing is complete.
3. No internal wiring shall be disconnected for transportation.

1.10 MATERIALS AND QUALITY

A. The Instrument Schedule in Section 40 70 00 lists major instruments required to provide the process instrumentation system. Provide all functions specified in the instrument schedule. Provide additional instruments that may be required to complete the instrument loops because of certain characteristics of the particular equipment selected by the Contractor. Provide such additional instruments even though not specified in the Instrument Schedule or shown on the Drawings.

B. In some cases, it is possible to combine the functions of two or more instruments specified in the Instrument Schedule into a single instrument. An example of functions that may be ordinarily combined into a single instrument are multiple alarms derived from a common transmission signal. Alarm or safety functions derived directly from process measurements shall not be combined with instruments operating from transmission signals. Critical alarms or safety functions shall not be combined into any instrument used for process control, indication, or recording.

C. Existing instruments to be re-used and connected to the SCADA/PLC system for control/monitoring shall be reconnected to the new PLC and/or motor control systems.

D. Material shall be new, free from defects, and of the quality specified. Each type of instrument, accessory, and device shall be by the same manufacturer.

E. Unless otherwise specified, electronic equipment shall be of solid-state construction. Components of standard electronic assemblies shall not be replaced with components of different characteristics in order to meet the performance requirements of the specification. Parts shall be as shown in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

PART 2 PRODUCTS

2.1 SCADA SYSTEM

A. General:

1. The hardware systems integrator subcontractor shall provide network hardware as described herein and as shown on the Drawings. The developed SCADA software and ladder logic programming shall be provided by the Engineer/SSI. The Contractor shall provide the process control servers and workstations setup and configured based on the City's IT/OT standards.

2. Minimum SCADA hardware to be provided are listed below. Additional hardware may be required as part of the system to complete a functioning Ethernet network and is the responsibility of the hardware system integrator. Refer to the I-300 drawing for the network diagram.

   a. Roaming Operator Workstation

   b. South Site – SCADA/Historian Server and Workstation located in existing pump building.

   c. Filter Building South – Workstation located in the MCC room of the new filter building

   d. Filter building North – Workstation located in the MCC room of the new filter building

   e. Well Networks – No Workstations located in the Well buildings.

   f. FIRSTNET Cellular installation, configuration and setup – Portable workstations, South existing pump building, North filter building, Well No. 6, and No. 7.

   g. Wells 4, 8 and 9 shall be connected via ethernet fiber optic and require FO/RJ45 converters.

   h. Contractor to supply all network hardware as identified on the network diagram and any additional network equipment required by Rockwell and AT&T FirstNet to complete the network communication systems.

   i. Each PC hardware shall be based on (Minimum Requirements) Dell Optiplex towers with Windows 10 Professional, 32GB, 1x32GB, DDR4 non-ECC Memory

RAM, 3.5 inch 2TB 7200rpm SATA Hard Disk Drive and 10th Generation Intel® Core™ i9-10900K (10-Core, 20MB Cache, 3.7GHz to 5.3GHz, 125W), NVIDIA GeForce RTX 3070, 8GB (3DP/HDMI), Dell Pro Wireless Keyboard and Mouse - KM5221W – English, Dual Dell 27 Monitor - E2720H (2 for each computer).

j. Laptop shown on the network diagram was prepurchased by the City and is not part of this contract.

k. Network switches shall be based on (Minimum Requirements): 1783 Stratix® 5700 Managed Industrial Ethernet Switches sized for each location shown on the network diagram. PLC panel switches shall be 1783 Stratix® 2500 Lightly Managed Switches All switches shall be configured and tested.

3. The Contractor's on-site instrumentation and controls project engineer shall supervise and coordinate all activities related to the requirements of Division 40 and be responsible to the Contractor.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. The Contractor's on-site instrumentation and controls project engineer shall supervise and coordinate all activities related to the requirements of Division 40 and be responsible to the Contractor.

2. Equipment shall be located and protected so that it is readily accessible for operation and maintenance as required by NFPA70. Equipment shall be located between 48 and 66 inches above the floor or a permanent work platform.

3. Provide instrument tags for all field instruments engraved with the equipment number as identified on the Process and Instrument Diagrams and/or the Instrument Schedule Section and in compliance with 26 05 53. Tags shall be stainless steel and affixed to the field equipment with stainless steel screws or stainless-steel wire. Engraved text shall be not less than 0.125 inches high.

4. Use API RP 551 and PR 552 as a guide where installation procedures that are not specified herein.

5. Coordinate installation with other work to avoid interference with normal operation of on-line equipment and processes.

6. Provide the services of skilled instrument technicians for testing, calibration, and adjustment activities.

7. Unless otherwise specified, instrumentation support systems shall be constructed of stainless steel.

8. Instrument supports shall not be attached to handrails, process piping, or mechanical equipment unless required in order to perform the measurement function.

9. No instrument shall be mounted directly flush to walls without a minimum of 5/8” spacing.

10. Anchor and brace equipment.

B. Signal Transmission:

1. Unless otherwise specified, signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall have a loop compliance of at least 500 ohms.

2. Two-wire loop transmitters shall operate at 24 VDC.

3. Loops shall be grounded at the LCP terminal block by bonding to the instrument panel signal ground bus. Separate grounded conductors shall be provided for each loop. Daisy chaining of grounded conductors from one loop to another is not allowed.

4. Provide isolating amplifiers for field equipment possessing a grounded input or output, or having a common mode voltage other than system ground.

5. Convert platinum resistance temperature detector (RTD) outputs to 4-20 milliampere signals at the RTD, or where shown on the Drawings.

6. All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted except where specifically noted in the Instrument Schedule. When transmitters with non-standard outputs are approved as an “Or Equal” substitution, their output shall be converted to 4 to 20 milliamperes at the field instrument.

3.2 TESTS AND INSPECTIONS

A. General Requirements:

1. All required tests beginning with the Factory Test, will be witnessed by the Project Representative or County-designated person unless a written exemption is provided.

2. Notify the Project Representative of the test date seven days prior to the test.

3. Submit a detailed step-by-step test procedure, complete with forms for the recording of test results, testing equipment used, and identification of the technician performing and witnessing the test.

4. Test reports: conform to the requirements of the testing Forms in 40 61 06 and ISA S20.

B. Test Equipment:

1. Unless specified otherwise, provide all test equipment to complete all specified tests.

2. Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test.

3. Each test instrument shall be calibrated prior to the commencement of a testing activity and checked after the completion of a testing activity.

4. Submit dated and certified calibration reports traceable to the National Institute of Standards and Technology (NIST) with the test report. Calibration certification date shall be within three months of date of use on this Contract.

5. Provide buffer solutions and reference fluids for tests of analytical equipment.

C. Test Stages:

1. General:

2. Testing of piping, wiring, and individual components shall be completed with certified test reports completed, which shall be provided to the Project Representative prior to commencement of individual loop testing.

3. Un-witnessed factory test: Testing prior to Factory Test: see Paragraph 40 61 13-1.08.

4. Factory test: see Paragraph 40 61 00-1.08.

5. Individual component calibration and test:

    a. Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test form.

    b. This test is to be witnessed by the Project Representative.

c. Alarm trips, control trips, and switches shall be set to initial values specified in the Instrument Schedule.

d. Final elements shall be checked for range, dead-band, and speed of response.

e. Any component that fails to meet the required tolerances shall be repaired by the manufacturer or replaced.

f. Repeat above tests until the component is within tolerance.

6. Loop test:

a. Test each instrument loop as an integrated system. This test shall check operation from transmitter to signal receiving components, and from the main control panel to final control elements. This test is to be witnessed by the Project Representative.

b. Inject signals at the field terminations to simulate primary measuring elements.

c. Output of each auto/manual station shall be manually varied from 0 to 100 percent, and correct operation of final control element verified.

d. Each alarm circuit shall be manually actuated at the field sensor.

e. Verify correct operation of the applicable annunciator window.

f. Where alarm contact is connected to the PLC system, correct PLC responses shall be monitored and verified.

7. Closed-loop test:

a. Test shall demonstrate stable operation of the loop under actual Facility operating conditions. This test includes adjustment of loop tuning parameters and shall be witnessed by the Project Representative.

b. Unless otherwise specified, adjust tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop to provide ¼-amplitude damping or better.

c. Prepare a chart recording showing loop response to a step disturbance for each loop.

d. Make two charts for cascade loops, one showing the secondary loop response with its set point on manual, and the second showing overall loop response.

e. Electronic chart recordings shall be made at sufficient speed and amplitude to clearly show specified amplitude damping and shall be annotated to show loop number and title, and settings of parameters and set point.

8. SCADA system test:

   a. Coordinate with the SSI and the Owner's Project Manager/Representative for the requirements of this test.

   b. Test both the PLC-to-SCADA connection, and the FirstNet connection. Check both systems end-to-end from the field sensor location to the treatment plant control room.

   c. Provide the services of a qualified technician for at least 24 labor-hours to assist in this test.

   d. Check that the equipment is functioning correctly and as specified.

   e. Check that all specified signals are telemetered and received at each location.

   f. Check that all control signals are telemetered correctly from the treatment plant control room and the appropriate control action is observed on the field equipment.

END OF SECTION

SECTION 40 61 06 - INSTRUMENT LOOP TESTING FORMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Related Work Specified in Other Sections:

1. Section 40 70 00 Instrumentation for Process Control
2. Section 26 08 00 Commissioning of Electrical Systems

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association (NEMA) Publication:

1. ICS 1 General Standards for Industrial Controls and Systems
2. ICS 6 Enclosures for Industrial Controls and Systems Enclosures

B. International Electrical Testing Association (NETA):

1. TS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

1.3 SUBMITTALS

A. Submit all test data sheets in accordance with the Product Review category of the General Conditions and the submittal requirements of the General Conditions (Volume 1).

1.4 QUALITY ASSURANCE

A. Follow written procedures for loop testing and verification. Any failed test shall be repeated after corrections are made.

1.5 PROJECT CONDITIONS

A. Verify the equipment has been installed properly and all work is complete prior to testing.

1.6 COORDINATION

A. Coordinate with other contractors, the engineer and the Client's operations personnel to conduct all testing functions. Test must be witnessed and the Owner's Representative must signoff for each loop test.

PART 2 PRODUCTS

2.1 MANUFACTURERS

None.

PART 3 EXECUTION

3.1 INSTALLATION

None

3.2 TESTING

A. Field Tests. Perform the tests for all instrumentation as identified in the attached loop test forms. Submit reports for review by the Engineer.

END OF SECTION

40 61 06 - 1. INSTALLED ANALOG INSTRUMENT TEST FORM:

Equipment/Tag Number: ________________________________ Date of Test: _______________________

Equipment Description: ____

Location/Process: ______________________________________ Ambient Temp ºF __________________

Associated Circuit Breaker/Fuse Identification: Panel # _____________________ CB/Fuse # ___________

Factory Set Range of Device: _______________, Field Set Range of Device:__________________________

Sample Averaging Implemented? NO □ YES □ # of Samples Averaged: _______________________________

Period of Sampling: ___________

Note other Configuration Settings modified in Device:

____

Resistance of wire (Ohm Meter Readings – NOTE: Not a Meger test):

Signal Wire to GND ___________, Return to GND ___________,

Shield to GND (not terminated) _____________, Signal to Return _____________,

Signal to Shield ______________, Return to Shield ______________,

% of Range	Signal Generated	Expected Output	Actual Output	PLC Input Raw	PLC Input Scaled	HMI Display Reading
0%		4 mA				
25%		8 mA				
50%		12 mA				
75%		16 mA				
100%		20 mA				

Associated PLC: ________________________ Rack: ___ Slot: ___ Channel: ___
Associated PLC tag name: _________________________
Associated HMI tag name: _________________________

Note any other anomalies during testing:

____

____

CERTIFIED ____ Date ________________________
Contractor's Representative

WITNESSED ____ Date ________________________
Owner's Representative

40 61 06 - 2. INSTALLED DISCRETE INSTRUMENT TEST FORM:

Equipment/Tag Number: ___________________________ Date of Test: ____________________

Equipment Description: ____

Location/Process: ____________________________ Ambient Temp ºF _____________________

Associated Circuit Breaker/Fuse Identification: Panel #_______________ CB/Fuse #__________

Factory Settings of Device: ___________, Field Settings of Device: _________________________

Hysteresis Characteristics of Device: Set (1) Point: ____________ Reset (0) Point ____________

Function of Discrete Point: ____

Note other for Device:

____

Resistance of wire (Ohm Meter Readings – NOTE: Not a Meger test):

Signal Wire to GND ___________, Return to GND ___________,

** Shield to GND (not terminated) ____________, Signal to Return ____________,

Signal to **Shield _____________, Return to ** Shield _____________,

** Insert N/A if no shield on cable

Discrete Signal	Signal Generated	Expected Output	Actual Output	PLC Input Raw	PLC Input Scaled	HMI Display Reading
Actuated Closed		Set or 1				
Actuated Opened		Reset or 0				

Associated PLC: ______________________ Rack: ___ Slot: ___ Channel: ___
Associated PLC tag name: ______________________
Associated HMI tag name: ______________________

Note any other anomalies during testing:

____

____

CERTIFIED ____ Date ____________________
Contractor's Representative

WITNESSED ____ Date ____________________
Owner's Representative

SECTION 40 61 93 - PLC INPUT/OUTPUT LIST

Process Area Code	Equipment Name	Number Code	Equip Suffix	Description	Type	ISA ID	PLC
WEL04	LIT	0401	AA	Well No. 4 Level	AI	LI_	WELL 4
WEL04	PMP	0401	AA	Well No. 4 Pump Over Temperature	DI	TAH	WELL 4
WEL04	PMP	0401	AB	Well No. 4 Pump Fault	DI	XA_	WELL 4
WEL04	PMP	0401	AC	Well No. 4 Pump Local Switch in Auto	DI	YI_	WELL 4
WEL04	PMP	0401	AD	Well No. 4 Pump Running	DI	XI_	WELL 4
WEL04	PMP	0401	AE	Well No. 4 Pump Call to Run	DO	XC_	WELL 4
WEL04	PIT	0401	AA	Well No. 4 Discharge Pressure Transmitter	AI	PI_	WELL 4
WEL04	PSH	0401	AA	Well No. 4 Discharge Pressure Switch	AI	PAH	WELL 4
WEL04	FIQ	0401	AA1	Well No. 4 Flow Totalizer Indication (Pulse Input)	DI	FIQ	WELL 4
WEL04	SCA	0401	AA	Well No. 4 Pump Runtime	R_	XQI	WELL 4
WEL06	LIT	0601	AA	Well No. 6 Level	AI	LI_	WELL 6
WEL06	PMP	0601	AA	Well No. 6 Pump Over Temperature	DI	TAH	WELL 6
WEL06	PMP	0601	AB	Well No. 6 Pump Fault	DI	XA_	WELL 6
WEL06	PMP	0601	AC	Well No. 6 Pump Local Switch in Auto	DI	YI_	WELL 6
WEL06	PMP	0601	AD	Well No. 6 Pump Running	DI	XI_	WELL 6
WEL06	PMP	0601	AE	Well No. 6 Pump Call to Run	DO	XC_	WELL 6
WEL06	PIT	0601	AA	Well No. 6 Discharge Pressure Transmitter	AI	PI_	WELL 6
WEL06	PSH	0601	AA	Well No. 6 Discharge Pressure Switch	AI	PAH	WELL 6
WEL06	FIQ	0601	AA1	Well No. 6 Flow Totalizer Indication (Pulse Input)	DI	FIQ	WELL 6
WEL06	SCA	0601	AA	Well No. 6 Pump Runtime	R_	XQI	WELL 6
WEL07	LIT	0701	AA	Well No. 7 Level	AI	LI_	WELL 7
WEL07	PMP	0701	AA	Well No. 7 Pump Over Temperature	DI	TAH	WELL 7
WEL07	PMP	0701	AB	Well No. 7 Pump Fault	DI	XA_	WELL 7
WEL07	PMP	0701	AC	Well No. 7 Pump Local Switch in Auto	DI	YI_	WELL 7
WEL07	PMP	0701	AD	Well No. 7 Pump Running	DI	XI_	WELL 7
WEL07	PMP	0701	AE	Well No. 7 Pump Call to Run	DO	XC_	WELL 7
WEL07	PIT	0701	AA	Well No. 7 Discharge Pressure Transmitter	AI	PI_	WELL 7
WEL07	PSH	0701	AA	Well No. 7 Discharge Pressure Switch	AI	PAH	WELL 7
WEL07	FIQ	0701	AA	Well No. 7 Flow Totalizer Indication (Pulse Input)	DI	FIQ	WELL 7

Process Area Code	Equipment Name	Number Code	Equip Suffix	Description	Type	ISA ID	PLC
WEL07	SCA	0701	AA	Well No. 7 Pump Runtime	R_	XQI	WELL 7
WEL08	LIT	0801	AA	Well No. 8 Level	AI	LI_	WELL 8
WEL08	PMP	0801	AA	Well No. 8 Pump Over Temperature	DI	TAH	WELL 8
WEL08	PMP	0801	AB	Well No. 8 Pump Fault	DI	XA_	WELL 8
WEL08	PMP	0801	AC	Well No. 8 Pump Local Switch in Auto	DI	YI_	WELL 8
WEL08	PMP	0801	AD	Well No. 8 Pump Running	DI	XI_	WELL 8
WEL08	PMP	0801	AE	Well No. 8 Pump Call to Run	DO	XC_	WELL 8
WEL08	PIT	0801	AA	Well No. 8 Discharge Pressure Transmitter	AI	PI_	WELL 8
WEL08	PSH	0801	AA	Well No. 8 Discharge Pressure Switch	AI	PAH	WELL 8
WEL08	FIQ	0801	AA	Well No. 8 Flow Totalizer Indication (Pulse Input)	DI	FIQ	WELL 8
WEL08	SCA	0801	AA	Well No. 8 Pump Runtime	R_	XQI	WELL 8
WEL09	LIT	0901	AA	Well No. 9 Level	AI	LI_	WELL 9
WEL09	PMP	0901	AA	Well No. 9 Pump Over Temperature	DI	TAH	WELL 9
WEL09	PMP	0901	AB	Well No. 9 Pump Fault	DI	XA_	WELL 9
WEL09	PMP	0901	AC	Well No. 9 Pump Local Switch in Auto	DI	YI_	WELL 9
WEL09	PMP	0901	AD	Well No. 9 Pump Running	DI	XI_	WELL 9
WEL09	PMP	0901	AE	Well No. 9 Pump Call to Run	DO	XC_	WELL 9
WEL09	PIT	0901	AA	Well No. 9 Discharge Pressure Transmitter	AI	PI_	WELL 9
WEL09	PSH	0901	AA	Well No. 9 Discharge Pressure Switch	AI	PAH	WELL 9
WEL09	FIQ	0901	AA	Well No. 9 Flow Totalizer Indication (Pulse Input)	DI	FIQ	WELL 9
WEL09	SCA	0901	AA	Well No. 9 Pump Runtime	R_	XQI	WELL 9
WTR13	LIT	1301	AA	South Storage Tank No. 1 Level Transmitter	AI	LI_	SFB PLC
WTR13	LSH	1301	AA	South Storage Tank No. 1 Level Alarm High	DI	LAH	SFB PLC
WTR13	LSL	1301	AA	South Storage Tank No. 1 Level Alarm Low	DI	LAL	SFB PLC
WTR13	LIT	1302	AA	South Storage Tank No. 2 Level Transmitter	AI	LI_	SFB PLC
WTR13	LSH	1302	AA	South Storage Tank No. 2 Level Alarm High	DI	LAH	SFB PLC
WTR13	LSL	1302	AA	South Storage Tank No. 2 Level Alarm Low	DI	LAL	SFB PLC
WTR14	PMP	1401	AA	South Booster Pump No. 1 Local Switch in Auto	DI	YIA	SFB PLC
WTR14	PMP	1401	AB	South Booster Pump No. 1 Local Switch in Hand	DI	YIB	SFB PLC

Process Area Code	Equipment Name	Number Code	Equip Suffix	Description	Type	ISA ID	PLC
WTR14	PMP	1401	AC	South Booster Pump No. 1 Fault Alarm	DI	XA_	SFB PLC
WTR14	PMP	1401	AD	South Booster Pump No. 1 Running Indication	DI	XI_	SFB PLC
WTR14	PMP	1401	AE	South Booster Pump No. 1 Speed Indication	AI	SI_	SFB PLC
WTR14	PMP	1401	AF	South Booster Pump No. 1 Call to Run	DO	XC_	SFB PLC
WTR14	PMP	1401	AG	South Booster Pump No. 1 Demanded Speed	AO	SC_	SFB PLC
WTR14	PMP	1402	AA	South Booster Pump No. 2 Local Switch in Auto	DI	YIA	SFB PLC
WTR14	PMP	1402	AB	South Booster Pump No. 2 Local Switch in Hand	DI	YIB	SFB PLC
WTR14	PMP	1402	AC	South Booster Pump No. 2 Fault Alarm	DI	XA_	SFB PLC
WTR14	PMP	1402	AD	South Booster Pump No. 2 Running Indication	DI	XI_	SFB PLC
WTR14	PMP	1402	AE	South Booster Pump No. 2 Speed Indication	AI	SI_	SFB PLC
WTR14	PMP	1402	AF	South Booster Pump No. 2 Call to Run	DO	XC_	SFB PLC
WTR14	PMP	1402	AG	South Booster Pump No. 2 Demanded Speed	AO	SC_	SFB PLC
WTR14	PMP	1403	AA	South Fire Pump Local Switch in Auto	DI	YIA	SFB PLC
WTR14	PMP	1403	AB	South Fire Pump Local Switch in Hand	DI	YIB	SFB PLC
WTR14	PMP	1403	AC	South Fire Pump Fault Alarm	DI	XA_	SFB PLC
WTR14	PMP	1403	AD	South Fire Pump Running Indication	DI	XI_	SFB PLC
WTR14	PMP	1403	AE	South Fire Pump Speed Indication	AI	SI_	SFB PLC
WTR14	PMP	1403	AF	South Fire Pump Call to Run	DO	XC_	SFB PLC
WTR14	PMP	1403	AG	South Fire Pump Demanded Speed	AO	SC_	SFB PLC
WTR11	FIT	1101	AA	South WTP Flow Indicating Transmitter	AI	FI	SFB PLC
WTR11	FIT	1101	AA	South WTP Flow Totalizer Indication	R_	FQI	SFB PLC
WTR11	PIT	1101	AA	South WTP Pressure Indicating Transmitter	AI	PI	SFB PLC
WTR12	LT	1210	AA	South Hypo Storage Tank Level Transmitter	AI	LIT	SFB PLC
WTR12	LSH	1210	AA	South Hypo Storage Tank Leak Switch	DI	LAH	SFB PLC
WTR12	LSL	1210	AB	South Hypo Storage Tank Low Level Switch	DI	LAL	SFB PLC
WTR12	LSHH	1210	AC	South Hypo Storage Tank High-High Level Switch	DI	LAHH	SFB PLC
WTR12	PMP	1210	AA	South Hypo Meter Pump 1 Call to Run	DO	XC_	SFB PLC
WTR12	PMP	1210	AB	South Hypo Meter Pump 1 Demand Speed	AO	SC_	SFB PLC
WTR12	PMP	1211	AA	South Hypo Meter Pump 2 Call to Run	DO	XC_	SFB PLC

Process Area Code	Equipment Name	Number Code	Equip Suffix	Description	Type	ISA ID	PLC
WTR12	PMP	1211	AB	South Hypo Meter Pump 2 Demand Speed	AO	SC_	SFB PLC
WTR12	LT	1221	AA	South xxx Storage Tank T-501 Level Transmitter	AI	LIT	SFB PLC
WTR12	LSH	1221	AA	South xxx Storage Tank T-501 Leak Switch	DI	LAH	SFB PLC
WTR12	LSHH	1221	AB	South xxx Storage Tank T-501High-High Level Switch	DI	LAHH	SFB PLC
WTR12	PMP	1221	AA	South xxx Meter Pump 1 Call to Run	DO	XC_	SFB PLC
WTR12	PMP	1221	AB	South xxx Meter Pump 1 Demand Speed	AO	SC_	SFB PLC
WTR23	LIT	2301	AA	North Storage Tank No. 1 Level Transmitter	AI	LI_	NFB PLC
WTR23	LSH	2301	AA	North Storage Tank No. 1 Level Alarm High	DI	LAH	NFB PLC
WTR23	LSL	2301	AA	North Storage Tank No. 1 Level Alarm Low	DI	LAL	NFB PLC
WTR23	LIT	2302	AA	North Storage Tank No. 2 Level Transmitter	AI	LI_	NFB PLC
WTR23	LSH	2302	AA	North Storage Tank No. 2 Level Alarm High	DI	LAH	NFB PLC
WTR23	LSL	2302	AA	North Storage Tank No. 2 Level Alarm Low	DI	LAL	NFB PLC
WTR24	PMP	2401	AA	North Booster Pump No. 1 Local Switch in Auto	DI	YIA	NFB PLC
WTR24	PMP	2401	AB	North Booster Pump No. 1 Local Switch in Hand	DI	YIB	NFB PLC
WTR24	PMP	2401	AC	North Booster Pump No. 1 Fault Alarm	DI	XA_	NFB PLC
WTR24	PMP	2401	AD	North Booster Pump No. 1 Running Indication	DI	XI_	NFB PLC
WTR24	PMP	2401	AE	North Booster Pump No. 1 Speed Indication	AI	SI_	NFB PLC
WTR24	PMP	2401	AF	North Booster Pump No. 1 Call to Run	DO	XC_	NFB PLC
WTR24	PMP	2401	AG	North Booster Pump No. 1 Demanded Speed	AO	SC_	NFB PLC
WTR24	PMP	2402	AA	North Booster Pump No. 2 Local Switch in Auto	DI	YIA	NFB PLC
WTR24	PMP	2402	AB	North Booster Pump No. 2 Local Switch in Hand	DI	YIB	NFB PLC
WTR24	PMP	2402	AC	North Booster Pump No. 2 Fault Alarm	DI	XA_	NFB PLC
WTR24	PMP	2402	AD	North Booster Pump No. 2 Running Indication	DI	XI_	NFB PLC
WTR24	PMP	2402	AE	North Booster Pump No. 2 Speed Indication	AI	SI_	NFB PLC
WTR24	PMP	2402	AF	North Booster Pump No. 2 Call to Run	DO	XC_	NFB PLC
WTR24	PMP	2402	AG	North Booster Pump No. 2 Demanded Speed	AO	SC_	NFB PLC
WTR24	PMP	2403	AA	North Fire Pump Local Switch in Auto	DI	YIA	NFB PLC
WTR24	PMP	2403	AB	North Fire Pump Local Switch in Hand	DI	YIB	NFB PLC
WTR24	PMP	2403	AC	North Fire Pump Fault Alarm	DI	XA_	NFB PLC
WTR24	PMP	2403	AD	North Fire Pump Running Indication	DI	XI_	NFB PLC

Process Area Code	Equipment Name	Number Code	Equip Suffix	Description	Type	ISA ID	PLC
WTR24	PMP	2403	AE	North Fire Pump Speed Indication	AI	SI_	NFB PLC
WTR24	PMP	2403	AF	North Fire Pump Call to Run	DO	XC_	NFB PLC
WTR24	PMP	2403	AG	North Fire Pump Demanded Speed	AO	SC_	NFB PLC
WTR21	FIT	2101	AA	North WTP Flow Indicating Transmitter	AI	FI	NFB PLC
WTR21	FIT	2101	AA	North WTP Flow Totalizer Indication	R_	FQI	NFB PLC
WTR21	PIT	2101	AA	North WTP Pressure Indicating Transmitter	AI	PI	NFB PLC
WTR22	LT	2210	AA	North Hypo Storage Tank Level Transmitter	AI	LIT	NFB PLC
WTR22	LSH	2210	AA	North Hypo Storage Tank Leak Switch	DI	LAH	NFB PLC
WTR22	LSL	2210	AB	North Hypo Storage Tank Low Level Switch	DI	LAL	NFB PLC
WTR22	LSHH	2210	AC	North Hypo Storage Tank High-High Level Switch	DI	LAHH	NFB PLC
WTR22	PMP	2210	AA	North Hypo Meter Pump 1 Call to Run	DO	XC_	NFB PLC
WTR22	PMP	2210	AB	North Hypo Meter Pump 1 Demand Speed	AO	SC_	NFB PLC
WTR22	PMP	2221	AA	North Hypo Meter Pump 2 Call to Run	DO	XC_	NFB PLC
WTR22	PMP	2221	AB	North Hypo Meter Pump 2 Demand Speed	AO	SC_	NFB PLC
WTR22	LT	2221	AA	North xxx Storage Tank T-501 Level Transmitter	AI	LIT	NFB PLC
WTR22	LSH	2221	AA	North xxx Storage Tank T-501 Leak Switch	DI	LAH	NFB PLC
WTR22	LSHH	2221	AB	North xxx Storage Tank T-501High-High Level Switch	DI	LAHH	NFB PLC
WTR22	PMP	2221	AA	North xxx Meter Pump 1 Call to Run	DO	XC_	NFB PLC
WTR22	PMP	2221	AB	North xxx Meter Pump 1 Demand Speed	AO	SC_	NFB PLC
WTR15	FS	1501	AA	South Safety Shower Flow Switch Alarm	DI	FA_	Main
WTR15	FA	1501	AA	South Fire Alarm	DI	YA1	Main
WTR15	GEN	1501	AA	South Generator Running	DI	XI_	Main
WTR15	GEN	1501	AA	South Generator Fail	DI	YA2	Main
WTR15	GEN	1501	AA	South Generator Low Fuel	DI	YA3	Main
WTR15	GEN	1501	AA	South Generator Fuel Leak	DI	YA4	Main
WTR15	ATS	1501	AA	South ATS in Normal Position	DI	XI1	Main
WTR15	ATS	1501	AB	South ATS in Standby Position	DI	XI2	Main
WTR15	PF	1501	AA	South Power Fail	DI	A5	Main
WTR25	FS	2501	AA	North Safety Shower Flow Switch Alarm	DI	FA_	Main

Process Area Code	Equipment Name	Number Code	Equip Suffix	Description	Type	ISA ID	PLC
WTR25	FA	2501	AA	North Fire Alarm	DI	YA1	Main
WTR25	GEN	2501	AA	North Generator Running	DI	XI_	Main
WTR25	GEN	2501	AA	North Generator Fail	DI	YA2	Main
WTR25	GEN	2501	AA	North Generator Low Fuel	DI	YA3	Main
WTR25	GEN	2501	AA	North Generator Fuel Leak	DI	YA4	Main
WTR25	ATS	2501	AA	North ATS in Normal Position	DI	XI1	Main
WTR25	ATS	2501	AB	North ATS in Standby Position	DI	XI2	Main
WTR25	PF	2501	AA	North Power Fail	DI	A5	Main

END OF SECTION

SECTION 40 61 96.10 - EQUIPMENT HAND-OFF-AUTO OR START-STOP CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section describes the PLC control and monitoring of mechanical equipment such as pumps, blowers, and compressors.

1.2 PROCESS OVERVIEW

A. Operations puts the Hand-Off-Auto (HOA) or Start-Stop (0/1) switches for equipment in the desired positions. There may be more than one level of switches for each piece of equipment. The combined positions of the switches determine how the equipment operates and whether control is by the operator or PLC logic.

PART 2 PRODUCTS

2.1 PROCESS AND INSTRUMENTATION EQUIPMENT

A. There will be a local physical switch for each piece of equipment. This switch will either be within sight of the equipment or in an MCC that controls the equipment.

B. There may be one or more levels of computer based Human Machine Interface (HMI) control switches on HMI terminals and/or SCADA computers. These will be software switches which will be set through the terminals or computer interfaces.

PART 3 EXECUTION

3.1 CONTROL FEATURES

A. The local physical HOA switch determines whether control is direct from that switch or passed to the HMI/SCADA and PLC (automated) system.

1. For ON/OFF type of equipment, the HOA switches shall have switch “H” and “A” status and the MCC will provide the equipment Running/Stopped status connected to PLC discrete inputs. The “H” status will be shown as HOA HAND to indicate the equipment is not available for PLC control. For the HOA switch in the OFF position (not HAND & not AUTO) the status will be shown as HOA OFF to indicate the equipment is not available for control. The “A” status will be shown as HOA AUTO to indicate the equipment is available for SCADA control.

2. When a local HOA switch is in the “H” position, the switch contacts shall energize the motor control coil that starts the equipment; when it is in the “O” position, the coil is de-energized.

3. A valve which has a HOA switch is controlled locally in HOA HAND mode by selecting OPEN or CLOSE buttons at the VALVE actuator. When the valve HOA is in HOA OFF no control is available. When the valve HOA is in the HOA AUTO position, the SCADA system has control of the valve.

Equipment HOA Status indication at the SCADA system

FIELD HOA SWITCH*	SCADA HOA SELECTOR!	PLC ACTION	EQUIPMENT STATUS DISPLAY
HAND	Disabled	Local Control ON	HOA HAND/NA - RUNNING
OFF	Disabled	Local Control OFF	HOA OFF/NA - STOPPED
AUTO	HAND	Start ON	HOA AUTO/HAND - RUNNING
AUTO	OFF	Start OFF	HOA AUTO/OFF - STOPPED
AUTO	AUTO	By Logic	HOA AUTO/AUTO – Strategy Based

* Switch located in field on MCC or near the equipment.
! Selector located at the SCADA HMI

B. When the HOA switch is in the HOA AUTO position, the SCADA system has control of the equipment. Equipment associated with one process is considered a grouping of equipment and is controlled as a group. An operator with the correct security credentials can select various modes of equipment control. The primary mode of SCADA HOA Selector HAND and SCADA HOA Selector OFF modes. The next level of control is SCADA HOA Selector AUTO mode(s).

1. In SCADA selector MANUAL mode, the operator starts, manually sets the speed of the equipment.

2. In SCADA selector OFF mode, the operator stops the equipment.

3. In SCADA Selector AUTO mode, the operator can only set supervisory setpoints (such as Level, Pressure, Flow, etc.) or select sequence of operation (such as Lead/Lag/Standby). The SCADA software automatically starts/stops, opens/closes, changes speed or sets the valve position based on the software strategy design.

   NOTE: There can be as many AUTO modes programmed in the PLC to perform different automated strategic functions as required. For example, AUTO1 mode may control pumps based on a level setpoint and maintain that setpoint by varying the speed and number of operating pumps to maintain the desired level. AUTO2 mode may allow for cycling of a large body of water between a high and a low level setpoint. In AUTO2, the strategy may be turning pumps on and off as the high and low level setpoints are reached. AUTO(n), etc.

C. SCADA Generated Alarms: In addition to physical discrete equipment alarms, there are two types of equipment fail alarms generated via software in the SCADA system: Deviation Alarms and Discrepancy Alarms.

1. Deviation Alarms occur when equipment has been operating as requested and then deviates from that state. i.e., Start Request/Equipment Running, Stop Request/Equipment Stopped, Open Request/Valve Opened, Close Request/ Valve Closed, speed/position request and the equipment has reached the requested speed/position.

2. Discrepancy Alarms occur when the equipment has been requested to go to a new state and does not reach that state within an operator adjustable period of time. For Speed and Position requests, there must be an associated deadband (typically no more than 3%) to allow for inaccuracies in feedback signals.

SCADA Generated Deviations/Discrepancy Alarms

PLC OUTPUT	STATUS FEEDBACK	ALARM DELAY	FAIL ALARM
START ON	OFF	1-30 s *	IN ALARM
START ON	ON	1-30 s *	NORMAL
START OFF	OFF	1-30 s *	NORMAL
START OFF	ON	1-30 s *	IN ALARM
OPEN ON	CLOSED	1-120 s *	IN ALARM
OPEN ON	OPENED	1-120 s *	NORMAL
CLOSED ON	CLOSED	1-120 s *	NORMAL
CLOSED ON	OPENED	1-120 s *	IN ALARM
POSITION, SPEED	0-100%	1-120 s *	>3%* ALARM, <3%* NORMAL

* Values are operator adjustable and alarming can be enabled/disabled.

D. EQUIPMENT RUNTIME: Equipment shall have runtime registers that accumulate the time based on the equipment RUNNING status.

1. Equipment shall have an ongoing accumulated run time register that contains the hours the equipment has run. A Supervisor with the correct security level shall be able to reset the runtime accumulation to zero when executed. The runtime value shall be stored in the historian.

2. Equipment shall have a daily runtime register that accumulates runtime for the current day in tenths of hours. The register shall reset at a preset time each day. The previous daily runtime shall be stored in a previous day register and displayed in the SCADA system.

3. Runtime shall be formatted and stored in hours and minutes.

E. MOTOR STARTS COUNTER: Motors shall have start count registers that accumulate the number of starts for the equipment.

1. Equipment shall have an ongoing accumulated start count register that contains the number of starts the equipment has experienced. A Supervisor with the correct security level shall be able to reset the number of starts to zero when executed. The number of starts shall be stored in the historian.

2. Equipment shall have an hourly start count register that accumulates start counts. Depending on the motor requirements, the number of starts per hour may be used to minimize damage to a motor should the manufacturer's recommended number of starts per hour be reached. The motor shall only be allowed to start (in HOA AUTO) when the number of starts register decrements by one count. An alarm shall also be issued if the accumulator reaches the maximum counts per hour. NOTE: in Emergency situations, the HOA switch allows the operator to start the motor in HOA HAND even if the number of starts register value is equal to or greater than the manufacturers recommend hourly starts.

F. FLOW TOTALS: Flow metering at the SCADA level shall have either or both of the following flow accumulator registers associated with each flow meter.

1. For flow meter devices that provide an analog flow signal (typically 4-20mA) that do not have a discrete pulsed total signal, the analog signal shall be used to provide a flow totalization value at SCADA.

2. For flow meter devices that provide a discrete pulsed total (i.e., 1 pulse = 1000 gallons), the pulsed value will be used to provide a flow totalization value at SCADA. NOTE: f the flow meter device has both types of signals available, the discrete signal shall be used for flow totalization.

END OF SECTION

SECTION 40 61 96.20 - EQUIPMENT LEAD/LAG/STANDBY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section describes the monitoring and control of equipment that is installed in sets, where each item in the set has a common purpose. The purpose might be to provide an air flow or to pump a common fluid. For example, a Clear well pump station may have a set of two or more pumps.

1.2 PROCESS OVERVIEW

A. When two or more units of mechanical equipment are declared to operate in LEAD/LAG, LEAD/LAG /STANDBY, or LEAD /STANDBY modes, they will be controlled sequentially. The LEAD, LAG, and STANDBY status of each member of the set will be determined by selected control parameters.

PART 2 PRODUCTS

2.1 GROUPS OF EQUIPMENT WITH A COMMON PURPOSE

A. Two or more (n) equipment items are designated to run LEAD/LAG1/…/LAG(n-1).

B. Two equipment items are designated to run LEAD /STANDBY.

C. Three or more (n) equipment items are designated to run LEAD/LAG1/…/LAG(n-2)/STANDBY.

PART 3 EXECUTION

3.1 CONTROL FEATURES

A. The operator with the correct security access shall be able to select via SCADA display, the equipment LEAD/LAG1/LAG(n)/Standby priorities.

1. The operator shall select the AUTO mode of control and a popup window appears with the LEAD/LAG1/LAG(n)/Standby selection table. The operator can select LEAD/LAG1/LAG(n)/Standby priority of each piece of equipment. When the operator has completed the selection process, the operator must press the CONFIRM software button by selecting it with the mouse. If the operator has made an error in the selection process by having selected the same priority for two

different pieces of equipment, the CONFIRM button will “greyed out” and not available.

2. Equipment must be in HOA AUTO, in the selected AUTO strategy mode and not failed to be available for automated control. If a unit is not available for control, the PLC logic will exclude it from the set when determining LEAD /LAG/STANDBY status. If a unit is selected by switch to be LEAD and it is unavailable, the STANDBY unit in the set will act as LEAD. If the STANDBY unit is not available, then the LAG1 will act as LEAD and so on.

3. If a unit is running in “HOA HAND” mode, it will be designated as acting lead by the control logic. Lag selections will be determined by SCADA logic based on the operator selected priority and from equipment available to operate automatically.

B. Sequentially start and stop LEAD/LAG units.

1. When a process signal indicates a unit in a set should be stopped or started, a delay timer is started. When the timer expires, the unit is requested to start or stop. The delay timer will minimize cycling of pumps should a false signal be observed by the control system.

2. If a safety or equipment failure issue requires immediate stop or shutdown of the equipment, the logic shall shutdown the process and provide descriptive alarms as to the strategy shutdown procedure. NOTE: Hardware interlocks should already be in place to stop the equipment for personnel or equipment safety shutdown.

Example of Lead/Lag Selection

Description	Lead	Lag 1	Lag 2	Standby
Pump 1	X			
Pump 2		X		
Pump 3			X	
Pump 4				X

END OF SECTION

SECTION 40 61 96.30 - ALARMS AND EVENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section describes features common to all alarms and events.

1.2 PROCESS OVERVIEW

A. A specific alarm input to a PLC from equipment will indicate an alarm condition.

B. Operating conditions that indicate a hazardous or abnormal operation will cause a derived alarm condition. Control descriptions for equipment and systems will describe these alarms.

C. SCADA generated alarms are based on process conditions.

D. Events are any action, status, or change of state that occurs and is not defined as an alarm but is recorded and historically stored by the SCADA system.

PART 2 PRODUCTS

2.1 PROCESS AND INSTRUMENTATION EQUIPMENT

A. Alarm contacts on equipment wired to PLC inputs or bit registers for equipment that communicates by a control network with a PLC will indicate an alarm condition.

B. Derived alarms will be determined by PLC logic from analog signals and discrete signals and will be calculated as described in equipment or system control strategies. Signals may be PLC I/O wired to devices or from control network communications from equipment.

C. All alarms shall utilize the PLC/SCADA system ALARM MODULE object.

D. All alarms shall be displayed on an ALARM SUMMARY display in the SCADA system and historically stored in the Historian database.

E. Events shall be displayed on an EVENT SUMMARY display in the SCADA system and historically stored in the Historian database.

F. ALARMS and EVENTS shall be categorized in different groups within the SCADA system to allow separation of alarms from events. A supervisor with the correct logon credentials shall be able to generate an ALARM/EVENT log by combining the ALARM and EVENT groups. This function provides a sequence of events for review after an alarm occurs to identify process control or operational issues that may have caused the alarm.

PART 3 EXECUTION

3.1 CONTROL FEATURES

A. Alarms from alarm inputs for an equipment unit or package shall be delayed by an operator adjustable time. The time will be preset and timers shall be non-retentive. Unless specified otherwise in the equipment control description, the time shall be adjustable from 1 to 600 seconds. The alarm signal must remain on for the full delay period before the alarm output is generated and displayed.

B. Alarms derived from analog signals shall have supervisor/programmer adjustable setpoints. The setpoints shall be scaled in the same units as the displayed analog value. These alarms shall be delayed by an operator adjustable time. The time will be a preset for a non-retentive timer. Unless specified otherwise in the equipment control description, the time shall be adjustable from 1 to 30 seconds. The alarm signal must remain on for the full delay period before the alarm output is generated and displayed.

C. Alarms may be latched or non-latched. Equipment and system control descriptions will specify the alarm type.

1. Latched alarms will remain on once generated, until the alarm condition ends and a reset signal is generated by the operator. The reset signal will be specified as a global reset from a common operator input, or a specific reset input or action.

    a. Latched alarms for pumps, blowers, and compressors shall be reset by a dedicated momentary switch or by cycling an HOA switch to the OFF position and back to the AUTO position.

    b. Latched alarms may have interlocks as describe in the equipment control description.

2. Non-Latched alarms will cancel when the alarm condition stops. These alarms may also be interlocked with equipment operation.

D. Once an alarm is generated by the PLC, the HMI/SCADA displays will activate the alarm in the displays and log the alarm to an alarm history database. Failed equipment will flash on the HMI/SCADA displays (or an alarm indicator will flash near the failed equipment graphic) until the alarm condition ends, and for latched alarms, is reset. Alarm action for the HMI/SCADA displays shall be per ISA 18.1 Sequence A.

E. Alarm Dialer software in the SCADA system shall be configurable to call out specified alarms to an alarm alert list. A list of alarms that are to activate the dialer when enabled, and a list of names and phone numbers of personnel to receive alarms, will be supplied by the Owner during startup.

3.2 ALARM CATEGORIES

A. Alarms: Alarming is most important in making a HMI/SCADA System easy to operate and maintain. With a proper Alarm Management Philosophy, an operator can effectively identify and resolve issues with process alarming and provide correct information to maintenance personnel about equipment alarms. Alarm indication, acknowledgement, and handling can be addressed at the HMI/SCADA level. Alarms are generated from the PLC systems but no special alarm handling programming is required at the PLC level.

Keeping in mind the Harrisburg project is only a portion of the entire future SCADA system, careful designation of alarm Groups is important. By carefully assigning Groups at the early stages of a SCADA system's development effort, future addition of other SCADA "areas" (i.e., Reservoirs, Pump Stations, a second facility, etc.) will have already been provided room for the alarming functions required under the upgrade and any future expansion.

B. Alarm and Tag Groups: Groups of alarms are created to segregate alarms to a particular facility or process area. By creating groups of process specific alarms, an operator is enabled to create an "alarm filter" that allows isolated viewing of particular alarm groups in an Alarm Summary. This is particularly helpful when a large number of alarms have been received by the HMI and the operator is interested in focusing on a particular facility and/or process area.

An alarm can be a member of a specific Process Group and also a member of an Area Group. Alarm Groups can be set between 0000 to 9999 levels.

Group#	Description	SCADA Group Name Examples	Area Designation
0000-0099	**Reserved for SCADA**		**WTR00**
0000	SCADA & Telemetry System	0000_SCADA_GENERAL_SYSTEMS	WTR00
0100-0199	**Reserved for Wells**		**Wxx***
0100	Wells 1 through 99	0100_GROUND_WELL_SYSTEMS	WEL00
0104	**Well #4 Systems**	0104_WELL_4_xxxxxxxxxxxxxxxxx	**WEL04**
0106	**Well #6 Systems**	0106_WELL_6_xxxxxxxxxxxxxxxxx	**WEL06**
0107	**Well #7 Systems**	0107_WELL_7_xxxxxxxxxxxxxxxxx	**WEL07**
0108	**Well #8 Systems**	0108_WELL_8_xxxxxxxxxxxxxxxxx	**WEL08**
0109	**Well #9 Systems**	0109_WELL_9_xxxxxxxxxxxxxxxxx	**WEL09**
0200-0999	**Reserved**		
1000-1999	**Reserved for South WTP Site**		**WTR01**
1200	Pressurized Filter System	1200_SOUTH_PRESS_FILTR_SYSTEMS	**WTR** 01
1300	Reservoir Control	1300_SOUTH_RESERVOIR_SYSTEMS	**WTR** 01
1400	Booster Pumps	1400_SOUTH_BOOSTER_PMP_SYSTEMS	**WTR** 01
1500	Generator	1500_SOUTH_GENERATOR_SYSTEMS	**WTR** 01
1600	Electrical Room	1600_SOUTH_ELECTRICAL_SYSTEMS	**WTR** 01
1700	Chemical Systems Control	1700_SOUTH_CHEMICAL_SYSTEMS	**WTR** 01
1800	Facility Area Monitoring	1800_SOUTH_FACILITY_AREA_SYSTEMS	**WTR** 01
2000-2999	**Reserved for North WTP Site**		**WTR 02**
2200	Pressurized Filter System	2200_NORTH_PRESS_FILTR_SYSTEMS	**WTR** 02
2300	Reservoir Control	2300_NORTH_RESERVOIR_SYSTEMS	**WTR** 02
2400	Booster Pumps	2400_NORTH_BOOSTER_PMP_SYSTEMS	**WTR** 02
2500	Generator	2500_NORTH_GENERATOR_SYSTEMS	**WTR** 02
2600	Electrical Room	1600_NORTH_ELECTRICAL_SYSTEMS	**WTR** 02
2700	Chemical Systems Control	1700_NORTH_CHEMICAL_SYSTEMS	**WTR** 02
2800	Facility Area Monitoring	1800_NORTH_FACILITY_AREA_SYSTEMS	**WTR** 02
3000-3999	Reserved for additional WTP/Systems		
3000-3999	**Distribution Systems Monitoring**	**TBD**	**Dxx ***
4000-4999	**Reserved for Sewer Lift Stations**	**TBD**	**Sxx***
5000-5999	**Reserved for Storm Water Lift Stations**	**TBD**	**Sxx***
9000-9999	**Reserved for WasteWater System**	TBD	

* Indicates the Reservoir, Well, or System two-digit number.
Xxxxxxxxxxxxx TBD Based on requirements

C. Alarm Priority: Alarm Priority allows a Systems Developer to set various levels of alarming for further segregation on the Alarm Summary Alarm Priorities are set between 0000 to 9999 levels.

1. High-High Process Alarms – A very high priority alarm needing immediate operator attention and action. Example: Clear Well level has reached a critical high-high level and the lead and lag pumps have not been able to keep up with the increase in level. Operator intervention required.

2. High Process Alarms – A high priority alarm needing immediate operator attention and potentially operator action. Example: Clear Well level has reached a high level and the lead and lag pumps have not been able to keep up with the increase in level.

3. High-High Process Event – An event the process control system uses to control equipment in a normal manor. Example: Clear Well has reached the high-high level turn on the lag pump.

4. High Process Event - An event the process control system uses to control equipment in a normal manor. Example: Clear Well has reached the high-level turn on lead pump.

5. Intermediate Process Event - An event the process control system uses to control equipment in a normal manor. Example: Air scour is complete continue to next stage of backwash.

6. Low Process Event - An event the process control system uses to control equipment in a normal manor. Example: Shut the lag sump pump off.

7. Low-Low Process Event - An event the process control system uses to control equipment in a normal manor. Example: Shut the lead sump pump off.

8. Low Process Alarm – A high priority alarm needing immediate operator attention and potentially operator action.

9. Low-Low Process Alarm – A high priority alarm needing immediate operator attention and action. Example: Chemical tank level reaches critical low-low level.

10. Process Time-out Alarm – A medium priority alarm needing operator attention and potentially operator action. Example: Filter backwash sequence fails and times out.

11. Equipment Impending Fail Alarm – A high priority alarm needing immediate operator attention and potentially operator action. Example: Moisture alarm in a sump pump.

12. Equipment Fail Alarm – A high priority alarm needing immediate operator attention and action. Example: Motor circuit breaker trips.

13. Equipment State Deviation Alarm – A medium priority alarm needing immediate operator attention and potentially operator action. The equipment was on/open and changed state to off/closed without an automated process request or operator request to change.

14. Equipment State Discrepancy Alarm – A high priority alarm needing immediate operator attention and potentially operator action. The equipment was requested

to change state from on/open to off/closed and has not done so in the allot amount of time. Also applies to changes in position and speed.

The Alarm Priority also lends itself to creation of Events and an Event Summary. An Event Summary is any discrete point in the SCADA/HMI system designated with the lowest priority alarm status. This can be any event in the system that should be recorded in the Alarm History Records. Events can be; an operator signing on to the system, a valve reaching it's open/closed position, a motor run indication, any equipment transition from one state to another.

All alarm timers will have a system default of 3 seconds. If the PLC controller is reset or program downloaded and the previous operator entered setpoints are not retained, the system default will be 3 seconds.

D. Alarm Presentation: The typical Alarm Presentation occurs on the small alarm summary found on all process displays and the Alarm Summary. The alarm presentation provides the following information:

1. DATE
2. TIME
3. STATE of the alarm – UNACK, ACK, UNACK-RET
4. CLASS – Alarm Category
5. TYPE
6. PRIORITY
7. NAME – Tag used for the alarm
8. GROUP
9. PROVIDER
10. VALUE
11. LIMIT
12. OPERATOR – Operator's ID associated with ACK of the alarm
13. COMMENT – Information regarding the alarm.

END OF SECTION

SECTION 40 61 96.40 - PERIPHERAL MONITORING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section describes the monitoring of the peripheral devices at the Treatment Buildings and Wells 4, 6, 7, 8 and 9. Peripheral devices are not associated with the process but can be monitored by the SCADA systems.

B. These devices will be designated by the Client and may or may not be applicable for this application. If the devices are not shown on the drawings, then they are not applicable.

1.2 PLANT OVERVIEW

A. Peripheral device alarms/events appear on a Plant Overview display and the Alarms/Events displays to indicate their status.

PART 2 PRODUCTS

2.1 INSTRUMENTATION EQUIPMENT FOR PERIPHERAL DEVICES

A. Door Switches.
B. Roof or Reservoir Hatch Switches.
C. Fire/Smoke Switches (Typically from the FA Panel if connected to SCADA).
D. Operator-In-Trouble Panic Button (Typically an E-Stop mounted on the wall)
E. Motion Sensors for intrusion detection (not lighting).
F. Ambient Internal/External Temperatures
G. Equipment Temperatures
H. Weather Station Info
I. Misc.

PART 3 EXECUTION

3.1 MONITORING FEATURES

A. Refer to the drawings for applicable devices.

1. Monitoring and Alarming

a. Control Panel High Temperature
b. Well Building Temperatures
c. Well Building Intrusion Alarm

d. Operator In Trouble Alarm
e. Smoke Alarm
f. Low Air Temperature Alarm

2. Calculations

   a. None.

3. Graphics – Associated with Plant or Area Overview Displays

END OF SECTION

SECTION 40 61 96.50 - WELL CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section describes the PLC control and monitoring of the Wells 4, 6, 7, 8 & 9.

1.2 PROCESS OVERVIEW

A. An operator switches the Hand-Off-Auto (HOA) switches at the equipment to the desired position. The position of the switch determines how the equipment operates and whether control is by the operator locally at the MCC/FVNR/VFD or by remote SCADA logic.

B. Refer to the electrical drawing schematics for local electrical control functions and SCADA/PLC Input/Output process control and monitoring.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. The Wells include the following process related equipment.

1. Well 4 Pump
2. Well 4 Discharge to Waste Valve
3. Well 4 Main Feed Valve
4. Well 4 Check Valve
5. Well 4 Level Transmitter
6. Well 4 Pressure Switch
7. Well 6 Pump
8. Well 6 Discharge to Waste Valve
9. Well 6 Main Feed Valve
10. Well 6 Check Valve
11. Well 6 Level Transmitter
12. Well 6 Pressure Switch
13. Well 7 Pump
14. Well 7 Discharge to Waste Valve
15. Well 7 Main Feed Valve
16. Well 7 Check Valve
17. Well 7 Level Transmitter
18. Well 7 Pressure Switch
19. Well 8 Pump
20. Well 8 Discharge to Waste Valve

21. Well 8 Main Feed Valve
22. Well 8 Check Valve
23. Well 8 Level Transmitter
24. Well 8 Pressure Switch
25. Well 9 Pump
26. Well 9 Discharge to Waste Valve
27. Well 9 Main Feed Valve
28. Well 9 Check Valve
29. Well 9 Level Transmitter
30. Well 9 Pressure Switch

B. There shall be a local physical switch for each piece of equipment. This switch will be within sight of the equipment on the well control panel.

C. There will be MANUAL and AUTO systems selection switches at the SCADA HMI. These switches are operator selectable via the SCADA computer interfaces.

PART 3 EXECUTION

3.1 CONTROL FEATURES

A. Local control is performed by the operator at the MCC in the Well Building. For each pump, the operator selects the HOA HAND mode of control and the pump is requested to start. By selecting the HOA OFF position, the pump is requested to stop.

B. Remote control is performed by placing the HOA switch in the HOA AUTO position. The pumps are then controlled via the SCADA HMI system.

C. SCADA MANUAL control mode is performed by the operator selecting the MANUAL button on the SCADA HMI. A popup appears on the display and the operator must select the CONFIRM button on the popup to confirm the mode change. ALL equipment associated with each well in the process strategy is put in the MANUAL mode. The operator can now select a piece of equipment on the process display and a popup appears with all the control functions available for MANUAL control of that equipment.

D. SCADA AUTO control mode is performed by the operator selecting an AUTO button on the process display and a popup appears with all the control functions available for AUTO control of ALL of the equipment associated with each well in the process strategy. The popup display will also include process setpoint controls, timer values, as well as other operator inputs required to control the process in AUTO mode.

E. At least one well pump must be in the HOA AUTO position for the SCADA process control logic to begin automated operations.

F. Well 4, 6 & 7 control is based on the South Reservoir Tank level. Wells 8 & 9 are based on the North Reservoir Tank level. Since seasonal changes require different modes of control, there are three modes of control strategies to control the function of the pumps.

Example of Well Pump Start/Stop Settings

TABLE OF AVAILABLE FLOWS	
Action	**Operator Selected Reservoir Level Control**
Summer Mode	High Water Use Strategy
Spring/Fall Mode	Medium Water Use Strategy
Winter Mode	Low Water use Strategy

G. Pump fail alarms will alert operations of a well pump failure.

1. A discrete fault contact from the pump motor starter controls is connected to a PLC input to signal a FAIL alarm. This alarm will latch. An operator must cycle the local HOA switch to OFF and back to AUTO to reset the latch.

H. Accumulated run time and daily run time for each pump will be calculated as described above and displayed on the HMI and SCADA displays.

I. Accumulated start count and daily start count for each pump will be calculated as described above and displayed on the HMI and SCADA displays.

3.2 ALARMS

A. The following alarms are connected with well operation.

Alarm Tag	Description	Latch	Software Generated	Local Annunciation
W04_LAL_0104_ALM	Well 4 Low Level Alarm	No	Yes	HMI
W04_LALL_0104_ALM	Well 4 Low-Low Level Alarm	Yes	No	CP & HMI
W04_XA_0104A_ALM	Pump 4 Deviation Alarm	Yes	Yes	HMI
W04_XA_0104B_ALM	Pump 4 Discrepancy Alarm	Yes	Yes	HMI
W04_ZOA_0104_ALM	Pump 4 Check Valve Open Fail	Yes	Yes	CP & HMI
W04_PSH_0104_ALM	Pump 4 Pressure Switch Alarm	Yes	No	CP & HMI
W06_LAL_0106_ALM	Well 6 Low Level Alarm	No	Yes	HMI
W06_LALL_0106_ALM	Well 6 Low-Low Level Alarm	Yes	No	CP & HMI
W06_XA_0106A_ALM	Pump 6 Deviation Alarm	Yes	Yes	HMI
W06_XA_0106B_ALM	Pump 6 Discrepancy Alarm	Yes	Yes	HMI
W06_ZOA_0106_ALM	Pump 6 Check Valve Open Fail	Yes	Yes	CP & HMI
W04_PSH_0104_ALM	Pump 6 Pressure Switch Alarm	Yes	No	CP & HMI

Alarm Tag	Description	Latch	Software Generated	Local Annunciation
W07_LAL_0107_ALM	Well 7 Low Level Alarm	No	Yes	HMI
W07_LALL_0107_ALM	Well 7 Low-Low Level Alarm	Yes	No	CP & HMI
W07_XA_0107A_ALM	Pump 7 Deviation Alarm	Yes	Yes	HMI
W07_XA_0107B_ALM	Pump 7 Discrepancy Alarm	Yes	Yes	HMI
W07_ZOA_0107_ALM	Pump 7 Check Valve Open Fail	Yes	Yes	CP & HMI
W04_PSH_0107_ALM	Pump 7 Pressure Switch Alarm	Yes	No	CP & HMI
W08_LAL_0108_ALM	Well 8 Low Level Alarm	No	Yes	HMI
W08_LALL_0108_ALM	Well 8 Low-Low Level Alarm	Yes	No	CP & HMI
W08_XA_0108A_ALM	Pump 8 Deviation Alarm	Yes	Yes	HMI
W08_XA_0108B_ALM	Pump 8 Discrepancy Alarm	Yes	Yes	HMI
W08_ZOA_0108_ALM	Pump 8 Check Valve Open Fail	Yes	Yes	CP & HMI
W04_PSH_0108_ALM	Pump 8 Pressure Switch Alarm	Yes	No	CP & HMI
W09_LAL_0109_ALM	Well 9 Low Level Alarm	No	Yes	HMI
W09_LALL_0109_ALM	Well 9 Low-Low Level Alarm	Yes	No	CP & HMI
W09_XA_0109A_ALM	Pump 9 Deviation Alarm	Yes	Yes	HMI
W09_XA_0109B_ALM	Pump 9 Discrepancy Alarm	Yes	Yes	HMI
W09_ZOA_0109_ALM	Pump 9 Check Valve Open Fail	Yes	Yes	CP & HMI
W04_PSH_0109_ALM	Pump 9 Pressure Switch Alarm	Yes	No	CP & HMI

B. Refer to Programming Requirements for other alarm requirements.

3.3 CONTROL SIGNALS

A. The following discrete PLC inputs are repeated from each of the Well Pumps (P-0104, P-0106, P-0107, P-0108. P-0109).

1. Pump Running
2. Pump KWH
3. Pump HOA AUTO
4. Pump HOA HAND
5. Pump Check Valve Open
6. Pump Blow Off Valve Closed
7. Pump Flow Control Valve Closed

B. The following discrete PLC output is repeated from each of the Well Pumps (P-0104, P-0106, P-0107, P-0108. P-0109).

1. Pump Start Request.

C. The following analog PLC inputs are general inputs.

1. Well 4 Level LIT-0104
2. Well 6 Level LIT-0106
3. Well 7 Level LIT-0107

4. Well 8 Level LIT-0108
5. Well 9 Level LIT-0109

3.4 INTERLOCK SIGNALS FOR AUTOMATED SCADA CONTROL

A. The design of the system uses interlocks for automated SCADA control mode. The interlocks allow the automated strategy to determine if control is allowed and if not, then indicates which interlocks are in need of correction prior to the SCADA automated strategy assuming control. The design of the system for SCADA manual control does not include these interlocks as the operator assumes responsible control of the equipment when the operator starts or stops a piece of equipment in SCADA manual mode.

B. The following interlocks are required for automated SCADA control of the Well Pumps (P-311, P-321, P-331, P-341).

1. One Chlorine Pump is available for automated control.

2. Reservoir High-High Level Alarm

3. Level in the Reservoir has reached a HIGH-HIGH level for more than 10 seconds (operator adjustable time).

END OF SECTION

SECTION 40 61 96.60 - PRESSURIZED FILTER SYSTEM MONITORING

PART 1 GENERAL

1.1 SECTION INCLUDES

The Pressurized Filter System manufacturer's documentation shall provide the required status and alarming SCADA/PLC Inputs/outputs for monitoring and supervisory control.

A. The alarm and event status of the Pressurized Filter Systems.

B. Supervisory setpoints.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. REFER TO FILTER SPECIFICIATIONS

B. REFER TO THE PLC INPUT/OUTPUT SPECIFICATION FOR ADDITIONAL ASSOCIATED I/O

PART 3 EXECUTION

3.1 CONTROL FEATURES

A. REFER TO FILTER SPECIFICIATIONS

B. At least one Pressurized Filter bank must be in the HOA AUTO position for the SCADA process control logic to begin automated operations.

3.2 ALARMS

A. Refer to Pressurized Filter System Programming Requirements for other alarm requirements.

END OF SECTION

SECTION 40 61 96.70 - RESERVOIR BOOSTER PUMP CONTROL AND MONITORING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Clear Well Pump Control is performed by varying the speed and number of pumps running to maintain the level in the Clear Well. The pump speeds are varied to maintain a Clear well level setpoint.

1.2 DESCRIPTION OF OPERATIONS

A. Lead/Lag1/Lag2/Standby Control:

1. Refer to SECTION 002 for details about Lead/Lag/Standby operations.
   The following is an example of the operator selectable Lead/Lag selection of the Clear Well Pumps:

Example of Lead/Lag Selection (See Subsection 002 above)

Description	Lead	Lag 1	Lag 2	Standby
Clear Well Pump 1			X	
Clear Well Pump 2		X		
Clear Well Pump 3	X			
Clear Well Pump 4				X

PART 2 PRODUCTS

2.1 EQUIPMENT

A. The Clear Well Systems include the following equipment:

1. Four Large 3,000 gpm Variable Speed Clear Well Pumps.
2. One Clear Well Level Transmitter (LE/LIT-0400).

B. There is a local physical switch for each piece of equipment. This switch is within sight of the equipment.

C. There will be MANUAL and AUTO systems selection switches at the SCADA HMI. These switches are operator selectable via the SCADA computer interfaces.

PART 3 EXECUTION

3.1 CONTROL FEATURES

A. Local HOA control is performed by the operator at the motor. For each Clear Well Pump, the operator selects the HOA HAND mode of control and the pump is requested to start. The speed can be set by adjusting the speed on the front of the VFD via the Human Interface module (HIM). By selecting the HOA OFF position, the pump is requested to stop.

B. Remote control is performed by placing the HOA switch in the HOA AUTO position. The pumps are then controlled via the SCADA HMI system.

C. SCADA MANUAL control mode is performed by the operator selecting the MANUAL button on the SCADA HMI. A popup appears on the display and the operator must select the CONFIRM button on the popup to confirm the mode change. ALL equipment associated with the process strategy is put in the MANUAL mode. The operator can now select a piece of equipment on the process display and a popup appears with all the control functions available for MANUAL control of that equipment.

D. SCADA AUTO control mode is performed by the operator selecting an AUTO button on the process display and a popup appears with all the control functions available for AUTO control of ALL of the equipment associated with the process strategy. The popup display will also include process setpoint controls (Clear Well Level Set Point), lead/lag controls, timer values as well as other operator inputs required to control the process in AUTO mode.

E. The Clear Well Pump Automated Sequence is performed as follows (starting with no pumps running and all pumps available and normal):

1. The Clear Well level reaches a high process setpoint. The lead pump is requested to start. When the lead pump is running, the PID controller begins to modulate the speed of the pump to maintain the operator entered normal level setpoint. Typically, the speed of the pump increases to lower the Clear Well level from the high process setpoint to the normal and then slows down to maintain the normal setpoint.

2. If the Lead Pump increases speed above 97% and stays there for an operator entered period of time or a high-high process setpoint is reached, the Lag1 Pump is requested to start. When both the Lead and Lag1 pumps are running, the PID controller continues to modulate the speed of the pumps to maintain the operator entered normal level setpoint.

3. If the Lead and Lag1 Pump increases speed above 97% and stays there for an operator entered period of time or a high-high process setpoint is reached, the

Lag2 Pump is requested to start. When the Lead, Lag1 and Lag2 pumps are running, the PID controller continues to modulate the speed of the pumps to maintain the operator entered normal level setpoint.

4. If the Lead, Lag1, and Lag2 Pumps decreases speed to 50% and stays there for an operator entered period of time or a low process setpoint is reached, the Lag2 Pump is requested to stop. The Lead and Lag1 pumps continue running and the PID controller continues to modulate the speed of the pumps to maintain the operator entered normal level setpoint.

5. If the Lead and Lag1 Pumps decreases speed to 50% and stay there for an operator entered period of time or a low process setpoint is reached, the Lag1 Pump is requested to stop. The Lead pump continues running and the PID controller continues to modulate the speed of the pumps to maintain the operator entered normal level setpoint.

6. If the Lead Pump decreases speed to 50% and stays there for an operator entered period of time or a low-low process setpoint is reached, the Lead Pump is requested to stop.

7. If the low-low process level setpoint is reached while more than one pump is running, all pumps will be requested to stop.

8. If a Low-Level Alarm setpoint is reached all pumps are requested to stop immediately and an alarm is initiated at the SCADA HMI.

9. If a pump fails or fails to start, the standby pump will step in as that pump and operate as that pump lead/lag selection should.

10. If the process level transmitter fails during operation, all pumps are requested to stop and a propagating Systems Not-Ready Interlock signal is sent to Well Pumps 2 & 6, and Air Stripper.

3.2 ALARMS

A. The following alarms are connected with Clear Well Pumps operation.

Alarm	Description	Latch	Software Generated	Local Annunciation
LAHH-0301	Clear Well High-High Alarm	No	Yes	HMI
LAH-0301	Clear Well High Alarm	No	Yes	HMI
LAL-0301	Clear Well Low Alarm	No	Yes	HMI
LALL-0301	Clear Well Low-Low Alarm	No	Yes	HMI
XA-0311	Pump 1 Fail	Yes	No	HMI
XA-0311A	Pump 1 Deviation Alarm	Yes	Yes	HMI
XA-0311B	Pump 1 Discrepancy Alarm	Yes	Yes	HMI

Alarm	Description	Latch	Software Generated	Local Annunciation
XA-0321	Pump 2 Fail	Yes	No	HMI
XA-0321A	Pump 2 Deviation Alarm	Yes	Yes	HMI
XA-0321B	Pump 2 Discrepancy Alarm	Yes	Yes	HMI
XA-0331	Pump 3 Fail	Yes	No	HMI
XA-0331A	Pump 3 Deviation Alarm	Yes	Yes	HMI
XA-0331B	Pump 3 Discrepancy Alarm	Yes	Yes	HMI
XA-0341	Pump 4 Fail	Yes	No	HMI
XA-0341A	Pump 4 Deviation Alarm	Yes	Yes	HMI
XA-0341B	Pump 4 Discrepancy Alarm	Yes	Yes	HMI

B. Refer to Programming Requirements for other process alarm requirements.

3.3 CONTROL SIGNALS

A. The following PLC inputs and outputs are repeated for each of the Well Pumps.

1. Pump Running
2. Pump HOA AUTO
3. Pump HOA HAND
4. Pump Fail Alarm
5. Blower Outlet Valve Closed
6. Blower Inlet Valve Opened
7. Blower Inlet Valve Closed
8. Air Stripper Tower Water Level High
9. Air Stripper Tower Differential Pressure High.

B. The following discrete PLC output is repeated for each of the Well Pumps.

1. Pump Start Request.

C. The following analog PLC inputs are repeated for each of the Well Pumps (P-102, P-106) and are general inputs.

1. Pump Amps
2. Pump Output Power KWH
3. Clear Well Level (only one).

D. The following analog PLC output is repeated for each of the Well Pumps (P-102, P-106).

1. Pump Speed Control.

3.4 INTERLOCK SIGNALS FOR AUTOMATED SCADA CONTROL

A. The design of the system uses interlocks for automated SCADA control mode. The interlocks allow the automated strategy to determine if control is allowed and if not, then indicates which interlocks are in need of correction prior to the SCADA automated strategy assuming control. The design of the system for SCADA manual control does not include these interlocks as the operator assumes responsible control of the equipment when the operator starts or stops a piece of equipment in SCADA manual mode.

B. The following interlocks are required for automated SCADA control of the Well Pumps (P-102, P-106).

1. One Chlorine Pump is available for automated control.

2. Level in the Clear Well has not reached a LOW-LOW level for more than 10 seconds (operator adjustable time).

3. Pressure of the system has reached a HIGH-HIGH setpoint – shut all Clear well pumps off.

4. One air stripping tower inlet valve is fully opened (to start pump only).

END OF SECTION

SECTION 40 61 96.80 - CHEMICAL SYSTEMS CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section describes the chemical addition systems and procedures for the water treatment plant.

1.2 DESCRIPTION OF OPERATIONS

A. Chemical System Pacing:

1. The Chemical Systems have one pacing signal for each chemical system type. The following chemicals are used for the WTP.

B. Sodium Hypochlorite (Chlorine)

C. Leak Detection Systems:

1. Leak detection systems will be provided within all secondary containment areas as shown. These leak detection systems shall be configured to provide alarms as described herein. In addition, the hypochlorite leak detection system shall be configured to automatically close an isolation valve at each hypochlorite tank to mitigate further leakage from the tank.

2. The operator shall be able to disable any of the leak detection alarms and triggered activities by pushing a soft button on either of the chemical area HMI screens. Once the alarm is disabled, it shall remain disabled for an adjustable period of time.

D. Chemical Residual Monitoring Systems:

1. Temperature, chlorine, and pH will be monitored by hand.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. The sodium hypochlorite system includes:

1. Two double walled hypochlorite storage tank.
2. Two Diaphragm metering pump.
3. A secondary containment high level switch.
4. Storage Tank Level Probes

B. Monitoring for the chemical addition systems include:

1. One combination Chlorine, pH and Temperature Analyzer.

PART 3 EXECUTION

3.1 CONTROL FEATURES

A. Sodium Hypochlorite Systems: The operator determines dosing locations for sodium hypochlorite by manually positioning valves. Operation of the chemical metering equipment may vary depending on the manufacturer and model of equipment selected. Contractor must adapt the control strategy and SCADA programming to selected equipment. Addition of sodium hypochlorite is determined as follows.

1. The operator sets the stroke of the metering pump manually at the meter pump. The stroke can be used to change the quantity of chemical being fed into the water system.

2. An analog (4-20mA) pacing signal from the PLC is sent to the chemical feed pump. The pacing signal is based on the well flow and a post startup determined ratio/curve to achieve the proper chemical feed rate based on the quantity of water leaving the facility.

3. Monitoring of Chlorine shall be done by operations personnel by hand held device on a periodic basis.

3.2 ALARMS

A. The following alarms are connected with Chemical systems.

Alarm	Description	Latch/ interlock	Software Generated	Local Annunciation
	None			

* Latches/interlocks to shut the WTP down.

3.3 CONTROL SIGNALS

A. The following are discrete PLC inputs for the Chemical Addition System in the Operations Building.

1. Hypochlorite Tank 1 Leak

B. The following discrete PLC outputs for the Chemical Addition system in the Operations Building are required.

1. Chlorine Pace Control (ON/OFF)

C. The following are analog PLC inputs for the Chemical Addition system in the Operations Building.

1. Effluent Temperature

D. There are analog PLC outputs for the Chemical Addition system in the Operations Building as follows:

1. N/A

3.4 INTERLOCK SIGNALS FOR AUTOMATED SCADA CONTROL

A. The design of the system uses interlocks for automated SCADA control mode. The interlocks allow the automated strategy to determine if control is allowed and if not, then indicates which interlocks are in need of correction prior to the SCADA automated strategy assuming control. The design of the system for SCADA manual control does not include these interlocks as the operator assumes responsible control of the equipment when the operator starts or stops a piece of equipment in SCADA manual mode.

B. The following interlocks are required for automated SCADA control of the chemical systems.

1. Associated Well Pump is running.

END OF SECTION

SECTION 40 61 96.90 - SCADA DESIGN GUIDE AND FUNCTIONAL OVERVIEW

PART 1 GENERAL

This specification is provided as a reference for the intent of the SCADA Systems, Software design and operational functions. Familiarity of these specifications will provide an understanding of the intent of the design and how the field devices/instrumentation signals interact with the developed software. In Example: Both AUTO and HAND indications from an HOA switch provide complete information for the SCADA system to "know" when SCADA has control and when an operator has local control without generating nuisance alarms.

Refer to network diagram, the I/O requirements in 40 61 93 and 40 61 00 for hardware requirements.

1.1 INDUSTRY STANDARD REFERENCES

A. Organizations:

1. ISA – International Society of Automation
2. IEEE – Institute of Electronic and Electrical Engineers

B. References:

1. Understanding Distributed Processor Systems for Control, Samuel M. Herb, ISBN 1-55617-645-7.

2. ISA 101 – Human Machine Interfaces for Process Automation Systems, ISA 101 Automation Committee – (Not yet ratified for public distribution – obtained copy as a member of the committee).

3. Instrumentation Symbols and Identification, American National Standard ANSI/ISA-5.1-2009, Approved 18 September 2009.

1.2 SOFTWARE DEVELOPMENT PROCEDURES AND PROCESSES GUIDELINES

A. General Information

1. This section will function as a reference for the HSI and a pre-guide for the SCADA development process by the SSI under separate contract. It is a collection of standards and guidelines that provide consistency for this project and additions/modifications to future projects. It adapts to a variety of differing manufacturers' products.

B. Control Philosophy

The Contractors representative will configure all devices for appropriate operation and shall work with the City's Integrator for final incorporation into the operations system.

1.3 SOFTWARE DEVELOPMENT PROCEDURES

This section covers the procedures to plan, design, implement, and test the SCADA/HMI/PLC software. In-house testing is dependent on the availability of various pieces of equipment.

A. INSTRUMENTATION DIRECTORY STRUCTURE AND NAMING CONVENTIONS:

1. Identify Harrisburg's existing filing procedures and directory tree structures. (COH will provide.)

B. INSTRUMENTATION DOCUMENTS, SPREADSHEETS/DATABASE/PLC/HMI FILE NAMING CONVENTIONS

1. A typical file name or backup directory shall include date stamping (and in some instances military time stamping).
2. Begin the file name with the year: 2022
3. Followed with the Month: (two digit - include the leading zero for single digit months)
4. Followed by the Day: (two digit)
5. Followed by the Military time:
6. Followed by the document/spread sheet/program descriptive name: HRRSBRG_WTP_IO_list
7. Always include an underscore "_"mark between each piece of info as some programs still follow the older operating system confinements (i.e., Windows 95 and 98) and are not fully compatible with the newer naming conventions, extended length of file names and spaces in names.
8. The file will look similar to this: 2022_01_15_0900_ HRRSBRG _IO_list
9. What you will find by using this file naming procedure is that any subsequent backup files, when listed by file name, will fall into dated order even if an earlier dated file has been accessed and the actual computer-generated file date stamp has been automatically changed. This naming convention will also allow for daily, monthly, and yearly transitions, and the files will still be in chronological order.

Notes:

a. For firmware upgrade programs from manufacturers, programs that require short naming (i.e., 8 to 11 characters), this naming convention should be applied to the directory name and the file inserted within that directory.

b. Some software packages have a pre-defined naming convention and do not allow the naming convention above to be utilized. In that instance, the naming convention will be created describing the manufacturer constraint and how the naming convention has been adjusted.

C. PLC AND HMI BACKUP PROCEDURES

1. Development Process Backup Procedures

During development, loss of data can occur when the particular PLC or HMI program(s) being used “lock up” or if something causes the computer to reboot. This is a frustrating situation when the programming being done has not been recently saved. To minimize lost work, the following procedures should be followed for backing up the program being written.

a. Onsite Implementation and Modification Procedures:

1) First, backup what is currently in the PLC or computer to hard disk, a thumb drive, or on a laptop hard drive (two locations are better than one). Then, start to edit the PLC program, or enter development mode on the HMI. Use the naming convention previously described to identify the programs being saved. If modifications are being made to the installed program, the program should be resaved to a more current time as to not overwrite the backup copy that just made. This is the most recent copy of the program to modify and will be a restore point, if needed, when modifications to the program have begun. If virtual PCs are used for the HMI PCs, the backups may be clones of the virtual machines. Be sure such clones are fresh or PLC stored data (such as run times) and network passwords may be out of date. If you need to revert back to the backup version of the software in later days, use program backups rather than clones.

2) As modifications are being made, save work often to minimize the impact of PLC/HMI programming software “lock up” or computer reboot. Save work at least for every 30 minutes worth of work.

3) Back up work three times a day at a minimum: Once when arriving onsite; once prior to lunch; and once before leaving for the day. Note: Backups should also occur prior to any firmware or software upgrades for the systems or system components. This should accommodate “rolling back” the firmware and software with minimal impact to the operation of the system.

4) As modifications are being made, a documented record should be added to the MAIN program indicating the date of modification, the initials of the person making the modifications, and a brief description of the modifications being made. If multiple modifications are being made, include the names of any sub programs being modified and a brief description regarding what was modified.

D. POINT AND STRATEGY NAMING CONVENTIONS

1. General Information

a. When creating tags, program names in a processor, or architecture configuration names, it is not always easy to differentiate between what is a permanent point and what is a test point. To alleviate this problem please use the following point and strategy naming technique:

1) Use "CAPITAL_LETTERS" to indicate a permanent point or strategy name.

2) "all_lower_case_letters" to indicate a test point or test strategy name.

3) "First_letter_capped" to indicate a point or strategy name that needs to be modified to fit ISA/plant naming conventions.

4) Always use underscore "_" instead of a space. The use of space " " is not always acceptable to some software packages whereas the use of underscore "_" has been found to be an industry standard character.

(Note: Refer to the project naming conventions and standards to determine the appropriate naming scheme for ALL database points, strategy names, and architecture configuration names.)

1.4 PLC PLATFORM CONFIGURATION

A. This section is based on the System Architecture and details will be included during the development of each project at the engineering design phases and the configuration of the PLC software during the SCADA development phase.

1.5 HMI AND PLC DATABASE CONFIGURATION

A. This section is based on the physical I/O and HMI software standards. Details will be included during the development of each project at the engineering design phases and the configuration of the PLC software during the SCADA development phase.

1.6 SCADA/HMI PLATFORM AND DISPLAY CONFIGURATION

A. This section is based on the engineered P&ID drawings, projected SCADA requirements, HMI display hierarchy, display characteristics, and object standard functions. Details will be included during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

1.7 COMMUNICATIONS CONFIGURATION

A. This section is based on the System Architecture, motor control center (MCC) layout/ configuration, and field devices configuration. Details will be included during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

1. ETHERNET

   a. To be determined upon configuration.

2. FIELDBUS (DEVICENET, MODBUS, PROFIBUS, FOUNDATION FIELDBUS, HART, ETC.)

   a. Details will be included during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

1.8 PLC PROGRAM ORGANIZATION

A. GENERAL CONTROL PHILOSOPHY AND TERMS

1. The PLC programming standards in this document define modular programming code which will be developed. These standards create a method that any proficient programmer can use to build or edit programs in a uniform style. Modular code segments are standard code that accomplishes a function that repeats throughout a project.

2. One type of function that lends itself to modular logic is control of sets of equipment. For example, Lead-Lag-Standby operation of equipment with a common function is often desired. Rules for determining the Lead equipment, 1st Lag Equipment, 2nd Lag equipment, etc., and Standby equipment, remain consistent from one set of equipment to the next. So a common logic module which determines statuses for each of the equipment items in a set is possible. Then when the next set of Lead-Lag equipment is configured it will call the same logic. This saves programming time and ensures a single method for the logic. If a rule change is needed for the logic only the base module must be edited.

3. In addition to the common logic that each given equipment group will use, there are common types of equipment that require the same logic elements from one instance to the next. One equipment module program will work for each instance of that equipment in the facility.

B. TERMS

Term	Description
Add-on Instruction	A programmer created ControlLogix program instruction that can be used as a program module
Alternate Lead	Rules that determine when and which equipment goes from one status to another in Lead-Lag-Standby operation
Analog	A variable that can take any value within a predefined range
Digital	A variable that has values of 0 or 1 (ON or OFF)
Lead-Lag-Standby	Set of rules that determine which equipment element in a set starts 1st (lead), 2nd (1st lag), etc., and Standby
Modulating Valve	Automated valve that is commanded to Open a set percentage by control logic
Open-Close Valve	Automated valve that is commanded to Open or Close by the control logic
Program Module	A grouped set of program logic that can be used where needed for a predefined function
Simulated Input	An input where the value is calculated by an emulation program
Simulated Output	An output where the value is calculated by the logic for emulation
Single Speed Motor	Drive motor that runs at one speed
Two Speed Motor	Drive motor that can run at 2 different speeds
Variable Frequency Motor	Motor that runs at variable speeds

C. MODULE INSTRUCTIONS

1. Add-on-instructions provide a good method to produce program logic modules that can be inserted where needed in a PLC program. It is easy to save a library of these instructions that can be exported and imported into other programs. A number of preprogrammed instructions are available from the PLC Manufacturer. These provide a starting point for producing modules that will be used in this project. By using the PLC Programming software it is possible to propagate edits to a module in one program to other programs with the same module routine. An added strength of the method is that each instance can be viewed in RUN mode to troubleshoot the logic. The only weakness of add-on-instructions is that some programming instructions cannot be used. Most of these pertain to other subroutine methods. Edits and updates to the add-on-instructions must be made with the PLC offline. The changes then must be downloaded to the PLC in PROGRAM mode. Add-on-instructions will be the method chosen to produce program modules.

D. GENERAL PROGRAM ORGANIZATION STANDARDS

1. PLC programs are broken into tasks. Each task has programs, and each program has routines. There is one MainTask in each PLC that runs repetitively. Each program in the MainTask executes before the next in the queue executes. The order of execution can be specified. All other tasks are either periodic or event driven. Periodic tasks execute once each time the preset period ends. Event driven tasks execute when a condition in the program occurs.

2. Sequential logic will be organized in programs and routines under the MainTask. For instance, a Well 1 program will include routines that control and monitor the equipment associated with well 1. Routines of the Well 1 program will include a Main Routine, an Alarm Routine, Pump Control Routine, Valve Control Routine, and any other routines that might be required for specific well equipment. Each of the other well programs will have the same structure as Well 1's program. Other parts of the processes will be broken down in the same manner.

3. Periodic tasks will be used for totalizing and PID logic execution. Programs under these tasks will also be organized to match process groupings. It is unlikely that there will be any event driven tasks.

1.9 EQUIPMENT MODULE DEFINITIONS

A. A collection of standard equipment modules has prepared for each type of control equipment employed in the treatment plant and wells. Each module contains all of the input signals that determine the status of the equipment and all of the outputs that are needed to drive or operate that equipment.

B. This section is based on the PLC and HMI software development. Modules objects created in the PLC that correspond to a particular type of device shall have a corresponding HMI object. When an instance of the PLC object is used during development the same tag name will be used for the HMI object name thus making them an operational pair.

C. CASCADE PID (PIDE)

There are no Cascade PID instructions for the operations.

1.10 EQUIPMENT SET DEFINITIONS

Some instructions are related to sets of equipment or are auxiliary instructions used in the Equipment Modules. These are described below.

A. LEAD/LAG SELECTION

The PLC Lead/Lag routine determines lead and lag equipment assignments for up to 6 unit sets of equipment.

The lead is selected by a LeadSelSw value. If the value is 0, lead alternates and is set by the ES_AOI_LD_ALT instruction. If it is greater than 0 the value is the selected lead. When a lead is selected that is not available (Failed or not in Ready) the next available equipment in the set is selected as lead. Lags are specified by LagXSw value input to the instruction. If the assigned lead or any assigned lag is not available, then lags are assigned sequentially from available equipment following the lead. When the last unit in the set is assigned, the next lag is the next available unit starting with unit 1. e.g. for a set of 5 units, when 3 is lead, 4 is 1st lag, 5 is 2nd lag, 1 is 3rd lag, etc.

Equipment availability status bits are input as bits of a DINT for the Units_Available variable.

B. ALTERNATE LEAD

If the Lead equipment becomes unavailable this routine is called to select the next available piece of equipment as the Lead.

1.11 PLC POINT AND STRATEGY NAMING CONVENTIONS

A. PLC POINT NAMING IDENTIFIERS

1. DESCRIPTIVE PLC I/O TAGS ASSOCIATED WITH PHYSICAL, DEVICE-MAPPED I/O OR HMI SUPERVISORY TAGS

DI_<tag name>	Discrete Input associated with a tag point from a card or device mapping.
DO_<tag name>	Discrete Output associated with a tag point from a card or device mapping.
AI_<tag name>	Analog Input associated with a tag point from a card or device mapping.
AO_<tag name>	Analog Output associated with a tag point from a card or device mapping.
HMI_<tag name>	A discrete or analog associated with a supervisory control or set point function from the HMI.
FNT <tag name>	A tag that is communicated by Fieldbus interface.

Note - if Allen Bradley Controllers are used in the design: “Aliasing” is a function of the Allen Bradley ControlLogix platform. Using the aliasing function can limit the future testing of a point as the alias is permanently attached to the designated hardware tag in the current version of Control Logix 5000 programming (This may change in version 21). Many programmers prefer to designate input and output "I/O BUFFER" program routines to transfer the incoming/outgoing analog or discrete value from/to the hardware designated tags. **The use aliasing or I/O transfer program routines need to be established at the beginning of the development effort and followed consistently through the entire project. Refer to Allen Bradley document 1756-pm004_-en-p.pdf Chapter 1 section titled "BUFFER I/O" routines and Chapter 2 section titled "Alias Tags".**

2. INTERNAL PLC PROGRAM TAGS CREATED FOR SOFTWARE LOGIC NOT CREATED IN THE PLC GLOBAL DATABASE

B_<tag name>	B_BOOLEAN or b_boolean tag
D_<tag name>	D_DOUBLE_INTEGER or d_double_integer tag
R_<tag name>	R_REAL or r_real tag
N_<tag name>	N_INTEGER or n_integer tag
S_<tag name>	S_SINGLE_INTEGER or s_single_integer

Note: The tags associated with B_, D_, R_ or N_ can be ASSOCIATED to an usr_USER_DEFINED structure (see below) e.g., a point from the HMI which is located in a user defined EtherNet communication structure such as: usr_ETH_COMM_STRUCT_A).

3. USER DEFINED STRUCTURES

User defined structures will begin with USR, an underscore "_" and the tag name. For example: usr_<tag name> usr_USER_DEFINED or usr_user_defined tag.

4. SIMULATION TAGS (IF PROCESS SIMULATION ROUTINES ARE USED FOR TESTING PURPOSES)

Simulation tags will follow the designations above and be represented by all lower case letters. For example: "b_sim_point_001". Simulation tags may stay permanently in the PLC database for use at a later date if the CITY OF HARRISBURG's personnel decide they are useful for diagnostic purposes.

5. TEMPORARY TEST TAGS

Temporary tags used for testing do not follow the above designations but will be represented by all lower case letters and always begin with the "test_..." nomenclature. For example: "test_point_001, test_analog_bump_002, test_etc." Temporary tags are intended to be deleted from the PLC database when they are no longer needed and before the Operational Readiness Test. Test points should not be included in any final testing to confirm they do not have any adverse or influential effects in the final Process Control System operability.

6. CALCULATED RESULT TAGS

Calculated result tags can take on the nomenclature of the calculating module. For example: Using an RSLogix PLC CPT (Compute) module, a Programmer will use CPT_<tagname> or cpt_<tag name>.

7. ABBREVIATIONS

All abbreviations used in naming of SCADA/HMI and PLC points shall be included in the SCADA Design Document Point Naming abbreviations table.

B. EC 1137 PROGRAMMING LANGUAGES

The PLCs used for the RWTP Project incorporate IEC 1137 programming languages which include: Ladder Diagram (LD), Function Block (FB), Sequential Function Chart (SFC), and Structured Text (ST).

This project will primarily use the LD programming language. The FB programming language will be used where FB blocks can be used to simplify the process control (compared to LD) and for the Extended PID (PIDE) use.

Currently, there is no plan to use SFC or ST for the RWTP Process Control System as these languages are typically foreign to most technicians familiar with PLCs.

C. FIELDBUS I/O DATA BLOCK(S) OVERVIEW

1. FIELD DEVICES

This section is based on the Fieldbus Architecture(s) and field device configurations. Details will be included during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

2. MCC DEVICES

This section is based on the System Architecture, MCC layout/configuration, and field devices configuration. Details will be included during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

3. PLC TO PLC MESSAGES OR PRODUCER/CONSUMER DATA

A preferred method of passing data from one PLC to another will be specified for each class of data. Data tags are typically passed between PLCs as communication messages. Details will be included during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

D. SPECIFICATION PROCESS STRATEGIES WITH UPDATES

The Process Control Strategies will be revised and incorporated into the Process Control Strategy for software development. The revised strategies will conform to the format described in Section 2.1.2 above to facilitate the programming effort and incorporation into the final Process Control O&M Manual(s).

E. PROGRAM ROUTINE EXECUTION AND SYSTEM OPTIMIZATION

1. The execution of the Tasks within PLC programs can be continuous or periodic. The MAIN program is typically set to be CONTINUOUS" and the rest are designated to run as "PERIODIC" tasks.

2. Continuous tasks execute continually with every scan of the PLC.

3. Periodic tasks operate at a scheduled rate based on what "Period," "Priority," and the "Watchdog" times the programmer sets in the configuration.

1.12 SCADA/HUMAN MACHINE INTERFACE GUIDELINES

A. GENERAL INFORMATION

This section expands upon Section 2.3 with details regarding HMI development.

B. HMI/SCADA POINT NAMING CONVENTIONS

1. These naming conventions include PLC tags as well as HMI database abbreviation names. The HMI/PLC interface symbol (or point name) used for an analog or discrete point should be similar in both the PLC and the HMI.

2. Supervisory interface points between the HMI and the PLC shall use "HMI_" in the PLC to indicate the point originates from the HMI.

3. If the point is a field or strategy specific indication point (discrete or analog), the tag should be identical in the HMI and PLC.

4. Listed below are the constraints on the naming convention:

   a. HMI I/O Tag names are limited to 32 characters.

      1) SCADA tags are limited to 32 characters maximum.

2) PLC tags can be up to 40 characters maximum.

3) Characters not allowed are * , / ’ ” = + . { } [ ] ? < > | ! @ # $ % ^ & ( ) and spaces.

4) SCADA Tags shall be limited to 40 characters for both PLC and HMI.

5. Tag Format is as follows:

a. Tags are labeled AAAxxxBBBCCCC_FFFFFFFFFFFFFFFFF where:

1) AAA_ is alphanumeric abbreviation of the project area:

W04	Well 4
W06	Well 6
T01	Harrisburg Treatment Facility

2) xxx_ is alphabetic abbreviation of the point as described in Section 2.3.1 (Note: This allows for easy sorting of the database and identifying points while debugging a

a) DI_ = Digital Input
b) AI_ = Analog Input
c) DO_= Digital Output
d) AO_ = Analog Output

3) BBB_ is the ISA loop or equipment tag number:

a) 101 = Main PLC, Ethernet Rack Equipment, Work Station 1
b) 102 = Work Station 2
c) 103 = SCADA Historian
d) 201 = Well No. 1 Systems
e) 202 = Well No. 2 Systems
f) 502 = Hypochlorite Pump #2
g) 512 – Fluoride Pump #1
h) Etc.

4) CCC_ is the ISA designation characters:

a) FI (Flow Indicator)
b) PI (Pressure Indicator)
c) DPI (Differential Pressure Indicator)
d) AI (Analytical Indicator: pH, CL2, FL, etc.)
e) LAHH (Level Alarm High High)
f) LAH (Level Alarm High)
g) LAL (Level Alarm Low)

h) LALL (Level Alarm Low Low)
i) FAH (Flow Alarm High)
j) YI (State Indicator: HOA in Auto, Running Indication, etc.)
k) XI (Power Indicator)
l) XA (Equipment Fault Alarm)
m) TAH (Temperature Alarm High)
n) TAL (Temperature Alarm Low)
o) EA (Energy Alarm: Voltage or Power Alarm)
p) ZIC (Position Indication Closed)
q) ZIO (Position Indication Opened)
r) XC (Equipment Control)
s) XOC (Valve Open Control)
t) XCC (Valve Close Control)
u) UAL (Multifunction Alarm Light or Horn)
v) LI (Level Indication)
w) SI (Speed Indication)
x) FC (Flow Control)
y) PC (Pressure Control)
z) LC (Level Control)
aa) SI (Speed Control)
bb) Etc.

5) FFFFFFFFFFFFFFFFFF is used for any necessary visual clarification:

a) CL2
b) H2O
c) PCNGSGNL (pacing signal)
d) STROKE
e) HRTBEAT (heart beat – typically a communications check point)
f) ALARM or ALM
g) EVENT or EVT
h) VALVE or VLV
i) MOTOR or MTR
j) SPEED or SPD
k) FREQ or HZ
l) <abbreviations> or <abbr>
m) Etc.

Use of this standard will eliminate the potential for duplicate tags. Duplicate tags typically occur when an overall SCADA system is applied to existing facilities and two differing facilities have the same equipment with the same ISA loop designation. For instance, Pump Stations 10 and 20 have the same tags PS_PUMP_1_START_100_SS. By adding the site information, the tags will not conflict. By adding the area information at a site, tags within a site will not conflict and so on. Following the designated standard will allow for expanding SCADA operations throughout the life cycle of the software control system environment.

C. ALARMS AND EVENTS

The Alarms and Events will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

D. PROJECT HMI STANDARD TEMPLATES, COLOR CONVENTIONS, AND OBJECTS

The HMI Standard Templates and Objects are discussed below. Templates show “hard” and “soft” targets. Objects will be categorized process function and dynamic and static attributes. Dynamic objects will clearly defined by object functionality and changing visual characteristics.

1. ANALOG VALUES

    a. Analog values can be either integer or real depending on the use or precision required for each value. Both DINT (double integer) and REAL (floating point) data types are 32 bit values, so PLC memory requirements are the same for either. PLCs handle DINTs more efficiently when there is a choice. Also round off error will be less for DINTs that will not be bigger than a 32 bit value. However DINTs do not readily display fractional values. Other integer types are required for some types of registers in the programs. These are instruction specific and only of importance to the programmer and the program code. These integers are INT (16 bit integers) and SINT (single integer 8 bit values). With these considerations, DINTs will be used for analog values that do not require a fractional precision. REALs will be used for analogs that require factional precision. REALs will be used for Analog Input register values.

2. ANALOG ALARM CONFIGURATION

    a. Analog variables that have alarms based on comparison of an analog value to set point values will use the Analog Alarm ladder instruction (ALMA) to determine the alarm statuses. The instruction includes provision for Low-low, Low, High, and High-high alarms.

    b. There is also a tag for alarm delay through a DINT register, alarm acknowledge through a BOOL tag, alarm reset through a BOOL tag, BOOL alarm statuses for each configured alarm state, and many other features that can be used when needed.

    c. If additional Analog Alarm states are needed (such as Middle, Low-low-low, or High-high-high) additional analog alarm instructions will be created. Tag names for the set point variables as well as the instruction will make clear the intended alarms.

d. Each alarm instruction will be evaluated and configured to create latching (reset required) alarms where needed. Typically alarms that interlock equipment may require latching for safety or to prevent equipment damage. For example, a high pressure alarm that stops a pump motor might be latched to prevent automatic restart of the motor once the pressure bleeds off. This forces the operator to notice the alarm and decide if attention to the equipment is needed before another start attempt.

3. ALARM PRIORITY

Alarm Priority allows a Systems Developer to set various levels of alarming for further segregation on the Alarm Summary. Alarm priorities are set between 0000 to 9999 levels.

a. High-High Process Alarms – A very high priority alarm needing immediate operator attention and action. Example: Clear well level has reached a critical high-high level and the lead and lag pumps have not been able to keep up with the increase in level. Operator intervention required.

b. High Process Alarms – A high priority alarm needing immediate operator attention and potentially operator action. Example: Clear well level has reached a high level and the lead and lag pumps have not been able to keep up with the increase in level.

c. High-High Process Event – An event the process control system uses to control equipment in a normal manor. Example: Clear well has reached the high-high level turn on the lag pump.

d. High Process Event - An event the process control system uses to control equipment in a normal manor. Example: Clear well has reached the high level turn on lead pump.

e. Intermediate Process Event - An event the process control system uses to control equipment in a normal manor. Example: Air scour is complete continue to next stage of backwash.

f. Low Process Event - An event the process control system uses to control equipment in a normal manor. Example: Shut the lag sump pump off.

g. Low-Low Process Event - An event the process control system uses to control equipment in a normal manor. Example: Shut the lead sump pump off.

h. Low Process Alarm – A high priority alarm needing immediate operator attention and potentially operator action.

i. Low-Low Process Alarm – A high priority alarm needing immediate operator attention and action. Example: Chemical tank level reaches critical low-low level.

j. Process Time-out Alarm – A medium priority alarm needing operator attention and potentially operator action. Example: Filter backwash sequence fails and times out.

k. Equipment Impending Fail Alarm – A high priority alarm needing immediate operator attention and potentially operator action. Example: Moisture alarm in a sump pump.

l. Equipment Fail Alarm – A high priority alarm needing immediate operator attention and action. Example: Motor circuit breaker trips.

m. Equipment State Deviation Alarm – A medium priority alarm needing immediate operator attention and potentially operator action. The equipment was on/open and changed state to off/closed without an automated process request or operator request to change.

n. Equipment State Discrepancy Alarm – A high priority alarm needing immediate operator attention and potentially operator action. The equipment was requested to change state from on/open to off/closed and has not done so in the allot amount of time. Also applies to changes in position and speed.

   The Alarm Priority also lends itself to creation of Events and an Event Summary. An Event Summary is any discrete point in the SCADA/HMI system designated with the lowest priority alarm status. This can be any event in the system that should be recorded in the Alarm History Records. Events can be; an operator signing on to the system, a valve reaching it's open/closed position, a motor run indication, any equipment transition from one state to another.

4. ALARM PRESENTATION

   The typical Alarm Presentation occurs on the small alarm summary found on all process displays and the Alarm Summary. The alarm presentation provides the following information:

   a. DATE
   b. TIME
   c. STATE of the alarm – UNACK, ACK, UNACK-RET
   d. CLASS – Alarm Category
   e. TYPE

f. PRIORITY
g. NAME – Tag used for the alarm
h. GROUP
i. PROVIDER
j. VAULE
k. LIMIT
l. OPERATOR – Operator's ID associated with ACK of the alarm
m. COMMENT – Information regarding the alarm

5. TOTALIZER VALUES

    a. Standard modules will calculate totals for run times and flows. The TOT function block will provide the basis for the calculation. Daily, Yearly, and Running Totals will be calculated for each totalized variable. When the total register is reset, the pre-reset reading will be written to a previous value register and remain there until the next reset. Scaling of the total registers will be accomplished through configuration of the TOT blocks. The tags for the total value and previous total value will be the same data type (REAL or DINT). Running totals that may reach very high values will be configured as DINT to limit round off error inherent in REAL values. DINT totals that may reach more than 2x109 will include roll over counter registers to capture billions units for the totals. The base total tag from the TOT block will be reset to zero and the counter will increment each time the total register reaches 109.

PART 2 HUMAN MACHINE INTERFACE (HMI) CONFIGURATION

2.1 THE SCADA HMI PLATFORM

The HMI system development is created in the Rockwell FactoryTalk software. The displays created are designed to allow the operator a "window" into the process. Monitoring and control of the entire process can be performed at any one of the various operator interface display computers throughout the facility.

Various access restrictions based on the defined security model allow varying functional control. Depending on operator's security access and physical location of the computer an operator can view all information and control what has been determined critical for that operators expected role at the facility.

2.2 HARDWARE ARCHITECTURE DISPLAY

The Hardware Architecture Display provides Operations and Maintenance personnel with a high-level view of the network status and any alarms associated with the various systems components. Monitored equipment includes PLCs, Network Switches, fieldbus connections and Workstations. The Main Server (and Backup Server) will be a monitored component when the Backup Server is installed an operational.

A. EQUIPMENT COLOR CONVENTIONS

Equipment Object or TEXT Name	Designation (Object or associated Text)	Status/ Alarm	Primary Color	Secondary Color	Blinking/ Alternating Colors	
Normal Stopped	Object	Status	Green	None	NO	
Normal Running	Object	Status	Red	None	NO	
In Alarm Stopped	Object	Alarm	Green	Yellow	YES	
In Alarm Running	Object	Alarm	Red	Yellow	YES	
HOA AUTO	Text	Status	Black	None	NO	
HOA OFF	Text	Status	Black	None	NO	
HOA HAND	Text	Status	Black	None	NO	
FAILED	Text	Alarm	Yellow	White	YES	
STOPPED	Text	Status	Green	None	NO	
RUNNING	Text	Status	Red	None	NO	
TEMP	Text	Alarm	Yellow	White	YES	
DEV	Text	Alarm	Yellow	White	YES	
DISC	Text	Alarm	Yellow	White	YES	
Variable Speed Motor						
Normal Stopped	Object	Status	Green	None	N/A	NO
Normal Running	Object	Status	Red	None	N/A	NO
In Alarm Stopped	Object	Alarm	Green	Yellow	N/A	YES
In Alarm Running	Object	Alarm	Red	Yellow	N/A	YES
HOA AUTO	Text	Status	Black	None	White	NO
HOA OFF	Text	Status	Black	None	White	NO
HOA HAND	Text	Status	Black	None	White	NO
FAILED	Text	Alarm	Yellow	White	Black	YES
STOPPED	Text	Status	Green	None	Black	NO
RUNNING	Text	Status	Red	None	Black	NO
TEMP	Text	Alarm	Yellow	White	Black	YES
DEV	Text	Alarm	Yellow	White	Black	YES
DISC	Text	Alarm	Yellow	White	Black	YES
XXX% SPEED	Text	Status	Black	None	White	NO
Discrete or Modulating Valve						
Normal Closed	Object	Status	Green	None	N/A	NO
Normal In Transition	Object	Status	Cyan	None	N/A	NO
Normal Opened	Object	Status	Red	None	N/A	NO
In Alarm Closed	Object	Alarm	Green	Yellow	N/A	YES
In Alarm In Transition	Object	Status	Cyan	Yellow	N/A	YES
In Alarm Running	Object	Alarm	Red	Yellow	N/A	YES
OCA AUTO	Text	Status	Black	None	White	NO
OCA CLOSE	Text	Status	Black	None	White	NO
OCA OPEN	Text	Status	Black	None	White	NO
FAILED	Text	Alarm	Yellow	White	Black	YES

Equipment Object or TEXT Name	Designation (Object or associated Text)	Status/ Alarm	Primary Color	Secondary Color	Blinking/ Alternating Colors	
CLOSED	Text	Status	Green	None	Black	NO
OPENED	Text	Status	Red	None	Black	NO
DEV	Text	Alarm	Yellow	White	Black	YES
DISC	Text	Alarm	Yellow	White	Black	YES
XXX% POSITION	Text	Status	Black	None	White	NO
Analytical Process Values (AI, PI, FI, LI, etc.)						
XXX(units)	Text	Status	Black	None	White	NO
OOR (Out Of Range)	Text	Alarm	Yellow	White	Black	YES

B. PROCESS FLUID COLOR REPRESENTATION

The following table provides a guide for each process color to be used for the CITY OF HARRISBURG projects.

Process Text	Abbreviation	Display Pipe Color	Display Letter Color
Compressed Air (CA)	CA	Blue	Black
Acid Resistant Drain (ARD)	ARD	Orange	Black
Air Scour (AS)	AS	Blue	Black
Blowoff Drain (BD)	BD	Olive-Green	Black
Backwash Return (BWR)	BWR	Olive-Green	Black
Backwash Supply (BWS)	BWS	Dark Blue	Black
Backwash Waste (BWW)	BWW	Light Brown	Black
Sodium Hypochlorite (CL)	CL	Yellow	Black
Carrier Water (CRW)	CRW	Cyan	Black
Building Drain (D)	D	Light Brown	Black
Geotube Dewatering Drain (DEW)	DEW	Dark Brown	Black
Filter Drain (FD)	FD	Brown	Black
Filter Influent	FI	Olive-Green	Black
Fluorosilicic Acid	FL	Light Blue w/Red Band	Black
Fluoridated Water	FLW	Aqua	Black
Fire Protection Water	FPW	Red	Black
Fire Sprinkler Water	FSW	Red	Black
Filter to Waste	FTW	Aqua	Black
Filtered Water	FW	Aqua	Black
Hot Water	HW	Dark Blue	Black
Hot Water Tepid	HWT	Dark Blue	Black
Irrigation Water	IRR	Light Brown	Black
Sodium Hydroxide	NAOH	Yellow w/Green Band	Black
Non-Potable Water	NPW	Light Grey	Black
Plant Process Drain	PD	Brown	Black
Polymer	POLY	Orange w/Green Band	Black
Raw Water	RW	Olive-Green	Black
Sample	SA	Cyan	Black

Process Text	Abbreviation	Display Pipe Color	Display Letter Color
Sanitary Sewer	SAN	Dark Brown	Black
Storm Drain Pressure	SDP	Light Brown	Black
Treated Water	TW	Dark Blue	Black
Vent	V	Forest Green	Black
Vent to Roof	VTR	Forest Green	Black
Waste Solids pressure	WSP	Dark Brown	Black

C. DISPLAY NAMES

Display Names generated in the SCADA HMI software will have a descriptive name beginning with the facility, process, and any additional information to further refine and define the display purpose.

D. DISPLAY TYPES

1. There are three types of SCADA displays; REPLACE, OVERLAY and POPUP.

    a. A Replace display replaces the display the operator was on with the display the operator selected. The Overview and Process displays will be REPLACE displays.

    b. An Overlay display covers the display the operator selected with the display the operator has selected. OVERLAY displays may include displays showing O&M manual information, help displays and any information corresponding to REPLACE display the operator selected information from. An OVERLAY display requires a “CLOSE” button to close the display before moving to a new display. Note: Opening too many OVERLAY displays can slow display functions down. This is due to the data on each display having to be updated even if the display is not in the foreground and viewable. It is preferred to require all OVERLAY displays to have a CLOSE button so the operator is required to close the display before continuing.

    c. A POPUP display is any display used for control purposes and is initiated from an associated REPLACE process display. This includes faceplates, equipment control and automated control displays as selected by the operator from a REPLACE display. A POPUP display requires a “CLOSE” button to close the display before returning to the REPLACE display from which the POPUP came from.

E. PROJECT SPECIFIC STANDARDS

The Project Specific Standards will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase. For example, specific backup and recovery procedures for the WTP HMI and PLC systems will need to be performed at the WTP site. These will be separate from eventual CITY OF HARRISBURG-wide SCADA procedures.

F. HMI SYSTEM HIERARCHY

The HMI System Hierarchy will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

G. TRENDS – PRE-DEFINED AND USER MODIFIABLE

Trends present system data over time as a graph of the data variable(s) versus time. These will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

H. 2.2.8 SYSTEM AND USER SECURITY DEFINITIONS

System and User Security Definitions for the HMI will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase. Definitions will include a list of security levels and HMI system access permissions. Usually at least three levels are used:

1. Administrator
2. Maintenance
3. Operation.
    a. More than one level of Operation permissions may be desirable.

2.3 COMMUNICATIONS GUIDELINES

The Communication Guidelines will follow CITY OF HARRISBURG's established standards for Ethernet communications. Other communications guidelines and requirements will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

A. ETHERNET COMMUNICATIONS HARDWARE CONFIGURATION AND DETAILS

To be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

B. FIELDBUS COMMUNICATIONS HARDWARE CONFIGURATION AND DETAILS

To be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

2.4 HISTORICAL DATA COLLECTION GUIDELINES AND REQUIREMENTS

A. GENERAL INFORMATION

Historical Data Collection Guidelines and requirements will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

B. HISTORICAL DATA POINT NAMING CONVENTIONS

Historical Data Point Naming Conventions will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

C. DATA INTERVAL AND DEADBAND CONFIGURATION

Data Interval and Deadband Configuration will be done on a point by point basis and preliminary configuration for each point will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

D. DISCRETE AND ANALOG COLLECTION POINTS

Discrete and Analog Points designated for historical collection will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

E. DATABASE SIZE CONFIGURATION FOR DATA ARCHIVING

After configuration of the historical database and preliminary testing of the data, the Database Size Configuration for Data Archiving will be addressed and maintenance time intervals and procedures will be set.

2.5 QA/QC GUIDELINES

A. GENERAL INFORMATION

The QA/QC guidelines will provide CITY OF HARRISBURG a sense of how involved they should be through the entirety of the project.

B. REVIEW LISTS AND FUNCTIONAL ROLES AND RESPONSIBILITIES

To be determined between the Engineering Consultant’s Project Manager and CITY OF HARRISBURG. Prepare a list of roles and persons who will currently be filling those roles. Identify roles that are currently empty and who will address those roles until CITY OF HARRISBURG has filled the position (e.g., Operators, Maintenance, IT Personnel, etc. for the WTP Facility).

C. SOFTWARE INTERNAL REVIEW PROCESS

1. SOFTWARE METRICS

a. The purpose of the following software metrics is to provide quality assurance to the control strategies designed. To accomplish this, a structured walkthrough will be conducted throughout the development, implementations and startup phases for each strategy.

b. The checklist (included in this section) is used for all walkthrough reviews. A minimum of two people must be present for the walkthrough. The Engineer/Developer whose strategy is being reviewed cannot record the required changes. After the walkthrough, the Engineer/Developer is required to implement necessary changes, detail the changes in the resolutions section, and return a copy of the resolution to the other attendees. If significant changes occurred then printouts of the control software may clarify the resolutions section.

c. The initial design walkthrough includes a discussion of the nature of the controls involved, operator interaction, and sketches of the proposed graphics displays. The purpose of this walkthrough is to verify that all parties are in agreement with the process and how it is to be controlled. No detailed discussion of control logic is required at this time.

d. The design walkthrough includes a detailed discussion of the process and controls involved. Complete strategy flow, block or sequence diagrams, field point I/O lists, and graphics are reviewed.

e. The implementation walkthrough involves reviewing the software as implemented in the PLC and HMI. Control algorithms are checked for adherence to the process involved, control philosophies, and associated documentation.

f. The startup review records any problems associated with the starting of the control strategy, with regard to the control algorithm. It is not intended for this review to document field hardware problems. Exceptions to this rule include field points that no longer exist, additional field points, etc.

2. CHECKLIST FOR PROCESS SOFTWARE DOCUMENTATION

a. Organization and Completeness

1) Does the document follow the format established for the project?

2) Are all internal cross-references to other processes correct?

3) Are all processes written and documented at a consistent and appropriate level of detail?

4) Does the documented process provide an adequate basis for software design?

5) Is the implementation priority of each process included?

6) Are all external hardware, software, and communication interfaces defined?

7) Have algorithms intrinsic to the functional processes been defined?

8) Does the Process Documentation include all of the known customer or system needs?

9) Is any necessary information missing from a process? If so, is it identified as to be determined (TBD)?

10) Is the expected behavior documented for all anticipated error/alarm conditions?

b. Correctness

1) Do any point names conflict with or duplicate other points?

2) Does each point name, strategy name, and equipment identifying names follow the designated abbreviation list?

3) Is each process written in clear, concise, unambiguous language and in simple sentence structure?

4) Will each process be verifiable by testing, demonstration, review, or analysis?

5) Is each component of each process strategy in scope for the project?

6) Is each process strategy and its associated documentation free from content and grammatical errors?

7) Can all of the processes be implemented within known constraints based on the process design and process and instrumentation diagram (P&ID) information?

8) Are all specified event and alarm messages unique and meaningful?

9) Are all calculations properly documented and understandable?

c. Quality Attributes

1) Are all process strategy performance objectives properly identified (e.g., PID control, complex discrete control, etc.)?

2) Are all operator security and process safety considerations properly identified?

3) Are pertinent quality control goals explicitly documented and quantified?

d. Traceability

1) Is each automated process uniquely and correctly identified?

2) Can each level of software functionality be traced to a higher-level of process control without conflicts between the various modes (e.g., MANUAL control, AUTO1 control, AUTO2 control, CASCADE control, OVERRIDE control, etc.)?

e. Special Issues

1) Are all process strategies complete or are there unknowns or physical/field constraints that may cause changes during field implementation (e.g., skid mounted equipment that may be different than the original design functions)?

2) Are the time-critical functions identified, and timing criteria specified for them?

3) Have operational issues been adequately addressed?

D. SOFTWARE EXTERNAL REVIEW PROCESS

Based on CITY OF HARRISBURG's current staff and future staffing requirements, the Software External Review Process will be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

2.6 DOCUMENTATION GUIDELINES

A. GENERAL INFORMATION

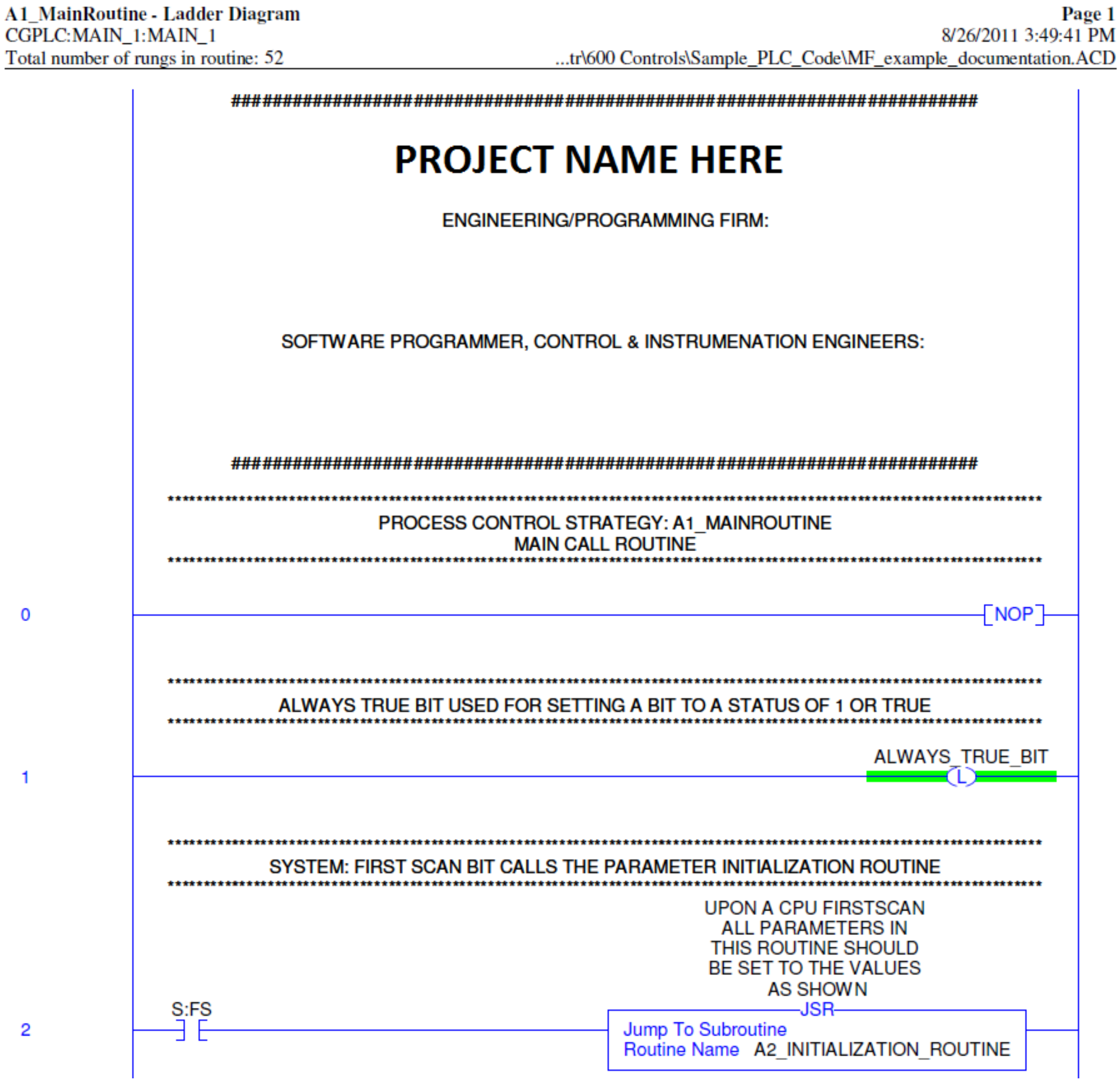
This section provides a basis for software documentation for the project. Formats are identified and followed throughout the development process.

B. PLC PROCESS CONTROL DOCUMENTATION

The PLC Ladder diagram (LD) and Function Block (FB) programs will be documented as follows:

1. All PLC database I/O and HMI interface points will have abbreviated tag names (per the standards designated in another section of this document) and associated descriptions following the abbreviated tag naming construct. (E.g., T01_315_FI_PMP1_FLW with a description of " WTP PUMP 1 FLOW" or T01_301_FI_PLNT_FLW with a description of " WTP PLANT FLOW").

2. All PLC LD programs will have documented rungs. For the Main Routine LD, the "header rung" will begin with a "NO OPERATIONS" [NOP] rung and the documentation will begin with "#" signs at the top and bottom of the "Header" documentation. The program description documentation will begin with "*" at the top and bottom. The documentation with appear as shown in the figure below.



C. SCADA/HMI/PLC STANDARDS DOCUMENTATION

The following is the Process Control Strategy (PCS) format that will be followed for each process. All sections shall be completed prior to internal review and corrected made prior to secondary internal review (if needed) and any external review. Items in <italics> indicate there is information specific to the process control strategy and must be changed prior to the internal review.

{*__beginning of document__*~

<Process Control Strategy name>

General Information:

<Provide the brief description of what is being controlled and generally how it is to be controlled.>

1. Local Manual Control

    a. <Description of Local Manual control with regards to any operator control at the equipment.>

2. PCS Manual HMI Control

3. <Description of manual control with regards to the HMI "MANUAL" functions.>

Rewritten Process Strategy Documentation for Programming

EXAMPLE:

__{ Beginning of example document –__

Strategy A

1. PCS Automatic HMI Control

    a. <Description of HMI/PLC control with regards to the HMI "AUTO" and "MANUAL" functions.>

2. Detailed programming sequence and strategy. This section provides the detail to coordinate the PLC programming functionality and HMI interface functions.

3. Monitoring and Alarming

    a. Monitoring PLC Analog Input Points

        1) List Analog Points with the additional information for each point.

            a) Point Name
            b) High and Low Engineering Scaling Units.
            c) Type of signal being processed (0-20mA, +/- 10VDC, etc.)
            d) Offset (if required).
            e) Digital Filtering in milliseconds (if not default).
            f) Notch Filter in Hz (f not default).

g) Alarming Discrete Points (LLA, LA, HA, HHA)
h) Alarms – Disabled, Latched, Rate Latched – Yes/No
i) Deadband Setting (to minimize alarm cycling).
j) Rate Alarm Setting (if required otherwise NONE).
k) Process Control Discrete Triggering Points (LL, L, H, HH)
l) Enable/Disable Analog Propagation of Signal
m) Temporary Over-ride Value (if required)
n) Supervisor Change - Process Control Discrete Triggering Points (LL, L, H, HH) via HMI.
o) Supervisor/Operator Change Alarm Set-points (ALL, AL, AH, AHH) via HMI
p) Operations Security Group(s) allowed for tag access.

b. Monitoring PLC Digital Input Points

1) List Analog Points with the additional information for each point.

a) Point Name
b) Alarm or Event Point Status (must designate A or E)
c) State of Point (Transition High = In Alarm or Transition Low = In Alarm, etc.)
d) Change of State Enabled (off>on & on>off PLC function)
e) Open Wire Monitoring (yes/no PLC function)
f) Diagnostic Latching Logic Enabled/Disabled (if required)
g) Input Filter Time Enable/Disable (off>on & on>off PLC function)
h) Enable/Disable Discrete Propagation of Signal
i) Temporary Over-ride Tag and security group
j) Operations Security Group(s) allowed for tag access.

c. Alarming

1) List ALL alarms not associated with an AI or DI point.

a) PLC Status Alarms
b) Ethernet IP, DeviceNet, Modbus, and HART Communication Alarms (as required)
c) Peripheral Equipment Alarms (Power Supplies, Chart Recorders, etc.)
d) Analog Output Clamping Limits Reached Alarm
e) Process Module Error Alarms (e.g., PIDE error, etc. status bits).

4. Calculations

    a. PLC

        1) Provide any calculation information (e.g., square root, process multi-variable calculations, analog conversion not already performed by other PLC configuration parameters, etc.)

        2) Sample and Averaging Calculation Information

        3) Totalization Calculations

        4) Timing calculations based on system clock variables.

    b. SCADA

        1) Provide custom calculations or signal modifications in the HMI. There should be very few, if any, of these signals as the calculations should be performed in the PLC and NOT in the HMI. Typically, these type of calculations are for dynamic graphics object motion or movement - which should be kept to a minimum due to reduction in performance of graphic display(s).

5. Graphics

    a. Include all displays and sub displays associated with this PCS.

    b. Identify any special graphic symbols and their function required for the displays and sub-displays that do had to be specially created for this PCS (e.g., radiation symbol).

~ end of example document }

D. ELECTRONIC FILE STORAGE

1. The SCADA software development process will follow CITY OF HARRISBURG's network filing system.

2. This filing system will be defined at a later date.

E. O&M DOCUMENT PROCESS

1. The O&M Document Process will follow the Corp of Engineer's documentation requirements unless otherwise determined by CITY OF HARRISBURG staff.

2.7 CHANGE MANAGEMENT GUIDELINES

A. CHANGE MANAGEMENT PROCESS

Change during a project is normal and typical. Changes occur for numerous reasons and from three distinct entities on the project; CITY OF HARRISBURG, the Contractor, and the Engineer.

1. CITY OF HARRISBURG changes typically occur as a result of:

   a. An operational change of a piece of equipment or process.
   b. Strong preferences by CITY OF HARRISBURG.

2. Contractor changes typically occur because of:

   a. Changes in equipment manufacturer or model.
   b. Contract additions/deletions.
   c. Mistakes by the contractor.

3. Engineer changes can occur:

   a. When equipment approved during the submittal process does not meet the original specifications and P&ID functions.

   b. Engineering Issues.

Note: Refer to the Change Management Process and Procedures Manual.

B. CHANGE MANAGEMENT DURING SOFTWARE DEVELOPMENT

1. After the SDD has been ratified, the software development phase begins. During the software development phase, changes to the SDD have minimal impact at the beginning and a growing impact as the software comes to completion.

C. CHANGE MANAGEMENT DURING FIELD STARTUP

1. After the software development phase is complete, the field startup can begin when the field installation is substantially complete. During the field startup, changes to the SDD have significant impact. This is the point at which the Change Management Process provides the most feasible approach to manage the changes, complete the project on time and produce a quality product.

D. CHANGE MANAGEMENT AFTER FIELD STARTUP

1. After the field startup is complete, the operational testing phases can begin. During the operational testing phases, changes to the SDD have significant impact. This is another point at which the Change Management Process provides the most

feasible approach to manage the changes, complete the project on time and produce a quality product.

E. CHANGE MANAGEMENT AFTER PROJECT COMPLETION

1. After the project is complete and accepted by CITY OF HARRISBURG, the warranty period begins. During the warranty period, changes to the SDD (or at this point the O&M Manuals) have significant impact. This is the final point at which the Change Management Process provides the most feasible approach to manage the changes during the warranty period.

2.8 TRAINING

A. OPERATIONS TRAINING

1. To be clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

B. MAINTENANCE AND SYSTEM EXPANSION TRAINING

1. To be defined clearly defined during the development of each project at the engineering design phases and the configuration of the software during the SCADA development phase.

END OF SECTION

SECTION 40 63 43 - PROGRAMMABLE LOGIC CONTROLLER (PLC)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Requirements of Division 1 and Section 26 05 00 form a part of this Section.

B. Related Sections Include:

1. Section 40 61 00: Process Control and Enterprise Management Systems General Provisions
2. Section 40 61 06: Instrumentation Loop Testing Forms
3. Section 40 61 93: Process Control System Input/Output List
4. Section 40 61 96: Process Control Descriptions
5. Section 40 70 00: Instrumentation for Process Systems
6. Section 40 60 00: Network Communication Equipment

1.2 SUBMITTALS

A. The following items shall be submitted in this Section shall be made in one package under the Product Review category of Shop Drawings.

1. Catalog cuts for PLC panel components. These shall include, but not be limited to the central processing unit, input modules, output modules, program storage device, interfacing equipment, power line voltage regulation transformer, power line surge protection device, Ethernet switches, fiber optic media converters and, fiber optic patch panels.
2. An Input/Output (I/O) record containing a textual description for each item of input and output, connection diagram addressing (rack, module, channel and address numbers), and data table bit and data table word assignments.
3. A typewritten document containing startup, operation, and maintenance procedures.
4. The Factory and Field Witnessed Test procedure.
5. The Factory and Field Witnessed Test results.

6. Documentation to confirm that the spare memory requirements comply with project requirements.

7. Catalog information on laptop computer and programming software packages.

8. Spare Parts Items: As specified herein.

1.3 QUALITY ASSURANCE

A. Provide PLCs, which comply with NEMA Standard ICS 3-304. This standard applies to the construction, programming, performance, test, installation, protection, and safety of PLCs.

B. UL Listed Industrial Control Panel, equipment and components shall be certified for US and Canada.

1.4 UL LABEL

A. Programmable controller enclosures shall bear the UL label.

PART 2 PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLERS

A. General: The panel builder subcontractor shall provide PLC hardware as described herein and as shown on the Drawings. PLC software and ladder logic programming shall be provided by the Engineer. Minimum PLCs to be provided are listed below. Additional PLCs may be networked as part of the system if required to split responsibilities of packaged equipment Vendors and panel builder subcontractor.

1. Main PLC South – located in the existing pump building.
2. Filter PLC RIO South – Located in the MCC room of the new filter building
3. Main PLC North – Located in the MCC room of the new filter building
4. Well PLCs – located in each Well building - Well No. 4, No. 6, No. 7, No. 8, and No. 9.

B. ControlLogix Programmable Automation Controller: Provide the Main PLCs and Filter PLC RIO with the following hardware as designated in the Drawings.

1. I/O Chassis: Provide appropriate universal I/O chasses as shown in the Drawings to house the processor, power supply, communication modules, and I/O modules. The selection of slot number size of chasses for each PLC and extended I/O will be specified in the Drawings.

2. Power Supply: The power supply modules will power the processor and local I/O modules and modules in extended chasses. Back plane loading shall not exceed

75% of power supply rating amps on any chassis. Primary power to power supply shall be 24 Vdc.

3. Memory: The processor shall have a minimum of 10 Mb of basic memory. Provide processors specified in the Drawings.

4. Cables: Provide a full complement of both Ethernet and serial cables for connecting to programming terminal and interface devices.

5. Central Processing Unit: The Central Processing Unit (CPU) shall have the following:

   a. PLC capable of executing ladder logic, function blocks, structured text, and sequential flow chart logic. PLC shall support on line/off line programming functions.

   b. Integer, double integer, and floating point arithmetic.

   c. PIDE (enhanced PID function block) loop control.

   d. CPU shall be Allen Bradley ControlLogix system model no. 1756-L83E. No equal or substitution will be accepted.

6. Input and Output Modules:

   a. Analog inputs (AI) shall meet the following requirements:

      1) 4 to 20 mAdc inputs, 250-ohm impedance maximum, eight single ended configuration.

      2) Accuracy of ±0.15% of span.

      3) Resolution: 16 bits

      4) Common Mode Rejection of 100 dB at 60 Hz, minimum.

      5) Normal Mode Rejection of 80 dB at 60 Hz, minimum.

      6) Isolation shall meet or exceed surge-withstand test, IEEE-472.

      7) Drift shall not exceed 1.5% within a one-year period @ 25 °C

      8) Modules shall be Allen-Bradley 1756-IF8, unless otherwise specified on the Drawings.

   b. Discrete inputs (DI) shall meet the following requirements:

      1) Unpowered contact inputs or power inputs at 24 Vdc.

2) Input isolation shall meet or exceed IEEE-472. Relay isolation is unacceptable.

3) Provide filtering on a per unit point basis to provide contact bounce protection.

4) Discrete inputs shall be powered from the PLC control panel by a 24 Vdc power supply; shall be current limited to conform to NEC Class 2 remote control and signal wiring circuits.

5) Modules with 16 inputs with common ground terminals.

6) Modules shall be Allen-Bradley 1756-IB16, unless otherwise specified on the Drawings.

c. Analog outputs (AO) shall meet the following requirements.

1) Output: 4-20 mAdc into a 0 to 500 ohm load; eight individual output configurations with separate grounds.

2) Isolation: From the multiplexer ground.

3) Resolution: 13 bits.

4) Accuracy: ±0.1% of 4 to 20 mA

5) Drift: Shall not exceed 1% in a one-year period.

6) Output short circuit protection shall be electronically limited to 21 mA or less with 24 V AC/DC maximum overvoltage protection.

7) Modules shall be Allen-Bradley 1756-OF8, unless otherwise specified on the Drawings.

d. Discrete outputs (DO) shall meet the following requirements:

1) Electrically-latched outputs shall require one program command for set and reset. Loss of power shall return the output to a preselected state. Both fail open and fail close contact states shall be provided.

2) Contact configuration shall be N.O.; supply with suppression circuit or interposing relay for inductive load.

3) Provide the following ratings: 2A steady state, 15A make at 125 VAC inductive load for external relays.

4) Provide arc-suppression for each contact.

5) Provide 16 isolated output configuration.

6) Modules shall be Allen-Bradley 1756-OB16E, unless otherwise specified on the Drawings.

e. Provide spare inputs and outputs so that a minimum of 20% of each type is spare, functional, and installed in the mounting racks. Permanently label each input and output on each module by the tag number and description given in the Instrument Schedule.

f. Provide at least two spare slots for future modifications/additions.

g. Remote I/O Adapter: Provide EtherNetIP I/O adapters, model 1756-ENBT, for communication between the CPU and other Remote I/O chassis. Configure RIO networks on a different subnet than the main PLC/SCADA Ethernet subnet. This will keep RIO EtherNet traffic off the main network subnet.

h. Provide blank plates for all unused I/O slots.

7. Communications Module (Built in): Provide PLC with Ethernet communications using TCP/IP protocol.

C. CompactLogix Programmable Automation Controller: Provide PLCs for the wells 4, 6, 7, 8, and 9 as designated in the Drawings.

1. Power Supply: Provide power supply modules shown on the Drawings to power the processors and local I/O modules. Primary power to power supply shall be 24 Vdc.

2. Memory: The processor shall have a minimum of 1 Mb of basic memory.

3. Cables: Provide a full complement of both Ethernet and serial cables for connecting to programming terminal and interface devices.

4. Central Processing Unit: The Central Processing Unit (CPU) shall have the following:

a. PLC capable of executing ladder logic, function blocks, structured text, and sequential flow chart logic. PLC shall support on line/off line programming functions.

b. Integer, double integer, and floating point arithmetic.

c. PIDE (enhanced PID function block) loop control.

d. CPU shall be Allen Bradley CompactLogix with integral Ethernet port, system model no. 5069-L310ER. No equal or substitution shall be accepted.

5. Input and Output Modules:

    a. Analog inputs (AI) shall meet the following requirements:

        1) 4 to 20 mAdc inputs, 250-ohm impedance maximum, eight single ended configuration.

        2) Accuracy of ±0.15% of span.

        3) Resolution: 16 bits.

        4) Common Mode Rejection of 100 dB at 60 Hz, minimum.

        5) Normal Mode Rejection of 80 dB at 60 Hz, minimum.

        6) Isolation shall meet or exceed surge-withstand test, IEEE-472.

        7) Drift shall not exceed 1.5% within a one-year period @ 25 °C.

        8) Modules shall be Allen-Bradley 5069-IF8.

    b. Discrete inputs (DI) shall meet the following requirements:

        1) Unpowered contact inputs or power inputs at 24 Vdc.

        2) Input isolation shall meet or exceed IEEE-472. Relay isolation is unacceptable.

        3) Provide filtering on a per unit point basis to provide contact bounce protection.

        4) Discrete inputs shall be powered by the PLC by a 24 Vdc power supply; shall be current limited to conform to NEC Class 2 remote control and signal wiring circuits.

        5) Modules with 16 inputs with common ground terminals. Voltage input modules shall have their channels fully isolated.

        6) Modules shall be Allen-Bradley 5069-IB16F.

    c. Analog outputs (AO) shall meet the following requirements.

        1) Output: 4-20 mAdc into a 0 to 500 ohm load; 4 individually isolated output configurations with separate grounds.

        2) Isolation: From the multiplexer ground.

3) Resolution: 16 bits.

4) Accuracy: ±0.1% of 4 to 20 mA

5) Drift: Shall not exceed 1% in a one-year period.

6) Output short circuit protection shall be electronically limited to 21 mA or less with 24 V AC/DC maximum overvoltage protection.

7) Modules shall be Allen-Bradley 5069-OF8C.

d. Discrete outputs (DO) shall meet the following requirements:

1) Electrically-latched outputs shall require one program command for set and reset. Loss of power shall return the output to a preselected state. Both fail open and fail close contact states shall be provided.

2) Contact configuration shall be N.O.; supply with suppression circuit or interposing relay for inductive load.

3) Provide the following ratings: 2A steady state, 15A make at 125 VAC inductive load for external relays.

4) Provide arc-suppression for each contact.

5) Provide 8 isolated output configuration.

6) Modules shall be Allen-Bradley 5069-OB16; no equal or substitution shall be accepted.

e. Provide spare inputs and outputs so that a minimum of 20% of each type is spare, functional, and installed in the mounting racks. Permanently label each input and output on each module by the tag number and description given in the Instrument Schedule.

f. Allow at least two spare spaces per rack for future modifications/additions.

6. Communications Module (Built in): Provide CPU with integral Ethernet communications using TCP/IP protocol.

D. PLC Software: Provide Rockwell Automation's Studio 5000 software.

E. PLC Enclosure:

1. The PLC hardware shall be furnished completely assembled and wired in control panel. Provide for serviceable layout of parts. Provide enclosure finish and color to match the motor control center.

2. Note that certain selector switches, pushbuttons, relays, and instruments shall be furnished and installed in addition to the programmable logic controller hardware.

F. Uninterruptible Power Supply (UPS): Provide a “online” UPS unit rated for 200% of PLC load with batteries sized to provide at least 1/2-hour service at full load. Provide Tripp Lite, Powerware, or equal.

G. Managed Ethernet Switches: Provide 10/100 Mbps combined copper cable and fiber optic cable managed switches in PLC panels and where shown on the Drawings. Auto-negotiation and manually configurable speed/duplex.

1. Wire speed switching fabric.

2. Latest version of the manufacturer’s software for configuring and monitoring Ethernet switches shall be provided. If more than one software package is available, provide the package with the greatest capability. If specialty cable is needed to connect between PC and switches, provide cable.

3. Each field Ethernet switch shall have at least one spare (unused) RJ45 port.

4. Managed Ethernet switches, as shown on the drawings, shall be compatible models from a single manufacturer. Refer to specification 40 66 00 for details.

5. Unmanaged switches for Wells and location remote from the Main PLC locations shall be N-Tron or approved equal.

H. Spare Parts: Provide the following spare parts.

1. One input/output module for each type provided.
2. One PLC processor module including memory for each type provided.
3. One power supply for each type provided.

PART 3 EXECUTION

3.1 WITNESSED FACTORY TEST

A. General: The PLCs that are not provided by the packaged equipment vendors shall be tested at the panel builder’s shop:

1. Programming of the PLCs shall be by the Engineer. The programs will be loaded to each PLC during the Witnessed Test and the entire system shall be tested by the panel builder subcontractor and the Engineer.

2. The panel builder subcontractor shall coordinate with the Engineer and provide any required technical information regarding PLC hardware.

B. Prior to shipment of the PLCs to the jobsite, perform a Witnessed Test. This test shall demonstrate full compliance of the PLCs with contract requirements. The test shall be performed by the panel builder subcontractor with the Engineer.

C. Prepare a detailed written witnessed test procedure to be submitted at least two weeks prior to start of the test. The test procedure shall describe testing methods and provide detailed specification of the input data and data sequences to be used in the test. If, in the opinion of the Engineer, a resubmission of the proposed test procedure is required, the date for the performance of this test shall be six weeks following delivery of the resubmitted test procedure.

D. Perform the witnessed test in accordance with the test procedure and coordinate with the Engineer. Any deviation in performance from that specified in these Specifications shall be corrected prior to shipment. If the deviation in performance is deemed by the Engineer to be substantial and if it is not corrected within the period allowed for the test, a second test shall be performed. No extension of Contract time will be allowed in the event that this second test in necessary.

E. Submit the results of the test in a formal document within two weeks following satisfactory performance of the test. The test results shall document all problems encountered in running the test, corrective action taken, and the detailed results of each phase of the test.

3.2 PERFORMANCE TESTING

A. After the PLC has been installed at the jobsite, a demonstration of compliance with all functional objectives shall be made under actual or simulated operating conditions, subject to favorable review by the Engineer.

B. Prepare a detailed written witnessed test procedure to be submitted at least two weeks prior to start of the test. The test procedure shall describe testing methods and provide detailed specification of the input data and data sequences to be used in the test. If, in the opinion of the Engineer, a resubmission of the proposed test procedure is required, the date for the performance of this test shall be set at least six weeks following delivery of the resubmitted test procedure.

C. Perform the witnessed test in accordance with the test procedure. Any deviation in performance from that specified in these Specifications shall be corrected prior to shipment. If the deviation in performance is deemed by the Engineer to be substantial and if it is not corrected within the period allowed for the test, then a second test shall be performed. No extension of Contract time will be allowed in the event that this second test in necessary.

D. Submit the results of the test in a formal document within two weeks following satisfactory performance of the test. The test results shall document all problems encountered in running the test, corrective action taken, and the detailed results of each phase of the test.

3.3 TRAINING

A. General: To familiarize the Owner's personnel with PLC operation, training shall be provided as detailed hereunder. The training course shall be conducted under the direction of a training director who shall design a detailed training plan that complements the experience and skill levels of the Owner's personnel.

B. PLC Operations Training: A minimum one-day course shall be provided for up to six persons by the Engineer. The level of training shall be sufficient to familiarize the personnel with the operation of the PLCs and programming and program storage device. All essential system operating procedures shall be described as required to enable Owner's personnel to observe the controller operation via the programming device displays.

C. PLC Corrective Maintenance Training: A one-day course shall be conducted for up to six persons on maintenance of modifications to the PLC by the Engineer. Instruction shall be given in the use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to the circuit board or module level and to implement repairs by replacing failed circuit boards or modules. Step-by-step written procedures shall be provided for identifying hardware faults to the circuit board or module level for all items of digital equipment. All equipment corrective maintenance training activities shall be limited to the use of diagnostic routines with the aid of the programming device.

D. Additional PLC Training: If requested by Owner, a portion of the field instrument training required in Section 40 70 00 may be allocated toward a continuation of either training course above or covering a specific topic. The Owner and Engineer must agree to the training content prior to commencing any training.

E. Documentation: Upon completion and acceptance of the PLC system, the Contractor shall provide complete documentation for all equipment provided in building the Industrial Control Panels. Any engineer approved modifications/changes to the electrical drawings shall be marked on a record set of drawings and returned to the Engineer for incorporation. Two copies shall be submitted to the Owner and one copy to the Engineer.

END OF SECTION

SECTION 40 66 00 - NETWORK AND COMMUNICATION EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Provide network and communication equipment and hardware as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Related Work: Documents affecting work under this section include, but are not necessarily limited to, General Conditions of these Specifications.

C. Work under this section includes:

1. Providing network enclosure with equipment.
2. Start-up and testing of the network equipment.

1.2 SUBMITTALS

A. Submit shop drawings in compliance with pertinent provisions of the General Conditions (Volume 1), including the network cabinet, network/communication equipment, accessories, and manufacturer’s detailed specifications (cut-sheets or data sheets).

B. Submit the operation and maintenance manuals in compliance with pertinent provisions of General Conditions (Volume 1).

C. Submit electronic copies of final equipment configurations (including passwords) after Substantial Completion on four USB Flash Drives.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Conform to Sections of General Conditions (Volume 1) during and after installation of the control and monitoring systems.

B. Maintain area, including enclosures, free of dirt and dust during and after installation of products.

1.4 QUALITY ASSURANCE

A. Provide enclosures, devices, components, etc., which have been listed and labeled by Underwriter’s Laboratories.

B. Equipment to be provided and installed by a business that supplies and installs/configures this equipment on a daily basis for the last 3 years.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with pertinent provisions of General Conditions (Volume 1)

PART 2 PRODUCTS

2.1 ETHERNET SWITCHES

A. Process Control System (In Field Control Panels):

1. Hot-swappable design.

2. 1 to 10 Gigabit connectivity.

3. Power over Ethernet Plus (PoE+).

4. 24 Ethernet ports.

5. Ethernet Switch: Allen Bradley Stratix (Layer 3) or Cisco Industrial Ethernet 3000 Series Switches (Layer 3), no equal.

6. Transceiver:

   a. Small form-factor pluggable (SFP) Gigabit interface converter (GBIC).
   b. Hot-swappable input/output device.

7. Mounting shall be in the control cabinets.

2.2 COPPER PATCH PANELS

A. Provide copper patch panels for the termination of field copper Ethernet cables in the network enclosure with the following requirements:

1. 48-Port rolled-metal construction.

2. 45-degree angled RJ-45 connectors.

3. Wiring to either T568A or T568B standard with 22 to 26 AWG solid or stranded cable.

B. Acceptable Manufacturers:

1. Black Box.
2. Or Approved Equal.

2.3 FIBER OPTIC PATCH PANELS

A. Provide fiber optic patch panels for the termination of field fiber optic cables in the network enclosure with the following requirements:

1. Wall and/or control panel mounted.

2. Painted steel.

3. 8-port, minimum.

4. Quantity as shown on the Drawings and as required by the application/installation.

5. Ortronics with LC connectors, no exception (consistent with Owner standards and existing network).

B. Acceptable Manufacturers:

1. Blackbox.
2. Or approved equal.

2.4 FIRSTNET DEVICES

A. Provide cellular modems designed for the FIRSTNET cellular systems with the following requirements:

1. Configuration: TBD.
2. Manufacturer: Cradle Point Systems.
3. Hardware: TBD.

2.5 NETWORK ACCESSORIES

A. Cable Management:

1. Provide vertical and horizontal cable management for entire network enclosure.

2. Size cable management to handle a quantity of cable greater than or equal to double of the existing cabling.

B. Filler Panels:

1. Provide filler panels over unused vertical rack space.
2. Constructed of 14-gauge steel with black powder coat finish.
3. Tool-less quarter-turn fasteners compatible with square M6 holes.
4. Maximum size of 3U.

C. Shelves:

1. Fixed vented 4-point shelf.
2. Weight capacity of 50 pounds.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's requirements.

B. Install nameplates and identification tags to comply with Division 26 and as follows: Label the enclosures, devices, and components.

C. Touch-up and clean enclosures after the start-up.

3.2 START-UP AND TESTING

A. Start-up and testing is the responsibility of the process control panel supplier.

B. Provide a minimum of two 8-hour days on site to support the start-up, testing and training for the installed network equipment in conjunction with the Owner's IT staff.

3.3 CYBER SECURITY

A. No Internet Protocol (IP) addresses shall be documented on any documentation that can be construed as a public discoverable document. In order to secure the network and minimize the potential for Cyber Criminal Exploitation, The City IT Staff shall work with the contractor to verbally provide IP address groupings, virtual network segments and any other information to allow the contractor to connect the North and South network systems together. If any IP addresses are written on paper, the paper shall be destroyed upon configuration of a device.

B. For all devices, device login and password settings shall be configured by the HSI Contractor and provided to the IT staff. During network training, the passwords shall be changed such that the Contractor no longer has knowledge of the passwords or access to the configuration of the device.

END OF SECTION

SECTION 40 70 00 - INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work Included:

1. Provide all tools, equipment, materials, and supplies and be responsible for all labor required to complete the installation, startup, and operational testing of a complete and operable Instrumentation and Control (I&C) System as indicated on the Drawings and as specified herein.

2. Provide all the necessary equipment components and interconnections along with the services of manufacturers' engineering representatives necessary to ensure that the Owner receives a completely integrated and operational I&C system as herein specified.

3. Provide all terminations for wiring at field mounted instruments, equipment enclosures, alarm, and status contacts.

4. Provide all Instrumentation and Control wire required for a fully functioning Instrumentation and Controls System as shown on the Drawings except for wire specifically specified in Division 26. See Section 26 05 00.

B. Work Specified in Other Divisions:

1. Instruments and controls that are provided as part of a package system.

2. Division 26 work, including all instrumentation and controls conduit, and only that wire specified in Division 26. Refer to Division 26 Specifications for specific requirements for wire, conduit, grounding, and other electrical equipment.

1.2 REFERENCE STANDARDS

A. American National Standard Institute (ANSI) Publications:

1. Y14.15a Drafting Practice
2. C62.1 Surge Arrestors

B. Instrumentation Society of America (ISA) Publications:

1. S5.4 Instrument Loop Diagrams

2. S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

1.3 HARWARE SYSTEM INTGRATOR QUALIFICATIONS

A. A Hardware Systems Integrator (HSI) shall be an electrical contractor who has demonstrated experience in purchasing, calibrating, fabricating, installing, and testing the Instrumentation and Control (I&C) products listed in this Specification Section. Normally, the HSI is a systems house regularly engaged in the business of panel fabrication, control component procurement, programmable logic controller and personal computer (PC) application in the process control industry.

B. The HSI must have at least 5 years of experience in performing all aspects of the type of work specified in this Section and shown on the Drawings.

1.4 I&C SUBCONTRACTOR SYSTEM RESPONSIBILITIES

A. General: The I&C equipment as specified in this Division shall be considered an integrated system. Entire system installation including calibration, verification, startup, operation testing, and training shall be performed by qualified personnel, possessing all the necessary skills and equipment, and who have had experience performing similar installations. Instrumentation and control systems drawings are diagrammatic only; it is the responsibility of the HSI to obtain technical data, determine performance requirements, develop instrumentation detail installation designs, and coordinate the selection of specified equipment with Contractor supplied equipment to meet the design conditions stated.

B. System Responsibilities:

1. Instrumentation and control system drawings are diagrammatic only. Obtain technical data, determine performance requirements, develop installation details and integrate I&C subcontractor supplied equipment with Contractor supplied equipment where depicted on the Drawings.

2. Compatibility: See that all components of the instrumentation system, including equipment specified under other Divisions, are completely compatible and function properly as a system. Provide such additional equipment, accessories, etc., as are necessary to meet these objectives at no cost to the Owner.

3. Coordination: For control components, devices, and systems specified in Divisions or shown on the Drawings.

   a. Provide technical advice to mechanical and electrical subcontractors as necessary regarding their installation of instruments.

   b. Verify the correctness of installation of all instruments.

   c. Verify that the proper type, size, and number of control wires with their conduits are provided.

d. Verify that the proper type, size, and number of pneumatic tubes with their conduits are provided.

e. Verify that proper electric power circuits provided for all components and systems.

f. Resolve all manufacturers' installation discrepancies between requirements and the detail requirements of the Drawings and Specifications.

g. Supervise final signal connections, both electric and pneumatic, to all process instrumentation and control equipment.

h. Adjust, startup, and test all process instrumentation and control equipment.

i. Provide specified documentation and training.

4. Performance: While the Drawings provide sufficient information to establish the form and function of the systems and their relationships, the responsibility for system integration and performance rests solely with the Contractor. The Engineer provides technical instruction and guidance where needed.

5. Site and Instrument Inspection: Inspect site for conformance to Drawings, paying special attention to space allocation and dimensions shown or required on Drawings. Inspect completed work and verify that it is ready for installation of instruments and equipment. Inspect each instrument and piece of equipment for damage, defects, completeness, and correct operation before installing.

1.5 SUBMITTALS

A. Refer to General Conditions (Volume 1) for required methods of preparation and transmittal and conform to requirements herein.

B. Shop Drawings: Submit shop drawings (diagrams) for review in complete bound sets indexed by Specification number, with exterior tabs marked by subject. Submit manufacturer's catalog cuts for each item for which shop drawings are not required. Manufacturer's catalog cuts, specifications, or data sheets shall be clearly marked to delineate the options or styles to be furnished. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Drawings shall be complete with device tag numbers, wire numbers, and terminal board numbers. Submit fabrication details, nameplate legends, and control panel internal wiring and piping schematic drawings. Submit panel graphic drawings where applicable. Include material lists and/or bills of material.

1. Loop Diagrams:

a. Provide with the Instrument Loop Diagrams all instrument model numbers, ranges, set points, sizes, process fluids, specification reference numbers, and all other information listed as "desirable and optional items of information" per ISA S5.4.

2. Interconnection Diagrams: Submit point-to-point type interconnection diagrams conforming to ANSI Y14.15a. Include each conduit run, with wire fill noted for each run. Include electric panel and circuit numbers for all sources of 120 Vac power. Show conduit and wiring interconnections between each control panel, instrument, multiplexer or telemetry unit, motor control center, motor combination starter, valve actuator, and other field-mounted device. Include all equipment and appurtenances provided in this contract regardless of the Division in which it is specified.

3. Elementary Diagrams: Submit an elementary diagram for control, protection, and monitoring circuits. Elementary diagrams are not required for lighting, communications and those systems clearly defined on the single line diagram. Show all interconnections between power sources, apparatus, and device elements of a particular system or equipment, and all interlocks with other systems in a manner which fully indicates circuit function and operation. Refer to the Drawings for functional and operational requirements.

C. Specification Forms:

1. Submit completed Specification Forms per ISA S20, including those instrumentation and control components directly related to process control, but specified in other Divisions of these Specifications.

2. Include on each form the assigned tag numbers, manufacturer's part numbers, and device data. More than one tag numbered item may be included on a sheet.

D. Record Drawings: Submit a revised set of shop drawings that incorporates all change orders and modifications made during performance of the work. In addition to updated loop diagrams, interconnect diagrams, and elementary diagrams, submit equipment and device wiring diagrams and other drawings as necessary to depict the "as-built" condition of equipment. Include all installed field and panel conduit and piping/tubing runs and routing, tray systems, supports, mounting details, interconnection diagrams with cable, wire, tube, and termination numbers. Coordinate all drawings with the conductor identification requirements in Division 26. Submit a copy of CAD produced drawings on magnetic media in AutoCAD DWG format.

E. Operation and Maintenance Manuals: Furnish Operation and Maintenance Manuals, including Instruction Manuals and Part Lists, for equipment provided under Division 40 as required by the General Conditions (Volume 1). Obtain data from manufacturers, and format and bind as specified. Obtain distribution method instructions from the Owner or his representative.

1. Schedule: Deliver at least two (2) copies of manuals in 3-ring binders (8-1/2 by 11-inch format) not later than the equipment shipment date.

2. Contents: Include in manuals not less than the following information, as applicable, for each instrument, equipment, subsystem and/or control loop:

    a. General, introduction and overall description, purpose, functions, simplified theory of operations, etc.

    b. Specifications (including equipment specification data sheet as described above under Shop Drawings), sufficiently detailed for reordering exact duplicates of the original items.

    c. Installation instructions, procedures, sequences, tolerances, and precautions.

    d. Operational procedures.

    e. Shutdown procedures.

    f. Maintenance, calibration, and repair instructions.

    g. Parts list and spare parts recommendations.

    h. Calibration curves, rating tables, and any other data showing the relationship of the variable inputs and the calibrated output of all measuring devices and controlled equipment.

3. Format:

    a. Use drawings and pictorials to illustrate the text to the extent necessary to insure a clear, concise presentation. If manuals have been written to cover a family of similar instruments or equipment, strike out inapplicable information in a neat fashion or emphasize applicable portion by heavily weighted arrows, circles, or boxes; whichever provides the clearest and neatest presentation.

    b. Group manuals by system control panels, including field instrumentation connected or associated with the panel. Where identical instruments are used in more than one control loop or subsystem, include only one instruction manual, per panel grouping; however, an index by tag number for all instruments shall identify its location in that manual.

c. Provide control loop and/or subsystem operational descriptions to identify the function of each instrument and its relation to the other instruments in the loop.

4. Binding: Bind each manual in a cover which indicates the panel or process area to which it applies, manufacturer's name, local address and telephone number, and year of purchase. Punch and bind manuals in standard three-ring binders and include system name and subcontractor's name on binding.

F. Accessory and Maintenance Materials: Submit data for the following items:

1. Special Tools and Accessories: Special tools, instruments, and accessories for maintaining instruments and equipment requiring periodic repair and adjustment as specified elsewhere herein. Also, furnish special lifting and handling devices for equipment requiring such devices.

2. Maintenance Materials and Spare Parts: Submit a list of manufacturer recommended spare parts for each item specified. Refer to other sections of these Specifications.

G. Test Reports: Refer to Specification 40 61 06

H. Demonstration and Final Operation Test Plan and Results: Submit a document that outlines all procedures to be used in final operational testing of instrument and control systems. Include a description of each system, the scope of testing, test methods and materials, testing instruments and recorders, a list of functional parameters to be recorded on each item, and Shop Drawings showing temporary bypasses, jumpers, and devices.

1.6 QUALITY ASSURANCE

A. Standard of Quality: The Contractor shall provide equipment of the types and sizes specified which has been demonstrated to operate successfully. Provide equipment which is new and of recent proven design.

1.7 INSPECTIONS

A. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. Provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory.

B. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests, and operations.

C. Favorable review of the equipment at the factory only allows the manufacturer to ship the equipment to the project site. The Contractor shall be responsible for the proper installation and satisfactory startup operation of the equipment to the satisfaction of the manufacturer and the Engineer.

1.8 DRAWINGS

A. Drawings: The Instrumentation Drawings are diagrammatic; exact locations of instrumentation products shall be determined in the field by the Engineer. Except where special details are used to illustrate the method of installation of a particular piece or type of equipment or material, the requirements or descriptions in this Specification shall take precedence in the event of conflict.

1. Locations of equipment, inserts, anchors, motors, panels, pull boxes, manholes, conduits, stub-ups, fittings, power and convenience outlets, and ground wells are approximate unless dimensioned; verify locations with the Engineer prior to installation. Field verify scaled dimensions on Drawings.

2. Review the Drawings and Specification Divisions of other trades and perform the instrumentation work that will be required for the installations.

3. Should there be a need to deviate from the Instrumentation Drawings and Specifications, submit written details and reasons for all changes to the Engineer for favorable review.

4. Resolution of varying interpretations of the Contract Documents shall conform to Division 0, General and Supplementary Conditions.

5. The Drawings provide details of installation and supersede the manufacturer's recommendation where a conflict exists.

1.9 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element that could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Notify the Engineer in writing in the event that any equipment or material is damaged. Obtain prior favorable review by the Engineer before making repairs to damaged products.

B. The appended Schedule lists pertinent information about instruments identified for the contract. The Schedule is a comprehensive listing of devices but shall not be construed as a Bill of Materials or as a complete listing. For example, equipment procured as a packaged unit or assembled in the field to perform a standardized function (such as water seals) may contain instruments that are not listed. Upon request, a copy of the database can be provided.

PART 2 PRODUCTS

2.1 MATERIALS AND STANDARD SPECIFICATIONS

A. Provide instruments, equipment, and materials suitable for service conditions and meeting standard specifications such as ANSI, ASTM International (ASTM), ISA, and SAMA. The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the plant. All instruments in the plant of the same type shall be made by the same manufacturer.

2.2 NAMEPLATES

A. For each piece of equipment, provide a manufacturer's nameplate showing his name, location, the pertinent ratings, and the model designation.

B. Identify each piece of equipment and related controls with a rigid laminated engraved phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with the equipment name. Securely fasten nameplates in place using two stainless steel screws or, where favorably reviewed by the Engineer, with epoxy cement. Where no inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription furnished by the Engineer upon prior request by the Contractor.

C. Each control device, including pushbuttons, control switches, and indicating lights, shall have an integral legend plate or nameplate indicating the device function. These shall be inscribed as indicated on the Drawings or as favorably reviewed by the Engineer.

D. Provide CAUTION or SAFETY nameplates to alert operators of special conditions that may result in faulty equipment operations. Devices containing batteries that must be replaced periodically must be clearly identified. Nameplates are not required if the device senses and displays a low battery warning.

2.3 NAME TAGS

A. All instrumentation and equipment items or systems shall be identified by name tags. Field equipment shall be tagged with the assigned instrumentation tag number listed in the Instrument Schedule.

B. Name tags shall be stainless steel with engraved or stamped black characters of 3/16-inch minimum height. Tags shall be attached to equipment with a tag holder and stainless steel band with a worm screw clamping device. Use 20-gauge stainless steel wire where banding is impractical. For field panels or large equipment cases use stainless steel screws; however, such permanent attachment shall not be on an ordinarily replaceable part.

2.4 FIELD-MOUNTED EQUIPMENT

A. All instrument and control equipment mounted outside of protective structures shall be equipped with suitable surge arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Protective devices used on 120 Vac inputs to field mounted equipment shall be secondary valve surge protectors conforming to the requirements of ANSI C62.1.

2.5 EQUIPMENT OPERATING CONDITIONS

A. All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:

1. Electrical Power: 120 Vac ±10 percent, 60 Hz, unregulated, except where specifically stated otherwise on the Drawings or in the Specifications, or when two-wire, loop-powered devices are specified.

2. Air: 85, +5, psig.

3. Field Instruments:

   a. Outdoor Areas:
      Ambient Temperature: -10°F to +120°F.
      Ambient Relative Humidity: 5 percent to 100 percent.
      Weather: Rain and sleet.

   b. Indoor Unheated Areas:
      Ambient Temperature: +35°F to +120°F.
      Ambient Relative Humidity: 5 percent to 95 percent, non-condensing.

   c. Indoor Environmentally Controlled Areas:
      Ambient Temperature: +60°F to +104°F.
      Ambient Relative Humidity: 10 percent to 90 percent, non-condensing.

2.6 EQUIPMENT LOCATIONS

A. Provide equipment and materials suitable for the types of locations in which they are located as defined under Division 26. All equipment specified for field mounting shall be weatherproof and splash proof as a minimum. If electrical or electronic components are contained within the equipment, they shall be housed in NEMA 3R gasketed cases, and NEMA 4X in corrosive locations unless noted otherwise on the Drawings or specific item specification.

2.7 ANALOG SIGNAL INDICATED UNITS

A. For all instruments with local or remote indicators, provide indicators scaled in actual engineering units, i.e., gallons per minute, feet, psi, etc., rather than 0 to 100 percent, unless noted otherwise on the Drawings or Instrument Index.

2.8 SIGNAL TRANSMISSION

A. Analog: Signal transmission between electric or electronic instruments shall be 4-20 mA and shall operate at 24 Vdc. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Where practical, milliampere signals from the field shall be converted to a voltage signal at the external terminals of each panel, and all instruments within a panel shall be parallel wired.

B. Nonstandard transmission systems such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted in the PLC I/O List or shown on the Drawings. When transmitters with nonstandard outputs do occur, their output shall be converted to 4-20 mA prior to transmission.

C. Discrete: All alarm and status signals shall be 120 Vac unless specified otherwise. Proprietary data highway or serial bit transmissions such as DeviceNet shall be allowed to the extent shown on the Drawings.

2.9 PANEL/RACK/ENCLOSURE BAY POWER SUPPLIES

A. For two-wire transmitters, provide a 24 Vdc regulated power supply from the appropriate PLC control panel.

B. Manufacturer: Provide Phoenix Quint 100-240AC/24DC with terminal blocks and internal diodes for external connections, or approved equal.

2.10 PAINTING

A. Factory paint all instruments and equipment except where installed in pipelines. Where instrument panels are installed adjacent to electrical control panels provided under Division 26, provide instrument panels of identical color to that of electrical control panels. Paint as required in Division 9 for structural supports, brackets, etc. Repair damaged factory paint to satisfaction of the Engineer. Feathering, priming and painting shall produce a reasonable match to the surrounding paint work.

2.11 FASTENERS

A. Fasteners for securing equipment to walls, floors, and the like shall be either hot-dip galvanized after fabrication or stainless steel. Provide stainless steel fasteners in corrosive locations. When fastening to existing walls, floors, and the like, provide capsule anchors, not expansion shields. Size capsule anchors to meet load requirements. Minimum size capsule anchor bolt is 3/8-inch.

2.12 TUBING, PIPE, FITTINGS AND SUPPORTS

A. General: Instrument tubing listed below is required for all instruments and control valves. Select the appropriate tubing materials to satisfy service conditions except where specifically shown on Installation Detail Drawing.

1. Copper Tubing: Soft-annealed copper tubing shall be 1/4-inch O.D. x 0.030-inch wall, 3/8-inch O.D. x 0.032-inch wall, or 1/2-inch O.D. x 0.032-inch wall as shown on the Drawings. Copper tubing shall be seamless copper, Type DHP, bright annealed after coiling, dehydrated and sealed in 50-foot aluminum coils, per ASTM B75. Use for instrument or valve connections only.

2. Copper Tubing: Hard-drawn copper tubing shall be in accordance with ASTM B88. Sizes shall be 3/8-inch standard: 3/8-inch O.D. x 0.030-inch wall; 1/2-inch standard: 1/2-inch O.D. x 0.035-inch wall; or 5/8-inch standard: 5/8-inch O.D. x 0.040-inch wall in 20-foot straight lengths with plastic capped ends. Use for header or branch service only.

3. Stainless Steel: Stainless tubing shall be Type 304 seamless, cold drawn and annealed per ASTM A269. Sizes shall be 1/4-inch O.D. x 0.045-inch wall, 3/8-inch O.D. x 0.035-inch wall or 1/2-inch O.D. x 0.035-inch wall. Use for instrument or valve connections.

4. Pneumatic Tubing: Pneumatic tubing for panel internals shall be 1/4 or 3/8-inch O.D. rigidwall, clear polyethylene, 125 psi rating. Tubing shall be supported in plastic duct or conduit where appropriate. Use for enclosed or indoor instrument or valve connections.

5. Fittings:

   a. Copper Tube: Solder joint fittings shall be seamless wrought copper per ASTM B75. Compression fittings shall be Brass equal to Imperial or Swagelok.

   b. Stainless Steel Tube: Weld joint fittings shall be Type 304 stainless. Compression fittings shall be Type 316 stainless steel equal to Imperial or Swagelok.

   c. Supports for Tubing: Supports located in areas exposed to the weather or corrosive atmosphere shall be Type 304 stainless steel Unistrut or equal or made of steel conforming to ASTM A276. Supports not exposed to the weather or corrosive atmosphere shall be carbon steel painted.

d. Weld joint fittings shall be permitted for header and branch service only. Instrument and valve connections shall be compression-type only. Use unions on as necessary to simplify instrument removal.

6. Valves:

a. Pipe, Pipe Fittings, and Valves: Main-line piping material and root valves for instrumentation shall be as specified in Section 15050.

b. Instrument valves shall be 1/4-inch, 3/8-inch or 1/2-inch from Whitey or Hoke to match tubing material and size.

2.13 INSTRUMENT CALIBRATION

A. Each field instrument shall be calibrated at 0%, 25%, 50%, 75%, and 100% of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. Such test instruments have accuracies traceable to the National Institute of Standards and Technology (NIST).

B. Submit a written report to the Engineer on each instrument. This report shall include a laboratory calibration sheet or the manufacturer's standards calibration sheet on each instrument and calibration reading as finally adjusted within tolerances.

C. The Contractor may, at his option, choose to perform calibration on an instrument by acquiring the services of an independent test lab, or by obtaining the required test instruments and performing the calibration.

2.14 FACTORY TESTING OF CONTROL PANELS

A. All fabricated equipment shall be tested before it leaves the factory. At the factory verify wiring continuity and equipment operation by simulating input and output.

B. Factory testing of control panels/devices/equipment shall be accomplished. Refer to individual Specification sections for tests requiring favorable review.

C. Upon completion of factory testing, submit a report certifying the control panels/devices/equipment are operable and meet the Specifications.

PART 3 EXECUTION

3.1 MOUNTINGS

A. Mount and install equipment as indicated. Mount field instruments on pipe mounts or other similar means in accordance with suppliers' recommendation. Where mounted in control panels, mount according to requirements of that Section.

B. Equipment specified for field mounting shall be suitable for direct pipe mounting or surface mounting, surface-mounted indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than 3 feet-6 inches nor higher than 6 feet above walkways, platforms, catwalks, and the like.

C. Note that applicable specifications require detail drawings showing seismic sway bracing design and anchorage requirements for their equipment. Seismic zone requirements are specified in Division 1.

D. All devices shall be accessible to operators for servicing, operating, reading, etc. Provide permanent platforms to assure devices are continuously accessible.

3.2 PROCESS CONNECTIONS

A. Provide instrument impulse tubing (see Part 2) to meet the intended process service and ambient environmental condition for corrosion resistance, etc. Install impulse tubing with a continuous slope according to service to promote self-draining or venting back to the process. Terminate connection to process lines or vessels in a service rated roof valve, provided under other Divisions, that will permit closing off the impulse line or removal of the element without requiring shut down of the process. Include blowdown of drip legs and valves for terminations of impulse lines at the instruments.

B. Process vessels, line penetrations, and root valves shall be furnished and installed under other Divisions of these Specifications. Instrument tubing and valve manifolds are installed as part of this Specification.

3.3 FIELD WIRING

A. Ring out signal wiring prior to termination and perform surge withstand tests where required (see Section 26 05 19). Verify wire number and terminations are satisfactory as designated on the Loop and Interconnect Diagrams. Verify all terminations are tight and shields are uniformly grounded at one location.

3.4 ELECTROMAGNETIC INTERFERENCE (EMI)

A. Construction shall proceed in a manner which minimizes the introduction of noise (RFI/EMI) into the I&C System.

B. Cross signal wires and wires carrying ac power or control signals at right angles.

C. Separate signal wires from wires carrying ac power or switched ac/dc control signals within control panels, terminal cabinets, telemetry equipment, multiplexer cabinets, and data loggers as much as possible. Provide the following minimum separations within such equipment unless indicated otherwise on the Drawings:

Power Wiring Capacity	Separation (Inches)
120 volts ac or 10 amps	12
240 volts ac or 50 amps	18
480 volts ac or 200 amps	24
4,160 volts ac or 800 amps	48

3.5 SIGNAL GROUNDING

A. Proper grounding of equipment and systems in this Division is critical, since computer and associated networks and peripherals are involved. The Drawings and Division 26, Section 26 05 26, specify safety grounding for all equipment in this Division.

B. A single-point grounding system for instrument signals is required for all instrument panels. This instrument single point grounding system does not use building steel or conduit systems for its ground path.

1. Ground all signal shields, signal grounds, and power supplies at an isolated signal bus within each instrument panel, rack, or enclosure. The shields at the far ends of these signal cables must be disconnected (floated) from any ground to prevent ground loops.

2. Do not connect the rack or enclosure frames to the signal grounding buses.

3. Connect each isolated signal ground bus within each panel using a stranded, insulated copper wire of size 6 AWG or larger directly to a system ground rod installed per the Drawings.

C. If more than one instrument panel or rack is installed side-by-side, locate an isolated system grounding plate in one of the panels.

1. Connect all the isolated signal buses in such instrument panel or rack radially to the system ground plate using a stranded, insulated copper wire of size 8 AWG or larger.

2. Do not use conduit, cable raceways or building steel to distribute the grounding connections; use dedicated wires as specified above. Install a single conduit containing a #2 AWG insulated ground wire from the insulated grounding plate directly to a system ground rod installed per the Drawings. See Division 26 for conduit requirements.

3.6 PREPARATION

A. Ensure that installation areas are clean and that concrete or masonry operations are completed prior to installing instruments and equipment. Maintain the areas in a broom-clean condition during installation operations.

B. Panels shall be protected during construction to prevent damage to front panel devices and prevent dust accumulation in the intervals. Other protective measures (lamp, strip heaters, etc.) shall be included as weather conditions dictate.

3.7 FIELD TESTING

A. General: The purpose of the field testing is to verify instruments are calibrated and operationally performing their intended function. Refer to specification 26 08 00 Commission of Electrical Equipment. Provide the services of factory trained and experienced engineers to perform verification and operational testing as prescribed below. Since the initial calibration of instruments may not satisfy the final operation of system, perform recalibration or adjust setpoints as required to satisfy the performance requirements of the system. Notify the Engineer and Owner in writing a minimum of 48 hours prior to the proposed date for commencing final operational testing and acceptance.

B. System Verification Testing: Verify that each instrument shown on the Instrument Schedule is operating and calibrated as specified in the Instrument Schedule by simulating inputs at the primary element in each system loop and verify performance at loop output devices (i.e. recorder, indicator, alarm, etc., except controllers). Simulate inputs at 0%, 25%, 50%, 75%, and 100% of span or with on-off inputs, as applicable. During system verification:

1. Make initial or provisional settings on levels, alarms, etc. listed in the Instrument Schedule.

2. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.

3. Cause malfunctions to sound alarms or switch to standby to check system operation.

4. Check all loop instruments thoroughly for correct operation.

5. Immediately correct all defects and malfunctions disclosed by tests.

6. Submit a report certifying completion of verification of each instrument system. This report shall include a data sheet on each instrument tested that indicates instrument tolerances, instrument calibration verification, data, and initial settings made to devices.

C. Final Operational Testing: Upon completion of instrument verification, test all systems under process conditions in the presence of the Owner or designated representative. System testing shall be accomplished in accordance with the approved Test Plans. The test for each portion thereof shall be witnessed, documented, and signed off upon completion by the Engineer. The intent of this test is to demonstrate and certify the operational interrelationship of plant instrumentation and control systems. This testing shall include, but not be limited to:

1. Making final adjustments to levels, alarms, etc.

2. Optimum tuning of controllers.

3. Checking all alarms, failure interlocks, and operational interlocks.

4. Verifying all computer input and outputs and CRT displays are fully functional.

5. Verifying automatic computer-generated reports are performing satisfactorily.

6. Immediately correcting all defects and malfunctions and retesting.

7. Submit the witnessed test results and a transmittal letter indicating that all required systems have been tested satisfactorily and the systems meet all the functional requirements of their applicable specifications.

3.8 INSTRUCTION OF OWNER'S PERSONNEL

A. Provide the services of a factory trained and field experienced instrumentation engineer to conduct group training of the Owner's designated personnel in the operation of each instrument system. This training shall be for the time period of up to five working days and shall be performed during the operational testing period. Include instruction covering basic system theory, operating principles and adjustments, routine maintenance and repair, and "hands on" operation. The text for this training shall be the Operation and Maintenance Manuals furnished under these Specifications.

END OF SECTION

APPENDIX A - INSTRUMENTATION SCHEDULE

<<<EXAMPLE>>>

"PROJECT TITLE" INSTRUMENTATION SCHEDULE								
I/O TAG	LOOP NUMBER	ISA SUFFIX	SHEET	TYPE	RANGE	EQUIPMENT DESCRIPTION	VARIETY	MANUFACTURER
101-LE	101	LE	I03	AI	0-10FT	LEVEL SENSING DEVICE	RADAR LEVEL TRANSMITTER	Vega Probe with NEMA 4X enclosure or approved equal
105-LE	105	LE	I03	AI	0-10FT	LEVEL SENSING DEVICE	RADAR LEVEL TRANSMITTER	Vega Probe with NEMA 4X enclosure or approved equal
200-LSL	200	LSL	I04	DI	ON-OFF	LEVEL SENSING DEVICE	FLOAT LEVEL SWITCH (TILT BULB)	USFilter Model 9G-EF or approved equal
200-LSH	200	LSH	I04	DI	ON-OFF	LEVEL SENSING DEVICE	FLOAT LEVEL SWITCH (TILT BULB)	USFilter Model 9G-EF or approved equal
200A-LIT	200A	LIT	I04	AI	0-30FT	LEVEL SENSING DEVICE	AIR BUBBLER TRANSMITTER	Lesman, Digital Control Co. or approved equal
200B-LIT	200B	LIT	I04	AI	0-10FT	LEVEL SENSING DEVICE	RADAR LEVEL TRANSMITTER	Vega Probe with NEMA 4X enclosure or approved equal
206-FIT	206	FIT	I04	AI	0-7.0 MGD	FLOW SENSING DEVICE	MAGNETIC METER	Endress and Hauser ProMag, or approved equal
206-PSH	206	PSH	I04	DI	0-160PSI	PRESSURE SENSING DEVICE	PROGRAMABLE HIGH PRESSURE SWITCH	IFM Efector or approved equal
321-LE	321	LE	I05	AI	0-10FT	LEVEL SENSING DEVICE	RADAR LEVEL TRANSMITTER	Vega Probe with NEMA 4X enclosure or approved equal
306-LSL	306	LSL	I05	DI	ON-OFF	LEVEL SENSING DEVICE	FLOAT LEVEL SWITCH (TILT BULB)	USFilter Model 9G-EF or approved equal
306-LSH	306	LSH	I05	DI	ON-OFF	LEVEL SENSING DEVICE	FLOAT LEVEL SWITCH (TILT BULB)	USFilter Model 9G-EF or approved equal
305-LE	305	LE	I05	AI	0-10FT	LEVEL SENSING DEVICE	RADAR LEVEL TRANSMITTER	Vega Probe with NEMA 4X enclosure or approved equal

SECTION 40 71 10 - MAGNETIC FLOW METERS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Refer to Section 40 70 00 for general requirements.

1.2 SUBMITTALS

A. Shop drawings to be submitted in this Section shall be made in one package. Submit material or equipment data in accordance with the requirements of Section 26 05 00.

B. Shop Drawings:

1. In addition to the requirements of Section 40 70 00, shop drawings shall include for each type of instrument: supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.

2. Furnish shop drawings for each item of mechanical equipment presenting sufficient data to determine compliance to these Specifications. Submit completed ISA S20 forms for each device and physical dimensions. Submit manufacturer's recommended upstream and downstream straight piping lengths, recommended location of any pressure taps, and estimates of pressure losses through the device.

C. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.

D. Parts List: Submit a Parts List with current net prices and a list of recommended spares.

E. Factory Testing and Calibration:

1. All meters shall be factory tested. Perform a factory test and/or provide certification of calibration from an independent test laboratory. Calibration curves based on factory and/or laboratory testing (see option below) shall be provided for the Engineer's review. Furnish calibration curves in units of output (inches or rpm/gpm) versus measured flow.

2. As an option to laboratory testing each meter, the calibration curves of six (6) "like devices" may be substituted provided the calibration data is available from at least one identical device (pipe size, flow range, and type plus accessories such as extension registers).

F. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.

G. Affidavits: Furnish affidavits from the manufacturers stating that the meters have been properly installed and tested and each is ready for full time operation.

1.3 QUALITY ASSURANCE

A. Manufacturer: In addition to the requirements of Section 40 70 00, flow measurement devices furnished shall be manufactured by firms regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.

B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or as specified.

1.4 SEISMIC PROTECTION

A. Seismic restraint for metering devices, which are integral with piping, shall be as specified for the piping system in which they are installed. Seismic design certification and anchorage descriptions as required.

1.5 INDICATING UNITS

A. Provide flow indication in GPM, CFS, MGD, etc. Do not use indicators that read 0 to 100 percent, 4-20 mA, etc.

1.6 SERVICE CONDITIONS

A. Refer to Section 26 05 00.

PART 2 PRODUCTS

2.1 MAGNETIC FLOWMETER

A. General: Magnetic meters shall utilize the principle of electromagnetic induction to produce an output proportional to the rate of fluid flow. A set of pulsed DC, electrically powered coils shall generate a magnetic field, which in turn induces a voltage in the flowing fluid, which is sensed by a pair of electrodes in contact with the fluid.

1. Protect coils from contact with the fluid. The electrodes shall be made of Type 316L stainless steel. The meters shall be housed in a NEMA 4X enclosure. The metering tube shall be lined with NSF-61 certified hard rubber. Meters shall be resistant to electrode coating. The probe sensor shall be designed to be inserted in water pipes and shall not be affected by solids, air bubbles, oil, or coating. The probe sensor wetted parts shall be of Type 316 stainless steel.

2. The meters shall be designed to operate from a 120 Vac, 60 Hz, single phase power supply. A 10 percent variation in power line voltage or frequency shall not affect the meter output accuracy in excess of 1 percent of full scale.

3. Provide magnetic flowmeters suitable for fluids with conductivities as low as 5.0 micromho/cm.

4. Each magnetic flow meter system shall have accuracy within 0.2% percent of actual for flow velocities between 10 percent and 100 percent of full scale. Meters shall have repeatability within 0.25 percent of full scale.

5. Each magnetic flow meter shall be equipped with a signal converter to transmit an analog 4-20 mADC signal proportional to flow rate. The signal will include Hart communications capability. Output span and zero shall be manually adjustable. Provide span adjustment capable of producing 100 percent analog output at flow rates that are 30 percent of maximum. Signal shall be linear with flow within the accuracy specified above. The converter shall be integrally mounted with the meter housing.

6. Each Magnetic Flow meter shall also provide a contact for pulse totalization to the PLC. This will allow the totalizer at the flow meter to be better synchronized with the PLC totalizer display.

7. The signal converter shall have the capability of positive zero return for shutdown conditions.

8. Connections shall be ANSI B16.5 Class 150 flanges.

9. Meter shall have a self-cleaning electrode.

B. The magnetic flow meters shall have flanged end connections. Field coils shall be either completely encapsulated in the meter lining material or a protective shield shall be provided suitable for withstanding the scouring velocities of the process fluid at the maximum flow rates.

C. Grounding: Provide a grounding circuit for each magnetic meter. Furnish and install grounding rings or protective shield when meter is installed in nonconductive line.

D. Manufacturer: Meters and signal converters for full pipe magnetic flow meters shall be Rosemount 8700 Series, Endress + Hauser Promag Model 53W, or equal.

E. Special Tools: Furnish special tools, which are necessary for the replacement of parts and the adjustment of the equipment.

2.2 TURBINE FLOW METERS

A. The turbine flow meter shall feature a magnetic type drive which shall prevent the process fluid from contacting any gears, bearings, shafts, etc., within a hermetically meter register. The rotation of the propeller shall be transmitted via the magnetic drive to the register and transmitter (where required) by means of a rigid shaft. The meter shall register flow to within 100 ±1.5% of actual throughput at all flows within the range specified in the Instrument Index. The main case assembly shall be cast water works bronze with integral flow straightening vanes.

B. Construction:

1. The meter shall consist of two basic assemblies, the main case and the measuring chamber. The main case includes the flow straightening vanes and the measuring chamber includes the rotor and calibration vanes. The materials of construction shall be compatible with the process fluids and service environment for the intended application service life of all parts shall be at least 10 years, minimum. End connections shall be flat-faced NSI B16.1 or AWWA Class 125. Provide with mating flange.

2. Meters shall be provided with a register consisting of a rate indicator and a six digit totalizer. Each Turbine Flow meter shall also provide a contact for pulse totalization to the PLC. This will allow the totalizer at the flow meter to be better synchronized with the PLC totalizer display.

3. A certified copy of a 10-point calibration curve taken over the entire operating range of the meter shall be submitted to the Engineer for favorable review. See Section 40 70 00.

4. Provide an inline strainer with the meter.

C. Manufacturer: Provide Badger with strainer; or equal.

2.3 FLOW SWITCHES - THERMAL

A. General: Flow switches shall sense a pulsed or steady-state flow rate of fluid in a pipe and operate a DPDT switch to actuate alarms or control circuits. The switch shall be rated for 1 ampere minimum load at 120 Vac, 60 Hertz. The fluid shall be water.

B. Thermal type flow switches shall be housed in a NEMA 4 enclosure with NPT electrical conduit connection and shall be of the probe type for threaded insertion in a pipe boss as shown on the Drawings. They shall operate by means of sensing the differential cooling of heated sensor elements caused by flow and no flow condition, and shall be all solid state. Operating power shall be 120 Vac, 60 Hertz at 25 watt maximum. The switches shall be available for pressure up to 2,000 psig and shall be capable of sensing velocities as low as 0.1 fps. Wetted parts shall be stainless steel.

C. Operating Conditions: The flow switch shall be sized and adjusted for the pipe diameter, fluid and flow rates shown in the Instrument Index. Repeatability of sensing shall be within 10% for any setting, and differential shall be less than ±40% within the flow range specified. Set point shall be shown on the Instrument Index.

D. Manufacturer: Thermal type switches shall be as manufactured by Fluid Components, Inc., Model 12-64; or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Section 40 70 00.

3.2 PERFORMANCE TESTING

A. Specific to device, call out details associated with 40 70 00

END OF SECTION

SECTION 40 71 20 - INSERTION-TYPE MAGNETIC FLOWMETER

PART 1 GENERAL

1.1 DESCRIPTION

This section includes materials and installation of insertion-type magnetic flowmeters.

1.2 SUBMITTALS

A. Submit shop drawings in accordance with the General Provisions

B. Submit manufacturer's catalog data and detail drawings showing dimensions, pressure rating, coatings, and meter parts and describe by material of construction specifications (such as AISI, ASTM, SAE, or CDA) and grade or type. Identify each meter by tag number to which the catalog data and detail sheets pertain.

C. Show meter insertion length.

PART 2 MATERIALS

2.1 FLOWMETER MANUFACTURER

McCrometer, Inc., FPI Mag, or equal.

2.2 METERING SYSTEM

The insertable flowmeter shall consist of two components: an electromagnetic averaging sensor and an electronic unit. The system shall use characterized electromagnetic induction to produce a signal linearly proportional to average flow rate.

2.3 ELECTRONICS

The flowmeter electronic unit shall be microprocessor based with a keypad for instrument set up and LCD displays for totalized flow, flow rate engineering units, and velocity or totalized flow. The electronic unit shall power the flow-sensing element and provide a galvanically isolated 4- to 20-mA output for flow and one programmable flow proportional or frequency output. It shall be possible, in the test mode, to set the transmitter outputs to any desired value within their range. The 4- to 20-mA scaling, time constants, pipe size, flow proportional output, engineering units, and test mode values shall be set via the keypad and display. Provide two separate fully programmable alarm outputs to indicate high/low flow rates, empty pipe, fault conditions, reverse flow, and overrange conditions. The transmitter shall perform self-diagnostics and display any resulting error messages. Set-up data and totalizer values shall be protected by a password.

2.4 SENSOR

The flow-sensing element shall be of an electromagnetic multipoint averaging type design and factory calibrated to traceable standards, such as NIST. Single point insertion or pressure port sensors are not acceptable. Install the averaging sensor under flowing conditions through a 2-inch valve into the pipe. Profiling or site calibration shall not be required. Sensor shall be suitable for clean, potable, raw, or other debris-free water applications. The sensor shall not be damaged by extended operation at partially full or empty pipe conditions.

2.5 SENSOR CABLE

The sensor cable shall be 20 feet of multiconductor, abrasive-resistant, polyurethane-jacketed cable, flexible to –40°F. The sensor cable shall be permanently bonded to the sensor. Velocity Measurement

A. Method: Electromagnetic.
B. Zero Stability: ±0.03 fps.
C. Range: 0 to 20 fps.
D. Accuracy: ±1% of reading from 0 to 20 fps plus zero stability.
E. Linearity: 0.3% of range.
F. Repeatability: 0.20% of range.

2.6 MATERIALS

A. Sensor: Fiberglass.

B. Cable: Polyurethane outer jacket.

C. Insertion Hardware: Type 316 stainless steel exposed to flow.

D. Compression Seal: Silicone rubber.

E. Sensor Electrodes: Carbon.

   1. Pipe sizes 6 to 11 inches = 3 pairs.
   2. Pipe sizes 12 to 60 inches = 5 pairs.

F. Electronic Enclosure: NEMA 4X/IP65. Glass-filled polypropylene with clear polycarbonate window.

2.7 OUTPUTS

A. 4 to 20 mA: Galvanically isolated and fully programmable for zero and full scale (800 ohms maximum).

B. Pulse/Frequency: One frequency/pulse output for flow rate or for external totalizer. Isolated protected transistor switch capable of sinking <250 mA at <35 volts.

C. Dual Alarms: Two separate programmable outputs.

D. Display: Three-line, 16-character, backlit LCD with 1/2-inch numerals for flow rate.

2.8 MOUNTING HARDWARE

Provide stainless steel restraining rods, of sufficient length, for the smooth installation of the electromagnetic averaging sensor. Provide shorter stainless steel restraining rods for the continuous operation of the electromagnetic averaging sensor. In order to provide stable and secure sensor placement, the sensor shall be capable of pressures up to 300 psi for use in plastic pipes and 600 psi for use in metal pipes.

PART 3 EXECUTION

3.1 INSTALLATION

Ground meters to adjacent pipe as specified and locate to ensure full pipe at all times.

3.2 SCHEDULE OF MAGNETIC FLOWMETERS

Provide the following flowmeters:

Tag No.	Service	Size (inches)	Flow Range (gpm)	Pressure Rating (psi)
WTR24FI_01	Finished Water	12	0 to 800	150
WTR14FI_01	Finished Water	12	0 to400	150

END OF SECTION

SECTION 40 72 00 - LEVEL MEASUREMENT

PART 1 GENERAL

1.1 DESCRIPTION

A. Work Included: Level measurement devices for process instrumentation, auxiliary equipment, and supplies directly related to the installation of and operation of these level measurement devices, to perform the required functions in conjunction with information and equipment specified in other Sections of Division 40. Refer to the Instrument Index in Section 40 70 00 for a listing of required devices.

B. Requirements of Section 40 70 00 form a part of this Section.

C. Furnish and install level measurement instruments and all appurtenant work suitable for wastewater, at ambient temperatures, complete and operable, and capable of continuous operation.

1.2 SUBMITTALS

A. Shop drawings to be submitted in this Section shall be made in one package. Submit material or equipment data in accordance with the requirements of Section 26 05 00.

B. Shop Drawings:

1. In addition to the requirements of Section 40 70 00, shop drawings shall include for each type of instrument: supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.

2. Furnish shop drawings for each item of mechanical equipment presenting sufficient data to determine compliance to these Specifications. Submit completed ISA S20 forms for each device and physical dimensions. Submit manufacturer's recommended location.

C. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.

D. Parts List: Submit a Parts List with current net prices and a list of recommended spares.

E. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.

1.3 QUALITY ASSURANCE

A. Manufacturer: In addition to the requirements of General Requirements, level measurement devices furnished shall be manufactured by firms regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.

B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or specified.

PART 2 PRODUCTS

2.1 ULTRASONIC LEVEL TRANSMITTER – CHEMICAL STORAGE

A. General: Provide level transmitters for the measurement of chemical level in the chemical storage tanks as shown on the Drawings.

B. Ultrasonic PVDF level transducer and transmitter/controller shall be Siemens Sitrans Probe LU with NEMA 4X enclosure or equal.

C. Accuracy shall be 0.15 percent over the range of measurement.

D. Provide a 4-20 mADC output to a PLC.

E. Mount the transmitter as shown on the Drawings.

F. Provide hand held configuration tool.

G. Acceptable Manufacturers: Siemens Hydro Ranger 200 Transmitter.Controller and Echomax Transducer

2.2 SUBMERSIBLE PRESSURE TRANSMITTER

A. General: Electric-indicating type submersible pressure transmitters shall convert a differential or gauge pressure measurement to a 4-20 mAdc linear electric output signal capable of transmission into a least a 600 ohm maximum load at 24 Vdc or less. Signal and power transmission shall be provided by a single pair of wires. Allowable operating ambient temperature shall be a least -10 to 70 degrees C.

B. Range: Instrument range shall be as noted on the Instrument Schedule. For factory set models that do not have an adjustable calibration, the range shall be the range nearest the Instrument Schedule range that meets the requirements of the physical installation. Engineer approval must be obtained for the ranges not matching the schedule.

C. Specifications: Reference accuracy shall be 0.2% of calibrated span or better. Drift shall be not greater than 0.1% of calibrated span per year. Over range protection shall be at least 1.5 times the range with no degradation of accuracy within the over range window. The local indicator shall be scaled to read in the units specified on the Instrument Schedule. Instrument shall be rated for the class and division indicated on the Drawings.

D. Construction: The sensor shall be within a sealed probe including an integral molded cable. Transmitter may be within the sealed assembly or external and mounted outside the wet well. External transmitters shall be NEMA 4X. The sealed probe with cable is to be installed in an open PVC pipe with ID slightly larger than the probe that is attached to the sidewall of the chamber, for protection of the sensor. Cable is to be attached to the top of the chamber with a strain relief to allow adjustment of probe depth. Attachment location must be readily accessible for maintenance.

E. Instruments shall be Druck 1230, 1730, or equal.

2.3 LEVEL SWITCH - FLOAT TYPE, GENERAL PURPOSE

A. Float switches shall be direct acting and consist of a Type 316 stainless steel housing, mounting clamp, flexible 3-conductor cable with a synthetic rubber jacket and a non-mercury switch. The float housing shall be a sphere of at least 4½ inches in diameter. The switch shall be embedded in a metal housing inside the float. The lead cable shall be #14 AWG with 105 strands per conductor, made specifically for underwater use and heavy flexing service. The switch shall be connected to two of the three conductors of the cable. The third conductor shall be an internal ground and shall be colored green. The switch shall have a 20 ampere rating at 115 Vac. An additional synthetic rubber jacket shall act as a hinge between the float and where the cable is held by the stationary clamp.

B. The clamp shall be stainless steel with an adapting fitting and two yokes for mounting on a vertical 1-inch pipe. A liquid rise of 1 inch from the reset position shall operate the float switch and reset shall occur when the liquid level drops 1 inch.

C. Operating temperature shall be 0°F to +180°F. Weight and buoyancy shall be such that contaminants, like a cake of grease, will not result in the float switch changing operating level more than 1 inch.

D. A NEMA 4X junction box shall be supplied for termination of the float cables to allow wiring and conduit to be run from the junction box to a control panel. It shall have terminal blocks for the required number of circuits and shall accept sealed fittings furnished with the float switch.

E. Provide intrinsically safe relays (IR) for switches used in hazardous locations where shown on the Drawings.

F. The float switches shall be USFilter Model 9G-EF or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation, testing, calibration, validation, startup, and instruction shall be in accordance with Section 26 08 00.

END OF SECTION

SECTION 40 73 00 - PRESSURE MEASUREMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section specifies pressure measurement devices for process instrumentation, auxiliary equipment and supplies directly related to the installation of and operation of these pressure measurement devices, to perform the required functions in conjunction with information and equipment specified in other Sections of Division 40. Refer to the Instrument Index in Section 40 70 00 for a listing of required devices.

B. Requirements of Section 40 70 00 form a part of this Section.

C. Furnish and install pressure measurement instruments and all appurtenant work suitable for the process fluid, at ambient temperatures, complete and operable, and capable of continuous operation.

1.2 SUBMITTALS

A. Shop drawings to be submitted in this Section shall be made in one package. Submit material or equipment data in accordance with the requirements of Section 26 05 00.

B. Shop Drawings: In addition to the requirements of Section 40 70 00, shop drawings shall include for each type of instrument: supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.

C. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.

D. Parts List: Submit a Parts List with current net prices and a list of recommended spares.

1.3 QUALITY ASSURANCE

A. Manufacturer: In addition to the requirements of Section 40 70 00, pressure measurement devices furnished shall be manufactured by firms regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.

B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated in the Instrument Index.

PART 2 PRODUCTS

2.1 PRESSURE GAUGES

A. Pressure gauges shall be of the local mounting type unless panel mounted type is shown on the Drawings.

B. Construction:

1. Gauges shall be of the bourdon tube or bellows type with 270 degrees C.W. pointer travel. Dials shall be white with black numerals. Panel-mounted gauges shall have round bezels for flush mounting and rear connection. Others shall have a stem mounting bottom connection, cast iron case, plastic lens, and blowout protection. Accuracy shall be 1 percent of full-scale maximum and readable to 1 percent. Connection for all gauges shall be male 1/4-inch NPT with square wrench flats. Provide diaphragm seals on corrosive fluid and gas lines.

2. Note additional requirements for snubbers, dampening, pressure limiting, and material requirements.

3. Pulsation dampeners and snubbers shall be stainless steel for the specific service involved.

C. Manufacturers: The gauges shall be a product of Ashcroft 1279, or equal. Pulsation dampeners and snubbers shall be Crosby 400SS; Trerice No. 870; or equal.

2.2 DIAPHRAGM PRESSURE SEALS

A. General:

1. Units shall consist of corrosion-resistant lower housing and diaphragm, and instrument mounting upper housing. Lower housing shall have a 1-inch NPT female process and a 3/8-inch flushing connection terminated with a 3/8-inch hose bibb and shall be Type 316 stainless steel. Diaphragm shall be Type 316 stainless steel, unless otherwise noted. Upper housing shall have bleed screw, NPT female instrument connection, and shall be steel, unless otherwise noted. Filling fluid shall be suitable for a temperature range of -17°F to +260°F.

2. Where noted on the Drawings, capillary assembly shall be furnished to connect diaphragm seal to instrument.

B. Manufacturers and models: Units shall be Blacoh Sentinel Model GK200T-5F; or equal.

2.3 PRESSURE TRANSMITTERS - ELECTRONIC

A. General:

1. Electronic indicating-type pressure transmitters shall convert a gauge or absolute pressure measurement to a 4-20 mAdc linear electrical output signal capable of transmission into at least a 600 ohm maximum load at 24 Vdc or less. Transmitter shall include Hart protocol signal over 4-20 mA output. Signal and power transmission shall be provided on a single pair of wires. Operating ambient temperature limits shall be at least -40°C to +82°C.

2. Range shall be as indicated in Section 17010. Over range protection shall be at least 1-1/2 times span without degradation of accuracy. Reference accuracy shall be ±1/2 percent or better.

3. Transmitter enclosure shall be mounted remotely from the pressure tap location as shown on the Drawings.

4. Transmitter is to include digital display for local reading.

B. Construction:

1. The transmitter enclosure shall be NEMA 4X rated except where explosion-proof is required as noted on the Drawings. The process connection for clean liquid service shall be 1/4-inch NPT. Enclosure and wetted surface material shall be corrosion resistant and suitable for the process fluid.

2. Transmitters shall be liquid-filled employing diaphragm where shown on the Drawings. Use optional remote seal with capillary length selected to suit installation needs, such as location, elevation, or orientation. Standard seal flange shall be a 3-inch 150-pound USAIS lap joint flange. A mating transmitter ANSI flange shall be provided with each transmitter per Section 15050.

C. Manufacturers and models: Rosemount Model 3051, or equal.

2.4 DIFFERENTIAL PRESSURE TRANSMITTERS - ELECTRONIC

A. General:

1. Electronic indicating-type pressure transmitters shall convert a gauge or absolute pressure measurement to a 4-20 mAdc linear electrical output signal capable of

transmission into at least a 600 ohm maximum load at 24 Vdc or less. Transmitter shall include Hart protocol signal over 4-20 mA output. Signal and power transmission shall be provided on a single pair of wires. Operating ambient temperature limits shall be at least -40°C to +82°C.

2. Range shall be as indicated in Section 17010. Over range protection shall be at least 1-1/2 times span without degradation of accuracy. Reference accuracy shall be ±1/2 percent or better.

3. Transmitter enclosure shall be mounted remotely from the pressure tap location as shown on the Drawings.

4. Transmitters with PDIT tag function are to include digital display for local reading.

B. Construction:

1. The transmitter enclosure shall be NEMA 4X rated except where explosion-proof is required as noted on the Drawings. The process connections for clean liquid service shall be 1/4-inch NPT. Enclosure and wetted surface material shall be corrosion resistant and suitable for the process fluid.

2. Transmitters shall be liquid-filled employing diaphragm where shown on the Drawings. Use optional remote seal with capillary length selected to suit installation needs, such as location, elevation, or orientation. Standard seal flange shall be a 3-inch 150-pound USAIS lap joint flange. A mating transmitter ANSI flange shall be provided with each transmitter per Section 15050.

C. Manufacturers and models: Rosemount Model 3051, or equal.

2.5 PRESSURE SWITCHES

A. Pressure switches shall incorporate bourdon tubes, diaphragms, or bellows as the sensing and actuating element. The actuating element shall be Type 316 stainless steel or phosphorous bronze, depending on compatibility with the process fluid. The actuating point shall be readily field-adjustable in the range specified with adjustable dead band. Switches shall be SPDT, rated at 5 ampere minimum at 120 Vac. Enclosures shall be NEMA 4X unless specified explosion-proof as shown on the Drawings. Process connection shall be 1/2-inch NPT.

B. There shall be calibrated external adjustments for set point and differential. Element shall be rated for at least 50 percent over range pressure. Switches used for alarm shall have manual reset.

C. Manufacturers and models: Schneider Electric/Telemecanique Nautilus Type XML B010A2S14, Ashcroft Type B 400, IFM Effector or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. On systems requiring diaphragm seals, the Contractor shall order (or assemble) a completely filled system. The filling fluid shall be silicone oil or glycerin. Interconnecting piping shall be kept short. The filled system shall retain the same calibration requirements of the individual components.

B. Installation, testing, calibration, validation, startup and instruction shall be in accordance with Section 40 70 00.

END OF SECTION

SECTION 40 78 00 - PANEL MOUNTED COMPONENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provisions: Requirements of Division 26 and Sections 40 70 00 form a part of this Section.

B. Work Included: This Section specifies the panel mounted and miscellaneous field instruments and equipment to perform the required functions in conjunction with information and equipment specified in other Sections of Divisions 26 and 40. Refer to the Instrument Schedule in Section 40 70 00 for a list of devices. This Schedule shall not be construed as a complete bill of materials.

C. Unit Responsibility: It shall be the responsibility of the qualified single firm as described in Section 40 70 00 of this Division to ensure that the instruments and equipment furnished under this Section are compatible with the equipment furnished under sections of this Division and other Divisions of these Specifications, and that the signal transmission methods are compatible.

D. Control and Performance Terminology used hereinafter in this Section shall be as defined in ISA-51.1-1979 - (R1993) “Process Instrumentation Terminology”.

E. Cases: Cases or front of panel mounted instruments shall be of uniform design and color scheme wherever possible. Front of case colors shall be compatible with panel colors, subject to final approval by the Owner. Normally, compatible standard colors of the manufacturer shall be acceptable.

F. Panel Mounted Equipment:

1. All flush mounted miniature electronic controllers, recorders, and stations shall be a matching style family of instruments utilizing multiple unit mounting cases and back of panel plug-in cable connections. The overall height shall be 6 inches. A nine station multi-unit case shall fit standard 19-inch rack spacing. Each multi-unit case and instrument shall be equipped for standby manual operation.

2. All front panel mounted instruments shall be capable of withdrawing chassis to all service and test positions without affecting operation, and complete removal by a single plug connection from the front.

3. All back of panel mounted signal conditioners and auxiliaries shall be mounted in plug-in card files with labeled adjustment and test point at front of card edge.

4. All instruments shall accept 4-20 mAdc or 1 to 5 Vdc input signals and shall produce 4-20 mAdc or 1 to 5 Vdc output signals as specified in the Schedules. Internal panel signals may be of either type. All analog signals coming to or leaving the panel shall be 4-20 mAdc.

5. Where IP65 requirements apply the panel mounted equipment shall be ordered with hardware to keep the IP65 integrity of the UL Listed Panel.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Panels: See Division 26.

1.3 SUBMITTALS

A. Shop drawings to be submitted in this Section shall be made in one package under the Product Review Category of Shop Drawings.

B. Refer to Section 40 70 00 for additional submittals required for each item herein.

1.4 QUALITY ASSURANCE

A. Manufacturer: In addition to the requirements of Section 40 70 00, instrumentation and control equipment furnished shall be manufactured by firms regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of the most recent design. Except where specified otherwise, the instruments furnished under this Section shall be as manufactured by Siemens; Honeywell; Fischer & Porter; Foxboro; or Engineer Approved equal. Behind-the-panel equipment shall be as manufactured by the above or by AGM Electronics; Siemens; Moore Industries; or Engineer Approved equal. Equipment called out in the Industrial Control Panel "I" drawing(s) Bill of Materials shall be supplied as designated by the manufacturer's column.

B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or specified.

D. All equipment, panel layouts and design shall conform to UL 508A.

PART 2 PRODUCTS

2.1 CONTROLLERS AND MANUAL CONTROL STATIONS

A. General: Controllers shall compare a process variable input signal with a remote or locally adjusted set point and shall produce a control output signal to correct any deviation of the process variable from the set point by means of a final control element. Manual control stations shall convert a remote or locally adjusted set point value to an output control signal to control a process variable by means of a final control element. Controllers and stations will only be used where PLC control function is not specified by the PLC I/O list in the appendices of Specification Section 40 63 43.

B. Controllers shall have the following features:

1. Auto-Manual Switching shall be provided on the front panel of each controller except for controllers with manual control action only or two-position control action. Switching from automatic to manual control shall be without an intermediate "Balance" position and shall cause no change in the controller output (bumpless transfer).

2. Remote Set Point shall be provided where indicated on the "Controller and Manual Control Station Schedule." A switch for transfer from remote to local and vice-versa shall be mounted on the front of the controller panel. When in the remote set point mode, the scale of the controller shall be servo motor positioned so that the value of the set point is always indicated.

3. Reference Accuracy for the automatic controllers shall be at least ±0.5% of span. All automatic controllers shall have provision for manually overriding and adjusting the controller output signal. Adjustable output limiting shall be furnished on all automatic controllers with integral control.

4. Replacement: Each automatic controller shall have provision for replacement by a manual control plug-in module. If this feature is not available in the manufacturer's line of equipment, manual control stations shall be mounted on the front of each local control panel with patch cords or other connecting devices necessary to reach the terminals of all automatic controllers mounted on that panel. In no case shall the manual control be mounted more than 2 feet from its associated automatic control station.

5. Indicating Scales: Scales of control stations shall be the center deviation indication type. A set point scale on the front of the instrument shall display the process variable and its deviation from set point. The set point scale shall be at least 4-1/2 inches long and shall be vertically oriented. A separate scale shall display the control output signal to the final control element as 0 to 100%. Set point scale graduation shall be readable to the nearest 1%.

6. Cases: Cases of control stations shall have front dimensions with a maximum of 4 inches wide by 6 inches high.

7. Signals: Process variable and analog remote set point input and control output signals shall be 4-20 mAdc except that two-position and proportional speed floating control output signals shall be contacts rated for a minimum of 5 amperes at 120 Vac. Signals between units mounted in a single panel may be 1 to 5 Vdc.

8. Control Algorithms shall be available in controllers with the following control actions:

   a. Proportional speed floating (integral).
   b. Proportional with manual bias.
   c. Proportional plus integral with adjustable output limiting.
   d. Proportional plus integral plus derivative with adjustable output limiting.
   e. Manual.
   f. Two-position with adjustable "dead zone."
   g. Feed forward in addition to "c" or "d" above.

9. Control Action provided for each controller shall be as indicated on the "Controller and Manual Control Station Schedule." Tuning adjustment of the control actions shall be integral to the control station and shall be accessible from the front of the control panel without disconnecting the controller from the process. When provided, control actions shall be continuously adjustable over the minimum ranges listed below:

   a. Proportional Speed Floating: 0.1 to 25 seconds repetition period, 0 to 10% dead zone, 0 to 100 speed factor.

   b. Gain: 0.2 to 33.

   c. Integral: 0.04 to 30 repeats per minute.

   d. Derivative: 0.01 to 8 minutes per repeat.

   e. Two Position: 0 to 10% dead zone.

   f. Feed Forward: 0.5 to 5 gain.

C. Schedule Abbreviations are listed below:

1. Refer to Section 40 61 93

2.2 PROCESS VARIABLE INDICATORS

A. Vertical single or dual channel process variable indicators shall have a vertical display at least 3 inches long, shall have a reference accuracy of ±2.0% or better, and the indicating pointer shall be driven by the output of a solid state electronic amplifier. Zero and span adjustment shall be provided. Indicating scale graduations shall be readable to 1% of full scale. Input signal shall be 1 to 5 Vdc or 4-20 mA as indicated on the Instrument Schedule. An optional single or dual integral alarm unit may be provided. Provide Red Lion, Ametek Dixson BB101P, Crompton 263 panel meter or Engineer approved equal.

B. Large Case Process Indicators shall be provided as shown on the Drawings and/or specified herein. Scale units shall be as specified in the Instrument Schedule. The pointer shall be servo driven with feedback and null balancing. Accuracy shall be 0.5% of full scale. Input signal shall be 1 to 5 Vdc or 4-20 mAdc. An optional integrator and 7 digit totalizer shall be provided where shown on the Drawings. When specified, SPDT alarm switches shall be provided, rated at 2 amperes, 120 Vac, 60 Hz. Indicators shall have 4-3/8-inch minimum scale length, and hinged locking door with glass window. Dimensions shall be 15 inches by 14 inches by 8 inches deep maximum. Operating power shall be 120 Vac, 60 Hz.

C. Digital Indicators shall be provided where indicated and shall display the decimal value of a numerically coded input. Accessories shall be provided to accept analog voltage or current inputs or other digitally coded inputs as specified in the Instrument Schedule. The number and size of the digits shall be as specified. The displayed digits shall be luminous and easily visible in a well lighted control room. The display style shall be the choice of the I&C Subcontractor, except that all displays shall be of the same style. The accuracy of the display shall be within ± one digit but not less than ±0.1% for analog inputs. There shall be no error with digital inputs. Automatic ranging and polarity selection and sign indication shall be provided.

2.3 SIGNAL CONDITIONERS AND CONVERTERS

A. General: Signal conditioners and converters shall be provided as shown on the Drawings and/or as specified herein. They shall have all solid state circuits on plug-in printed circuit boards and housed in card cases or single cases for in-panel mounting and weatherproof or explosion-proof cases for field mounting depending on the area rating. Accuracy shall be ±0.25% unless shown otherwise. They shall be as manufactured by Phoenix Contact, AGM Electronics; Rochester Instruments; or Engineer approved equal.

B. Signal Selectors: Signal selectors, if required, shall receive up to four dc control signals and shall retransmit the lower, the intermediate, or the higher of the signals. Signal selectors shall be back-of-panel mounted.

C. Signal Isolators and Impedance Converters: Signal isolators and impedance converters shall be provided for all field-located transmitters to prevent ground loops and ensure system compatibility and shall be either field-mounted or back-of-panel mounted in the control panels.

D. Volt-to-Current Converters: Volt-to-current converters shall be provided where indicated to receive a 1 to 5 Vdc input and convert this signal to a 4-20 mAdc current output, proportional to the sensed variable. Zero and span adjustment shall be provided. Unit shall be back-of-panel mounted.

2.4 CONTROL PANEL ACCESSORIES

A. Relays, timers and other internally mounted equipment shall be of the types specified in other Sections of these Specifications.

B. Panel face mounted equipment shall be of the types specified in other Sections of these Specifications.

C. Standards: All control devices shall conform to applicable provisions of NEMA Standards ICS 1 and ICS 2.

D. Pushbuttons, selector switches and pilot lights shall be heavy-duty oiltight units. Pushbuttons and selector switches shall have contacts rated 10 amperes continuous, Rating Designation A600 in conformance with NEMA ICS 2.

1. Pushbuttons used as emergency stop devices shall have a padlockable means for maintaining an open circuit. Indicating lights shall be push-to-test transformer type with lenses of the colors shown on the Drawings.

2. Multiposition control switches shall have rotary action, round knurled handle and the number of positions and stages shown on the Drawings. They shall be suitable for panel mounting. Each position shall have a positive detent. Contacts shall have a continuous current rating of 10 amperes at 300 Vac. Switches shall have integral indicator.

3. For 4-20 mAdc and 1 to 5 Vdc signal selector switches, provide oiltight selector switches with electronic duty gold contact blocks. Provide sliding contacts for reliable operation without benefit of thermal cleaning action.

4. Manufacturer: Provide Senasys heavy duty oil tight manual controls, with electronic duty gold contact blocks; Allen-Bradley Bulletin 800T oil tight selector switch with stackable "Logic-Reed" contact blocks; or Engineer approved equal.

E. Colors and Descriptions:

1. Indicating Lamps: Unless otherwise noted in the individual Loop Specifications, refer to Section 26 for color code and inscriptions for the lenses of all indicating lights and annunciators.

2. Lettering shall be black on white and amber lenses. Lettering shall be white on red and green lenses.

3. Pushbuttons: Follow color coding for indicating lamp above. All unused or non-inscribed buttons shall be black. Lettering shall be black on white and yellow buttons. Lettering shall be white on black, red and green buttons.

F. Nameplates: Unless specified otherwise in the Drawings, nameplates shall be black Lamacoid with minimum 3/16-inch-high white letters for major area titles, 5/32-inch for component titles, and 1/8-inch for subtitles, and shall be fastened with a permanent but dissolvable adhesive or by screws.

G. Pneumatic Tubing: Pneumatic tubing may be copper, stainless steel, or polyethylene as preferred by the panel vendor, except that the air header, valves, and fittings shall not be polyethylene. Tubing shall be 1/4-inch O.D. with a working pressure rating of at least 150 psi. Threaded fittings which hold air shall be assembled with bias cut Teflon tape lubricant. Polyethylene tubing shall be supported in plastic duct to within 1-foot of each termination and shall be color coded in accordance with ISA Recommended Practice RP7.2. Provide individual combination air filter regulators with gauge for each air consuming device.

H. Pneumatic Piping: Pneumatic piping shall be PVC and shall incorporate sufficient unions for assembly and disassembly. The Contractor shall supply 100 psig dried and refrigerated plant air to the panels requiring air. The control panels shall incorporate all the necessary pressure reducing valves and adapters for the instrumentation air piping. Piping shall be installed in accordance with the standards of ISA.

2.5 INSTRUMENT LOOP POWER SUPPLIES

A. General:

1. For each two-wire transmitter, provide a 24 Vdc regulated 50 mA power supply with 120 Vac input. Output voltage may be 24 Vdc ±5% manufacturing tolerance at no load, but shall hold within 1% from no load to full load at 120 Vac ±10% input.

2. Line-to-load regulation shall be within 0.1% from no-load to full load. Ripple shall be less than 15 mV peak-to-peak.

B. Manufacturer: Provide Phoenix Contact Quint power supplies for instrument loop power as called out in the Industrial Control Panel "I" drawing Bill of Materials.

2.6 TEST EQUIPMENT

A. Digital Calibrator: Provide one precision 4-20 mA signal pocket source designed for the calibration of electronic instruments. Provide the calibrator with the following features:

1. Four and one-half digit LED (light emitting diode) or liquid crystal digital display with integrating DVM (digital voltmeter).
2. Measurement capability of 0 to 22 mA.
3. Transmission range of 0 to 22 mA into any load from 0 to 1,300 ohms.
4. Capability for the user to substitute the calibrator for a 2-wire 4-20 mA transmitter. The calibrator shall simulate the output of any 2-wire 4-20 mA transmitter using a loop power supply of 22 to 100 Vdc.
5. Built-in rechargeable nickel-cadmium batteries, built-in charger, and battery condition indicator.
6. Gasketed case for environmental protection.
7. Switches with gold contacts.
8. Coated printed circuit cards.
9. Fuse protection and protection of electronic circuitry against accidental misconnection of the calibrator.
10. Automatic decimal point switching.
11. Input measurement calibrated accuracy of ±0.12% of range ±0.06% of reading.
12. Output calibrated accuracy of ±0.12% of range ±0.06% of reading maximum.
13. Repeatability of 0.10%.
14. Battery recharge time of 14 hours maximum.
15. Area classification of Class 1, Division 2, Group D.
16. Size not to exceed 8.25 inches by 2.75 inches by 4.5 inches.
17. Carrying case and test lead set.

B. Digital Multimeter: Provide one precision bench/portable digital multimeter designed for calibration of electronic circuitry. Provide the multimeter with the following features:

1. 4-1/2 digit liquid crystal display.

2. DC Voltage Specifications:

   a. Ranges of ±200 mV, ±2V, ±20V, ±200V, ±1,000V.

   b. Resolution of 10 microvolts on lowest range, 0.1V on 1,000V range.

   c. Accuracy of ± (0.03% of reading + 2 digits) all ranges.

   d. Response time of 1 second maximum, to rated accuracy within a range.

   e. Input impedance of 10 megohms, less than or Engineer approved equal to 100 picofarads, all ranges.

   f. Normal mode noise rejection of greater than or Engineer approved equal to 60 dB at 50 Hertz or 60 Hertz.

   g. Common mode noise rejection greater than or Engineer approved equal to 90 dB at dc, 50 Hertz, and 60 Hertz with 1,000 ohms unbalance.

   h. Overload protection of 1,000 volts dc or peak ac, continuous, except 10 seconds maximum on the 200 mV and 2V ranges.

3. AC Voltage Specifications:

   a. True rms, ac coupled.

   b. Voltage Readout Accuracy: ±(% of reading + number of digits)*

      *Between 5% of range and full range

Input Voltage	Resolution	Range	45 Hz 1 kHz	10 kHz	20 kHz	50 kHz
10 mV - 200 mV 0.1V - 2V 1V - 20V 10V - 200V 100V -750V	10eV 100 eV 1 mV 10 mV 100 mV	200 mV 2V 20V 200V 750V	+(0.5%+ 10)	+(1%+10)	+(5%+30)	
				NOT SPECIFIED		

   c. dB Resolution: ±0.01 dB above 1 mV, ±0.1 dB 0.77 mV to 1 mV.

d. Extended dB Response: Typically -72 dBm (600 ohms ref) ±1 dB to 10 kHz.

e. Extended Frequency Response: Typically -3 dB at 200 kHz.

f. Crest Factor: Waveforms with peak/rms ratio of 1:1 to 3:1.

g. Input Impedance: 10 megohms, < 100 pF, all ranges.

h. Common Mode Noise Rejection: > 60 dB at 50 Hz and 60 Hz with 1,000 ohms unbalance.

i. Overload Protection: 750V rms or 1,000V peak continuous, except 10 seconds maximum on the 200 mV and 2V ranges, not to exceed a volt-Hertz product of 107 (e.g., 200V at 50 kHz).

j. Response Time: 2 seconds maximum to rated accuracy within a range.

k. Decibel Reference Impedance: Fifteen user-selectable impedance reference levels shall be provided to reference a 0 dBm, 1 mW level (50w, 75w, 93w, 110w, 125w, 135w, 150w, 250w, 300w, 500w, 600w, 800w, 900w, 1,000w, 1,200w). An 8w impedance reference level shall be provided to reference 0 dBW.

4. DC Current Specifications:

   a. Ranges: ±200 eA, ±2 mA, ±20 mA, ±200 mA, ±2,000 mA.
   b. Resolution: ±0.01 microamp lowest range, 0.005% of range on all ranges.
   c. Accuracy: ±(0.3% of reading + 2 digits) on all ranges.
   d. Burden Voltage: 0.9V max on 2,000 mA range, 0.3V max on all other ranges.
   e. Overload Protection: 2A/250V fuse in series with 3A/600V fuse.

5. AC Current Specifications:

   a. True rms, ac coupled.

   b. Additional Specifications:

Range	Resolution	Accuracy: From 5% OF Range To Full Scale		Burden Voltage
		45Hz 2kHz	10kHz 20kHz	
200eA 2mA 20mA 200mA	0.01eA 0.1eA 1eA 10eA	+(1% of reading + 10 digits)	+(2% of reading + 10 digits)	0.3V rms max
2000mA	100eA	+(1% of reading + 10 digits)	Not Specified	0.9V rms max

c. Overload Protection: 2A/250V fuse in series with 3A/600V.

d. Crest Factor: Waveforms with peak/rms ratio of 1:1 to 3:1.

6. Resistance Specifications:

   a. Ranges:

Range	Resolution	Accuracy	Full Scale Voltage
200w 2 Kw	0.01w 0.1w	+(0.1% reading +2 digits + 0.02w)	0.19V 1.2V
20 kw 200 kw	1w 10w	+(0.05% of reading +2 digits)	0.2V 2V
2000 kw 20 Mw	100w 1kw	+(0.25% reading +3 digits)	0.2V 2V

   b. Overload Protection: 500V dc or rms ac on all ranges.

   c. Open Circuit Voltage: Less than 3.5V on all ranges.

   d. Response Time: 10 seconds maximum on 20 Mw range, 2 seconds maximum on all other ranges, to rated accuracy.

7. General Specifications:

   a. Temperature: 0°C to 50°C, operating; -40°C to +70°C (without batteries) and -40°C to +50°C (with batteries), non-operating.

   b. Relative Humidity: < 90% from 0°C to 35°C or < 70% to 50°C, except 2 megohm, 20 megohm, and 200 nS ranges where it shall be < 80%, from 0°C to 35°C.

   c. Common Mode Voltage: 500V dc or peak ac max.

   d. Line Voltage: 105 to 132V ac, 47 to 440 Hz.

   e. Power: 6W max.

   f. Size: 22 cm (W) x 6 cm (H) x 25 cm (L) (8.5 in (W) x 2.5 in (H) x 10 in (L) maximum.

   g. Weight: 3 lbs. max.

8. Accessories:

   a. High Voltage Probe.
   b. Clamp-on Current Transformer, 600A.
   c. Temperature Probe, -50°C to +150°C (-58°F to +302°F).

9. Manufacturer: Provide Model 8050A digital multimeter as manufactured by John Fluke Manufacturing Company, Inc.; Weston Instruments Model 6404; or Engineer approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation, testing, calibration, verification, startup, and instruction shall be in accordance with Section 40 70 00.

B. Wiring: Refer to Section 26 05 19, Part 3 and contract drawings.

C. Switching Circuit Schematics: Schematics shown are detailed. Contractor to verify panel wiring, with manufacturer's data, prior to assembly. Substituted components and circuits used shall be subject to review and Engineer approval prior to procurement. All switching circuits shall be checked and verified by testing before shipment.

D. Control Voltage:

1. When the control voltage is not specified in the schematics, the Contractor may elect to use the 120 Vac power, as supplied from the power panels supplies under Division 16; however, he shall provide a separate low voltage circuit for the indicating lamps or provide individual transformers with lamps. In any event the lamp voltage shall not exceed 30 Vac or dc.

2. Manual disconnect switches (and relays if necessary) shall be provided internal to the panel to isolate process related groups of circuit elements from panel power and foreign voltages to permit troubleshooting without disabling controls for other processes. Safety interlock switches shall be provided on access doors to disconnect local and foreign voltages if required by safety codes of applicable regulating authorities.

E. Supply Voltage:

1. When the supply voltage is not specified in the schematics, or an Engineer approved substitution requires a differing power supply than what is shown on the contract Drawings, the Contractor shall inform the Engineer and locate the closest power source (120VAC or 24 VDC) for the instrument.

END OF SECTION

SECTION 43 21 00 - PUMPS, GENERAL

PART 1 GENERAL

1.1 DESCRIPTION

A. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated.

B. Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.

C. Provide all labor, equipment and materials and perform all operations in connection with the installation and testing of pumps selected by the OWNER.

D. Coordinate and utilize all factory testing, installation, start-up and field-testing services supplied in conjunction with the pumping equipment.

E. All work performed under this Section shall be in accordance with all approved trade practices and manufacturer's recommendations.

1.2 SUBMITTALS

A. Submittals shall be furnished in accordance with Section 103.9.00 Shop Drawings and Sample Submittals.

B. Shop Drawings shall contain the following information

1. Pump name, identification number and specification Section number.
2. Performance data curves showing head, capacity, horsepower demand, NPSH required and pump efficiency over the entire operating range of the pump. The pump manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable speed drive, and a curve for each speed on two-speed pumps.
3. The limits on the performance curves recommended for stable operation without surge, cavitation or excessive vibration.
4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

C. Complete motor nameplate data as defined by NEMA, motor manufacturer and any motor modifications.

D. Operation and Maintenance Manual containing the required information for each pump section.

E. A spare parts list containing the required information for each pump section.

F. Signed, dated and certified factory test data for each pump system which requires factory testing submitted before shipment of equipment.

G. Certifications

1. Manufacturer's certification of proper installation
2. CONTRACTOR's certification of satisfactory field testing

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and equipment shall be standard products of a manufacturer and distributor regularly engaged in the manufacture and distribution of such products for at least 2 (two) years and shall be suitable for the service intended. All materials and equipment shall be new and unused except for the testing specified herein.

B. Compliance with the requirements of the individual pump sections may necessitate modifications to the manufacturer's standard equipment.

C. All centrifugal pumps shall have a continuously rising performance curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine or encroach on the service factor.

D. All components of each pump system provided under the pump sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings and appurtenances.

E. The pumps shall be supplied by a distributor authorized to service them throughout the warranty period and beyond. The distributor shall be located within a 100-mile radius of the site.

F. The pumps shall be warranted by the manufacturer for a minimum of one (1) year from the date of installation.

G. All materials and coatings coming in contact with potable water shall be ANSI/NSF Standard 61 approved.

2.2 MATERIALS

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A48 - Gray Iron Casings, Class 30, or equal.

2. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel shall be of Type 316, except in a septic environment.

3. Anchor bolts, washers, and nuts in non-corrosive applications shall be galvanized steel in accordance with the requirements of Section 05500 - Metal Fabrications. Anchor bolts, washers and nuts in corrosive service applications shall be stainless steel in accordance with that Section.

2.3 PUMP COMPONENTS, GENERAL

A. Flanges -- Suction and discharge flanges shall conform to the dimensions of ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 12, 125, 250, and 800 or B16.5 - Flanges and Flanged Fittings dimensions.

B. Handholes -- Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.4 PUMP APPURTENANCES

A. Nameplates -- Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed and Manufacturer's name and model number.

B. Gauges -- Provide and install pressure gauges as shown on the drawings.

1. All pumps (except sample pumps, sump pumps, hot water circulating pumps and chemical metering pumps) shall be equipped with pressure gauges on the pump discharge. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings. Isolation diaphragms shall be provided for all gauges except where pumping potable water.

2. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

2.5 FACTORY TESTING

A. The following tests shall be conducted on each indicated pump system

1. Pump Systems -- All centrifugal pump systems 100 hp and larger shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute. Tests shall be performed using the complete pump system to be furnished, including the motor. For motors smaller than 100 hp, the manufacturer's certified test motor shall be acceptable. The following minimum test data shall be submitted:

   a. Hydrostatic test data

   b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.

   c. Pump curves showing head, flow, bhp, efficiency and NPSH requirements.

   d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

   e. Pump test data curves showing head, flowrate, bhp, and efficiency. Acceptance level shall be Grade 1E as defined by ANSI/HI 14.6.

2. Factory Witnessed Tests: Factory witnessed testing for this project not required.

3. Acceptance -- In the event of failure of any pump to meet any of the requirements, the CONTRACTOR shall make all necessary modifications, repairs or replacements to conform to the requirements of the Contract Documents and the pump shall be retested at no additional cost to the OWNER until found satisfactory.

PART 3 EXECUTION

3.1 SERVICES OF MANUFACTURER

A. An authorized service representative of the manufacturer shall visit the project site to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted and readied for operation:

1. Installation of the equipment

2. Inspection, checking and adjusting the equipment

3. Startup and field testing for proper operation

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements

B. Instruction of the OWNER's Personnel

1. An authorized training representative of the manufacturer shall visit the project site to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least two year's experience in training.

3. Training shall be scheduled a minimum of three weeks in advance of the first session.

4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.

5. The training materials shall remain with the trainees.

6. The OWNER may videotape the training for later use with the OWNER's personnel.

3.2 INSTALLATION

A. General -- Pumping equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment -- All equipment shall be field tested to verify proper alignment, operation as specified and freedom from binding, scraping, vibration, shaft runout or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants -- The CONTRACTOR shall provide the necessary oil and grease for initial operation.

3.3 FIELD TESTS

A. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation or overheating of bearings.

B. Field testing methods and allowable tolerances shall comply with current version of the Hydraulics Institute standards for the type of pumps installed.

C. The following field testing shall be conducted

1. Startup, check and operate the pump system over its entire speed range. Where vibration analysis and measurement is required, it shall be within the amplitude limits specified and recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.

3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.

4. Electrical and instrumentation tests shall conform to the requirements of the Section under which that equipment is specified.

5. Field vibration readings for pumps over 30 hp shall be conducted by an OWNER-selected certified testing agency, paid for by the CONTRACTOR, with readings taken at the following positions with the average not exceeding the current Hydraulic Institutes standards for the type of pump installed.

    a. Measurements shall be taken at the locations as specified in the current Hydraulic Institute standards for the type of pump installed.

6. Provide written proof of vibration readings and provide test data.

D. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.

E. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

F. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests and the test data.

G. The CONTRACTOR shall bear all costs of field tests, including related services of the manufacturer's representative. If available, the OWNER's operating personnel will provide assistance in field testing.

END OF SECTION

43 21 52 - VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.1 DESCRIPTION

Work covered in this Section includes furnishing, installing, start-up and operation training for barrel or can (lineshaft) vertical turbine pumps. Vertical turbine pumps shall be of the open line shaft and fresh water lubricated type. Like items of equipment specified herein shall be the end product of one manufacturer. Electrical controls and motor design requirements are specified in this section and the electrical section of these specifications. The contractor shall provide all equipment labor and materials to furnish and install the 480-Volt, 3-Phase, 60-Hertz Vertical Turbine Pumps, Motors, Column Pipes, and Accessories, as shown on the drawings and required by these specifications. The pump supplier shall be responsible for coordinating the pump requirements with the pump drive manufacturer and shall be responsible for the overall pump and drive requirements.

1.2 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Section 103.9.00 Shop Drawings and Sample Submittals and 43 21 00 Pumps, General.

B. Name of nearest location of permanent parts supply from which parts may be obtained in sufficient quantity on a 24-hour basis.

C. Four copies of operating and maintenance manuals shall be supplied.

D. Manufacturer’s warranty.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

Pumps shall meet the requirements of the latest version of ANSI/AWWA E-101, Vertical Turbine Pumps – Line Shaft and Submersible Types and the Hydraulic Institute Standards, except where modified herein.

PART 2 PRODUCTS

2.1 DESCRIPTION

A. Identification:

Pump Label(s)	WTR14PMP01, WTR14PMP02, WTR24PMP01, WTR24PMP02	WTR14FP03, WTR24FP03

B. Performance Requirements at Full Pump Speed:

Maximum Shutoff Head (ft)	As required	As required
Minimum Shutoff Head (ft)	Per manufacturer	Per manufacturer

Duty Pt. 1	400 gpm @ 180 ft TDH	1,750 gpm @ 75 ft TDH
Minimum Efficiency @ Duty Pt. 1	70%	70%
Maximum Pump Speed (rpm)	1800	1800
Maximum NPSH Required (ft)	10	10
Maximum Motor Size (hp)	25	50

C. Performance Requirements at Variable Speed:

Minimum Flow Capacity	Per manufacturer	Per manufacturer
Minimum Pump Speed (rpm)	Per manufacturer	Per manufacturer

D. Operating Conditions:

Duty	Continuous	Emergency
Drive	Variable Speed	Variable Speed
Ambient Environment	Indoor	Indoor
Ambient Temperature	33° to 104° F	33° to 104° F
Fluid Service	Potable Water	Potable Water
Fluid Temperature	33° to 65° F	33° to 65° F
Fluid pH Range	6.0 to 8.0	6.0 to 8.0
Fluid Specific Gravity	1.0	1.0
Fluid Viscosity (absolute) (centipoises at 60° F)	1.12	1.12
Pump Station Floor Elevation	See drawings	See drawings
Pump Suction Header Centerline Elevation	See drawings	See drawings

E. Pump Dimensions:

Dimensions per pump manufacturer, pumps must connect with specified pipe diameters per drawings. Motor and pump must be sized to fit through maintenance hatches, see architectural and structural sheets

F. Other Requirements:

The head-capacity curve shall exhibit a uniformly rising characteristic from free discharge to shutoff. The pump motor shall be non-overloading throughout the entire pump curve.

2.2 PUMP CONSTRUCTION

A. The bowls shall be cast-iron, porcelain enamel lined and coated on the outside with a two component, self priming coating applied in a two coat process, over a sandblasted surface, to an 8 to 10 mil dry film thickness. Coating shall be Tnemec Series 140 Pota-Pox Plus. Bowl bolting shall be stainless steel.

B. The impellers shall be ASTM B62 or B584 bronze and shall be statically and dynamically balanced at the factory to grade G6.3 of ISO 1940 at minimum. They shall be fastened securely to the bowl shaft.

C. The bowl and impeller wear rings shall be bronze and replaceable.

D. The bowl shaft shall be stainless steel, Type 410, 416, or 316.

E. The suction bell shall be cast-iron with a bottom bearing and streamlined ribs. Lining and coating shall be the same as bowls.

F. The column pipe shall be not less than Schedule 40 steel pipe. Pipe sections shall not exceed 10 feet in length. The column pipe shall be epoxy lined and coated.

G. The line shaft and couplings shall be Type 416 stainless and sized such that the natural frequency of the shaft is avoided by a minimum 25 percent throughout the entire operating range. Line shaft sections shall not exceed 10 feet in length.

H. Line shaft lubrication shall be by water.

I. The shaft seal shall be a mechanical type seal and equipped with non-clogging, single coil springs and non-sliding, internal, secondary elasteners. Metal parts shall be Type 316 stainless steel alloy 20, or Hastelloy B or C. Sealing materials shall be carbon and ceramic.

J. The line shaft bearings shall be rubber with bronze retainers at each joint for open line shaft.

K. The discharge head shall be the manufacturer's standard fabricated steel. Fabricated steel discharge head shall be reinforced to withstand pipe thrust, lined and coated with approved epoxy and shall include flange and base plate. Forged steel half-couplings for air valve, pressure switch and drain connections shall be a minimum of 1 1/4-inch and 3000 lbs.

L. The motor shaft coupling shall be a 4-piece, heavy-duty adjustable spacer coupling, with registered fit, to allow for mechanical seal removal.

M. The bottom bearing shall be a close tolerance sleeve type with a length minimum of 2 1/2 times shaft diameter. Suction case shall be permanently grease lubricated with non-soluble grease.

N. The bowl and suction case bearings shall be of the bronze sleeve type.

2.3 SUCTION BARREL FOR CAN TYPE PUMPS

A. General

The suction barrels (cans) shall be of fabricated steel, 5/16-inch thick and lined with fusion bonded epoxy, with an extra-heavy carbon steel mounting plate, drilled and tapped to match the discharge head, suction inlet and flange as shown. Suction barrel shall come equipped with flow vanes.

B. Suction Barrel Sizing

The required minimum free area between pump and suction barrel listed above shall determine the required diameter of the fabricated suction barrels. The length of the barrel shall be determined by minimum measurements as shown on the drawings or the minimum pump setting specified under pump dimensions herein.

2.4 MOTORS

Each pump shall be provided with a vertically mounted electric motor that conforms to the following requirements and the specifications in Division 26. In the event of conflicts, the more restrictive specification shall apply. The brake horsepower required by the driven equipment anywhere on the pump curve shall not exceed the rated nameplate horsepower of the motor. The ratings indicated are minimums. Motors shall be designed to accept the total, unbalanced thrusts imposed by the pump.

The motor shall be a heavy-duty squirrel cage induction type, NEMA Class B or Class F insulation with WP-1 enclosure, Premium Efficient, Inverter Duty, 1800 RPM vertical hollow shaft motor, with a non-reverse ratchet (or self-release coupling) to prevent reverse rotation of the rotating elements. A thrust bearing of ample capacity to carry the weight of all rotating parts plus the maximum hydraulic thrust load under all conditions of operation calculated L10 life shall be no less than 8800 hours. Provision shall be made for momentary up thrust equal to 30 percent of the rated down thrust. The motor shall be standard (or premium) efficiency, 1.15 service factor, and suitable for use on 480-Volt, 3-phase, 60-Hertz electric service. A solid coupling shall be provided at the discharge head for setting the impeller to bowl running clearance.

2.4 PUMP CONTROLS

For control see Specification Division 26.

2.5 SPARE PARTS

The pumps shall be provided with the following spare parts for each pump:

One mechanical seal

Packing gland materials and tools

2.6 MANUFACTURERS

A. The CONTRACTOR shall use Fairbanks Morse, Peerless, Vertiline, Floway, Goulds, Flygt, American Marsh or approved equal.

PART 3 EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Installation -- The service representative of the manufacturer shall be continuously present at the site to supervise the assembly and installation of the pumps.

B. Inspection, Startup and Field Adjustment -- The service representative of the manufacturer shall be present at the site for three (3) consecutive work days, following requirements per Section 110.16.00 – Performance Testing, to furnish the services required by Section 43 21 00 - Pumps, General. Coordinate with OWNER.

C. Instruction of OWNER's Personnel -- The training representative of the manufacturer shall be present for one (1) work day, to furnish services required by Section 43 21 00 Pumps, General. Coordinate with OWNER.

D. For the purposes of this paragraph, a work day is defined as an eight hour period at the site, excluding travel time.

E. The ENGINEER may require that the inspection, startup, and field adjustment services above be furnished in three separate trips.

END OF SECTION

SECTION 43 41 13 - WELDED STEEL TANK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: All labor, material, equipment, tools and services required for the design, fabrication, erection, painting and testing of a ground level, welded steel water storage tanks (2) and accessories.

B. Related Sections:

1. Section 09 97 13.24: Steel Water Storage Tank Painting
2. Section 09 33 01 10.59: Disinfection of Water Utility Storage Tanks
3. Section 40 46 42: Cathodic Process Corrosion Protection
4. Section 33 05 00: Pipe, Valves and Accessories
5. Section 43 41 13.10 Reservoir Hydrodynamic Mixing System

1.2 REFERENCES

A. American Iron and Steel Institute (AISI)

B. American Welding Society (AWS):

1. AWS D10.4 Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing

C. American Water Works Association Standards (AWWA):

1. AWWA D100 Welded Steel Tanks for Water Storage
2. AWWA D102 Painting Steel Water Storage Tanks
3. AWWA C652 Disinfection of Water Storage Facilities
4. AWWA C200 Steel Water Pipe
5. AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe
6. AWWA C207 Steel Pipe Flanges for Waterworks Service

1.3 SUBMITTALS

A. Submit in accordance with the General Conditions (Volume 1).

B. Product Data:

1. Hangers, pipe and equipment supports.
2. High-strength bolts.
3. Stainless steel items.
4. Manufactured items, including access hatches, vents and safety devices.

C. Shop Drawings:

1. Fabrication and erection drawings for tank and all accessories, including all welding details.

2. Design calculations for tank and accessories.

3. Design calculations for footings and foundations.

4. Depth versus volume calibration table for the tank in units of inches, feet and gallons.

5. Mixing system (Red Valve)

6. Accessibility ladder

7. Fall protection

8. Sampling station

D. Manufacturer's Certifications:

1. Tank design, including all (welded or bolted) joint details and inspection personnel data.

2. Tank fabrication, including mill tests and shop inspection report.

3. Tank erection, including field inspection and testing report.

E. Mixing System

1. The mixing system shall be a hydrodynamic mixing system (HMS) design by Tideflex of approved equal as described in Section 43 41 13.10.

1.4 QUALITY ASSURANCE

A. General:

1. Demonstrate that the tank manufacturer has been regularly designing, fabricating and erecting similar steel tanks for at least 10 years.

2. Stamp and sign all shop drawings, calculations and welded joint details by a Civil Engineer registered in the state (Oregon) where the tank will be installed.

3. Supply all new materials and fabricated items.

4. Verify adequacy of tank foundation.

B. Codes and Standards:

1. Overall Tank Design: AWWA Manal M42
2. Tank Manufacture: AWWA D100.
3. Safety of Access: UBC or ICBO.

C. Testing Program:

1. Qualification of Weld Procedures: AWWA D100.

2. Qualification of Welders: AWWA D100.

3. Shop and Field Weld Inspection: AWWA D100. If Section 14 applies, retain a Certified Welding Inspector.

4. Weld Inspection Procedures: AWWA D100.

5. Tank Bottom Weld Testing: AWWA D100.

6. Tank Water Tests: AWWA D100.

PART 2 PRODUCTS

2.1 GENERAL

All tanks shall be anchored to the ringwall.

A. Tank Manufacture: AWWA D100. Note also:

1. Copper-bearing steel is not required.

B. Seismic Requirement: The site is located in a Seismic zone 3. Provide positive anchorage between tank and ringwall. Comply with requirements specified in Section 2.02 and on Drawings.

1. The Contractor shall review the Geotechnical report for site-specific design data. Design shall be for the Maximum Probable Earthquake, defined as that with a 10% probability of exceedance in 50 years. Included in the design calculation will be:

   a. an estimate of the mean peak lateral and vertical accelerations at the site,
   b. the site amplification factor (coefficient) S,
   c. comments on liquefaction, land sliding and other gross ground movement.

2. Design of the tanks will include a review of the AWWA D100 pseudodynamic procedure in Section 13. If the design lateral acceleration exceeds 0.4g (Zone 4) or 0.3g (Zone 3) the Z coefficient should be adjusted to a higher value.

3. Pressure stability shall be calculated for stability when the tank is full.

4. Roof columns, overflow pipes and other fixed appurtenances within the tank shall resist seismic water sloshing forces. Use the UBC formula for components of a building and the importance factor of 1.25 and provide calculations.

2.2 DESIGN CRITERIA

A. AWWA D100 and also:

1. Minimum roof snow load 30.00 psf or state and local code

2. Minimum roof live load: 15.00 psf or state and local code

    a. Within guardrails: [50] psf.
    b. Outside guardrails: [20] psf

3. Minimum design metal temperature: $0^{o}F + 15^{o}F = 15^{o}F$.

4. Wind speed: 130 mph.

5. Seismic design: AWWA D100, Section 13 and also:

    a. Mean peak horizontal ground acceleration: Tank manufacturer to verify based on geotechnical report.

    b. Mean peak vertical ground acceleration: Tank manufacturer to verify based on geotechnical report.

    c. Modified zone coefficient, Z: Adjust to zone 4.

    d. Seismic Use Group III

    e. Site amplification factor, S: To be determined by the Tank manufacturer.

    f. Apply horizontal and vertical accelerations simultaneously.

    g. Calculate hoop stress combination: Root Mean square method.

    h. Pressure stability: check with tank full.

    i. Lateral wave load on columns: To be determined by the Tank manufacturer.

    j. Lateral wave load on overflow pipe: To be determined by the Tank manufacturer.

6. Tank anchor system: Resist tension from seismic overturning moment (AWWA D100 equation 13.8), without any reduction for vertical loads.

   a. Design anchor connections at basic allowable stresses.

7. Soil bearing pressures:

   a. Dead and live or operating loads: as provided in the geotechnical report.
   b. Design to include dead, live, operating loads plus seismic or wind loads.

8. Construction loads: Distribute roof concentrated loads so the specified uniform live load is not exceeded. Provide roof shoring where necessary.

9. Tank Mixing System: Hydrodynamic Mixing System (HMS)

2.3 TANK DESIGN

A. Roof: Design purlins and rafters for seismic water sloshing where it will occur. Provide continuous fillet welds all around lapped surfaces at all purlin and rafter connections and beam supports.

B. Roof Supports: Pipe or tubular columns, hermetically sealed.

C. Corrosion Allowance: The Contractor will provide a corrosion protection installation as described in Section 40 46 42.

D. Roof-to-Shell Joint: Continuous fillet welds, each side of shell and roof plates.

E. Shell Circumferential Joints: Complete penetration butt joints.

F. Column Bases: Design to distribute column load plus water pressure on plating without exceeding soil bearing pressure. Number, location and footing design shall be determined by the tank manufacturer.

2.4 TANK ACCESSORIES

A. General: Provide the tank complete with all pipe connections, access openings, nozzles, taps, drains, ladders, and other accessories as shown on the Drawings or required herein. All accessories shall conform to the AWWA D100 and as specified.

B. Stainless Steel Items: Provide AISI Type 304 material, unless Type 316 is specifically specified.

C. Shell Manholes: Two 36-inch -diameter manholes located in the shell and centered 36 inches above the tank bottom. Provide suitable means to hold the manhole covers in the open position. Hinge shall be loose, so that easy bolting is possible. Coating shall match the existing coating specifications after fabrication.

D. Valves, Piping and Pipe Connections:

1. Pipe: AWWA C200, Schedule 20.
2. Pipe lining: AWWA C210-15.
3. Pipe flanges: AWWA C207, Class B.
4. Provide epoxy lined, welded steel inlet, outlet, overflow and drain piping.
5. Outlet pipe: Provide vortex breaker plate assembly.
6. Overflow pipe: Provide external overflow.
7. Pipe connections: Locate exterior face of flanges 36 inches minimum from shell plate, unless shown otherwise.
8. Flexible connections: provide Flex-tend connections where shown on drawings.
9. Gate valve for drain line: AWWA C509-23
10. Duckbill valve for overflow pipe: Red Valve TF-2

E. Roof Access:

1. Provide an exterior steel ladder and guarded, safe access to the roof hatch and a stainless steel interior ladder from the roof hatch to the interior floor of the tank, all in accordance with the UBC. Hot-dip galvanize all parts of the steel ladders, guardrails, chain closure, access platform, and ladder supports after fabrication.

2. Exterior Ladder: Furnish with a safety cage and lockable access prevention at the bottom. Provide appropriate fall protection. Provide a removable extension for the any ladder safety device above the roof elevation and other appurtenances required for use of the safety devices, including one personnel harness/belt.

3. Interior Ladder: Furnish with a ladder fall prevention safety device of stainless steel (in lieu of a safety cage) that conforms with UBC. Provide a removable extension for the ladder safety device above the roof hatch and other appurtenances required for use of the safety devices, including one personnel harness/belt.

4. Roof Hatch: Provide weathertight, hinged steel cover raised 3 inches minimum above roof. Select a cover that opens a full 90°, locks when open and can be pushed open from inside the tank. Support 300 lbs. on cover when closed.

5. Guardrail: Provide around the roof hatch and ladder area in accordance with UBC.

6. Chain Closure: Provide 5/16-inch weldless carbon steel oblong link chain at each rail level. Fasten with boat type snap hook at one end and eye bolt at the other end.

F. Roof Crane: For exterior installation. Meet OSHA requirements for human service and:

1. Capacity: 350 lb. while swinging 360° at boom reach shown.

2. Boom Height: 6-1/2 feet above roof, to lifting hook.

3. Lift Distance: capable of reaching over the opening and 3 feet outside of the edge of tank while providing the required capacity.

4. Winch: Hand-operated, with ratchet brake.

5. Materials: Galvanized steel including wire rope.

6. Provide safety latch on lifting hook and additional 310-pound capacity pad-eye on boom.

7. Provide fall prevention rescue device meeting OSHA requirements for human service.

8. Provide DBI/SALA Davit System assembly adapted to provide features above, or equal.

G. Vents:

1. Provide 2 -foot-diameter, welded steel center roof vent with screened opening, removable top.

2. Provide shell vents of the dimension(s) and at the location(s) shown. If no vents are shown the tank manufacturer shall design size and locations.

3. Design shell vents for a maximum tank overflow of 200 gpm.

4. Provide screens over all vents. Manufacturer shall verify that adequate venting is provided to equalize pressure and prevent buckling of the tank. Screens shall be designed to pop out into the interior of the tank if the internal tank pressure becomes large enough to cause buckling of the tank shell. Maximum tank in/out flow for venting design is 200 gpm.

5. The screen shall consist of an 18x18 Type 316 stainless steel mesh, 0.017 wire diameter or favorably reviewed equal.

6. Covers shall be fiberglass.

H. Safety Eyes:

1. 3/8-inch-diameter forged pad eyes with minimum 1-inch inside diameter eye and 1-1/4-inch-diameter shoulder.

2. Weld perpendicular to the inside and outside of the tank roof at the locations shown.

3. Weld with 1/4-inch fillet welds all around the pad eye shoulder.

4. Load capacity: 400 lbs, any direction.

I. Sight Level Gauge:

1. Provide float-operated gauge.

2. Steel with baked enamel coating, black numbers and gradations on white background.

3. Scale: Feet and tenths of feet.

J. Miscellaneous:

1. Provide connection in shell plate for level (pressure) transmitter.

2. Provide holes in roof plate for level sensor units. Float tree will be located adjacent to the ladder below the hatch. The Ultrasonic unit shall be designed to be locate away from the access hatch. Seal around hole with Viton rubber grommeted penetrations.

3. Provide openings for cathodic protection system as designed by the tank manufacturer.

4. Provide sampling station with two ports.

2.5 FABRICATION

A. AWWA D100 and also:

1. Fabricate and assemble in the shop to the greatest extent possible.

2. Shape all members correctly, with no kinks, twists, dents or other blemishes prior to erection. Evenly spring all curved work.

3. Make exposed edges free of burrs and sharp edges. Make corners rounded or chamfered.

4. Shop prime all steel items that are not galvanized or epoxy-coated, with material that is compatible with the finish coat.

5. Stainless Steel Items:

a. Use the proper type of stainless steel electrodes or welding rods complying with AWS D10.4.

b. Remove by grinding and polishing, all scratches, marks, pits and other blemishes on exposed surfaces.

c. Use grinding wheels and other tools that have never been used on carbon steel.

2.6 SOURCE QUALITY CONTROL

A. Material: Verify that satisfactory mill test reports are available on all steel, including stainless steel.

B. Welding:

1. Verify welders are qualified.
2. Verify that weld procedures are followed.

C. Report: Provide a shop inspection report including mill tests, radiographs and inspection records, before tank erection is started.

PART 3 EXECUTION

3.1 PREPARATION

A. Develop a written erection plan and welding sequences for the tank bottom, side shell and roof plating.

B. Develop this plan and sequences to minimize welding distortions and kinks between plates.

C. Furnish this plan and sequences to the erection crew.

3.2 ERECTION

A. AWWA D100 and also:

1. Comply with erection plan and welding sequences.

2. Follow qualified weld procedures.

3. Use qualified welders.

4. Provide complete penetration butt welds at all side shell joints.

5. Remove all evidence of any welding of temporary erection devices.

6. Stainless steel items:

   a. Use the proper type of stainless steel electrodes or welding rods complying with AWS D10.4.

b. Remove by grinding and polishing, all scratches, marks, pits and other blemishes on exposed surfaces.

c. Use grinding wheels and other tools that have never been used on carbon steel.

3.3 FIELD QUALITY CONTROL

A. AWWA D100, and also:

1. Provide 24-hours notice of all testing to Engineer.

2. Provide all testing equipment and satisfactory access to the work being inspected.

3. Perform and evaluate all radiographs promptly, so any repairs can be made and re-evaluated without delay of the erection.

4. The Engineer will be the sole judge of compliance with the quality of work specified herein or in AWWA D100.

5. Repair all leaks and retest by the same method that discovered the leak.

B. Tank Welding:

1. Inspection by trepanning, air carbon arc gouging and removal of sectional segments will not be permitted.

C. Tank Bottom: Test all joints by the vacuum method after erection and prior to painting.

D. Tank Bottom and Side Shell: Test by the water method, after erection and prior to painting. The Owner will provide the water.

E. Report: Provide a field inspection report, including radiographs and inspection records before acceptance of the tank by the Owner.

3.4 DISINFECTION

A. After protective coatings have been applied and accepted, disinfect the interior tank surfaces in the presence of the Engineer in accordance with the requirements of AWWA C652 and Section 33 01 10.59

3.5 TESTING FOR VOLATILE ORGANICS

A. Refer to Section 09 97 13.24 for requirements relating to testing for volatile organics.

3.6 DISPOSAL OF TEST WATER

A. Water used for testing and disinfection procedures shall be disposed of within the overflow system. Coordinate disposal with the Engineer and Owner.

END OF SECTION

SECTION 43 41 13.10 – RESERVOIR HYDRODYNAMIC MIXING SYSTEM (HMS)

PART 1 GENERAL

1.1 SUMMARY

A. The Hydrodynamic Mixing System (HMS) is defined as a supplemental system installed within a potable water storage reservoir which passively utilizes the energy provided by the inlet water supply (via pumped or gravity head) and generates a sufficient inlet momentum to achieve a complete homogeneous blending of the water volume within the reservoir with the inlet supply flow. Determination of Complete Homogeneous Blending shall be defined by the modeling requirements and supporting hydraulic analysis as conducted by each individual manufacturer for their specific system configuration as defined within these specifications. System submittals not providing this validation shall not be considered as a viable Hydrodynamic Mixing System (HMS) and shall not be accepted as an equivalent to this system specification.

B. The specifications in this section include all components of the Reservoir Hydrodynamic Mixing System (HMS) consisting of a bi-directional flow manifold equipped with variable orifice duckbill inlet nozzles and outlet flow check valves that are NSF61 certified. The HMS manufacturer shall be responsible for designing the system in accordance with the hydrodynamic criteria defined within these specifications and submit design calculations verifying compliance in accordance with the submittal requirements.

C. All modeling and hydraulic and mixing calculations pertaining to the HMS shall originate from the duckbill valve manufacturer. Modeling and calculations provided by parties other than the duckbill valve manufacturer are not allowed.

D. The complete Hydrodynamic Mixing System shall be supplied by the variable orifice nozzle manufacturer to maintain single source responsibility for the system. The complete system shall be defined as all piping and appurtenances within the tank downstream of the tank penetration. Appurtenances include pipe, fittings, horizontal and vertical pipe supports, expansion joints, variable orifice duckbill check valves, and any other equipment specified within this section of the specifications. The approved manufacturer for this system to be included within the Base Bid shall be manufactured by Red Valve Company/Tideflex Technologies, Pittsburgh, PA 15220. Local Equipment Supplier is Mike Duer, 412-446-2278.

E. Manufacturer’s and/or contractors submitting an alternative to the named Red Valve/Tideflex Technologies mixing system shall be responsible for obtaining any and all proprietary rights, license fees, royalties, technology licenses, and/or permissions required to provide such a system. The Manufacturer shall indemnify and hold harmless the Owner and Engineer against all claims, damages, losses, and expenses arising out of any infringement of patent rights or copyright incident relating to this system. Alternate mixing systems, even if listed by name, shall comply with the performance specifications in this section.

1.2 MATERIAL SOURCING (DOMESTIC / INTERNATIONAL):

A. The steel material sourcing shall be at the discretion of the equipment supplier; sourcing can be either local domestic or foreign import.

1.3 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):

1. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings

2. B16.5 – Pipe Flanges and Flanged Fittings

3. B36.10 – American National Standard Weights and Dimensions of Welded and Seamless Wrought Steel Pipe.

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

1. A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

2. A234 – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

3. A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

4. A351 – Standard Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts

5. A536 – Standard Specification for Ductile Iron Castings

6. C110 – Ductile Iron and Gray-Iron Fittings, 3 In. through 48 In. for Water

7. D1330 – Standard Specification for Rubber-Sheet Gaskets

8. D1784 – PVC/CPVC Pipe Compounds

9. D1785 – PVC Pipe, Schedules 40, 80 & 120

10. D2466 – PVC Solvent Cement

11. D2855 – PVC Solvent Joints

12. D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings
13. D3915 – PVC Pipe Fitting Compounds

C. American Iron and Steel Institute (AISI):

1. AISI 304 – 304 Stainless Steel Plate
2. AISI 316 – 316 Stainless Steel Plate
3. AISI 1040 – Carbon Steel Plate

D. American Water Works Association (AWWA):

1. C104 – Cement-Mortar Lining of Ductile Iron Pipe and fittings for Water
2. C110 – Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In. for Water
3. C115 – Flange Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges
4. C200 - AWWA Standard for Steel Water Pipe 6" and Larger
5. C207 – Standard for Steel Pipe Flanges for Waterworks Service – Size 4 In. to 144 In.
6. C220 – AWWA Standard for Stainless Steel Pipe, 4 In. and Larger
7. C900 – AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. for Water Distribution
8. C905 – AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In Through 48 In. for Water Transmission and Distribution
9. C906 – AWWA Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 63 In. for Water Distribution

E. American Water Works Association Research Foundation (AwwaRF):

1. Project No. E20-J08 – Physical Modeling of Mixing in Water Storage Tanks (Forthcoming)

F. National Sanitation Foundation (NSF):

1. NSF Standard 14 – Plastic Piping System Components and Related Materials
2. NSF Standard 61 – Drinking Water System Components – Health Effects

1.4 SUBMITTALS

A. Independent CFD Modeling Validation

1. The mixing system designer/supplier must supply data or report from at least one project where an independent company conducted CFD modeling on their mixing system design and the modeling results verified the design achieved complete mixing.

B. Full Scale Tracer Study Validation

1. The mixing system designer/supplier must supply data or report from at least one project where a full scale tracer study using calcium chloride was conducted on a circular reservoir and the tracer study results verified the mixing system design achieved complete mixing.

2. The mixing system designer/supplier must supply data or report from at least one project where a full scale tracer study using calcium chloride was conducted on an elevated tank and the tracer study results verified the mixing system design achieved complete mixing.

C. Tideflex Inlet Nozzle and Waterflex Outlet Valve Testing and Validation

1. Verification of independent hydraulic testing to determine headloss and jet velocity characteristics on a minimum of eight (8) sizes of duckbill valves ranging from 2" through 48". The testing must include multiple constructions (stiffness) within each size and must have been conducted for free discharge (discharge to atmosphere) and submerged conditions.

2. Verification of Independent Laboratory Testing for Manufacturing Consistency - the duckbill valve manufacturer shall provide summary documentation of a report conducted by an Independent Laboratory for hydraulic testing where multiple duckbill valves (at least four) of the same size and construction (stiffness) were tested to validate the submitted headloss characteristics and to prove the repeatability and consistency of the manufacturing process to produce the same hydraulic characteristics.

3. Report of independent testing that studied the flow distribution characteristics of duckbill valves installed on multiport manifolds. The manufacturer must have been in the business of manufacturing duckbill valves at the time the report was published.

4. Verification of Finite Element Analysis (FEA) of duckbill valves. The duckbill valve manufacturer shall provide summary documentation of Finite Element Analysis modeling on representative duckbill nozzle sizes to determine deflection, stress and strain characteristics under various load conditions. Modeling must have been done

for flowing conditions (positive differential pressure) and reverse differential pressure.

5. Verification of independent hydraulic testing to determine headloss characteristics on a minimum of three (3) sizes of perforated disc/elastomeric membrane check valves ranging from 6” through 36”. Testing must have been conducted with and without the membrane installed. At least two (2) sizes shall have tested two (2) different membrane thicknesses.

6. Verification of Finite Element Analysis (FEA) modeling on a perforated disc/elastomeric membrane check valve to determine stress and deflection characteristics under reverse differential pressure.

D. Validation of Long-term performance

1. The mixing system designer/supplier must supply at least one inspection report showing proper operation of, and no deterioration of, the duckbill valves after being in service in a water storage tank mixing application for a minimum of 10 years.

E. NSF61 Certification

1. Copy of the NSF61 Certified listing for the valves used in the Hydraulic Mixing System (HMS).

2. The valves themselves must be NSF61 certified, not just the elastomer used in construction of the valves. NSF61 approved/certified materials will not be accepted in lieu of valve certification.

3. The NSF61 Certification for the valves must be for a minimum volume of 2,000 gallons. Valves with NSF61 Certification for minimum volume of greater than 2,000 gallons are not acceptable.

F. Test Report on Elastomer Exposure to Chlorine and Chloramine

1. Copy of test report from an accredited independent laboratory that confirmed there is no degradation in the elastomer when exposed to chlorine and chloramine per the ASTM D471-98 “Standard Test Method for Rubber Property – Effect of Liquids.”

G. System Installation Drawings

1. The duckbill valve manufacturer shall be responsible for providing engineering installation drawings of the complete manifold piping system as supplied by the manufacturer. These drawings shall include plan view piping arrangement, sections and elevations as required, support bracket installation details, duckbill nozzle orientation details, and all dimensions required for locating the system within the specified dimensions of the tank.

2. Six (6) sets of plans shall be provided to the Engineer for review and approval.

3. Drawings shall be a minimum of 11 x 17 inches and provided in digital PDF format.

4. Two (2) sets of final fabrication and installation drawings shall be included with the shipment of the manifold piping equipment.

H. Design Calculations

1. All Design Calculations, curves, and reference information listed below must originate and be submitted by the duckbill valve manufacturer. Calculations, curves, and reference information provided by contractors relating to the HMS are not allowed. The duckbill valve manufacturer MUST include within the submittal package the following design calculations, curves, and reference information.

   a. Calculations showing the fill time required, under isothermal conditions, for the HMS system to achieve complete mix of the reservoir volume at minimum, average and peak fill rates. Complete mixing defined as 95% homogenous solution. The theory and equations used in calculating the mixing times must be from a published AWWA reference manual or paper. The reference document(s) must be submitted with the equations and calculations.

   b. Calculations showing the water level drawdown required to achieve complete mixing on the fill cycles at minimum, average, and peak flow rates.

   c. Calculations of average storage tank water age for both fill-then-draw, and simultaneous fill and draw scenarios. Theory used in calculating water age must be submitted with the calculations.

   d. A representative Computational Fluid Dynamics (CFD) model evaluation of the proposed HMS system configuration applied within a reservoir of similar geometry. Model output documentation shall include all design variables applied for the simulation, plot of the 3-D geometry showing the mesh definition, velocity magnitude vector and contour plots at different cross-sections throughout the water volume, simulated tracer animations showing the spatial and temporal distribution of inlet water in real time during the fill cycle.

   e. Hydraulic calculations showing the resulting jet velocities of each inlet nozzle at minimum, average, and peak fill rates.

   f. Hydraulic calculations showing the flow distribution among all inlet ports at minimum, average, and peak fill rates.

   g. Manifold hydraulic calculations showing the total headloss of the HMS at minimum, average, and peak fill and draw rates. Headloss shall include all minor losses and headloss of nozzles and outlet check valves.

h. Hydraulic curves showing thrust vs. flow for the inlet nozzles.

i. Hydraulic curves for each outlet check valves showing headloss vs. flow.

j. Calculations showing the terminal rise height of the jets that discharge at an angle above horizontal. The terminal rise height shall be calculated assuming 10ºF and 20ºF colder inlet water and calculated at minimum, average and peak fill rates. The theory and equations used to calculate the terminal rise height shall be included.

k. Hydraulic curves for each inlet nozzle of Densimetric Froude number vs. flow.

l. If the calculations and supporting data provided do not show compliance with the hydrodynamic requirements of the system as interpreted by the Engineer or Owner then the submittal shall be rejected.

I. Installation, Operation and Maintenance Manuals

1. After final approval of the submittals by the Engineer, the HMS valve manufacturer shall provide one (1) Digital copy of the Installation, Operation and Maintenance (IOM) Manual for the mixing system. Hard copies of the IOM manual can be requested and will be made available at a fee.

2. The IOM manual shall include the following information as a minimum:

a. A cover page listing project specifics.

b. Table of contents.

c. Completed sections for the following: equipment list, shipment and storage instructions, assembly and installation instructions, safety notice, operating instructions, troubleshooting guide, and spare parts list.

d. Copy of hydraulic, mixing, and water age design calculations for the mixing system and all associates supporting curves and calculations.

e. Copy of complete set of the installation plans.

f. Copies of valve IOMs, NSF61 Certification listing, chlorine/chloramine exposure test report.

g. All validation documentation.

h. Component specification sheets for any specialized items supplied with the system.

1.5 WARRANTY

A. All piping, pipe supports, expansion joints, and anchors shall be warranted by the HMS manufacturer against failure under design conditions for a period of one (1) year from the date of final installation certification.

B. Duckbill inlet nozzles and perforated disc/elastomeric membrane outlet check valves shall be warranted by the manufacturer against failure under design operating conditions for a period of one (1) year from the date of final installation certification. Elastomer components damaged as a result of maintenance activities, foreign debris, or excessive exposure to direct ultraviolet and thermal radiation shall be excluded warranted coverage.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Tideflex Variable Orifice Duckbill Inlet Nozzles:

1. Inlet ports/nozzles shall be duckbill-style check valves that allow fluid to enter the reservoir during fill cycles and prevent flow in the reverse direction through the nozzle during draw periods. Inlet ports/nozzles may not be fixed-diameter ports or pipes.

2. The flange drilling shall conform to ANSI B16.1 Class 125/ANSI B16.5, Class 150 standards. The duckbill valve shall be furnished with stainless steel 316 back-up rings for installation.

3. The duckbill valves shall be NSF61 Certified. NSF61 approved/Certified materials will not be accepted in lieu of valve certification.

4. Inlet ports/nozzles shall have a variable diameter vs. flow hydraulic profile that provides a non-linear jet velocity vs. flow characteristic and a linear headloss vs. flow characteristic. The hydraulic characteristics of the duckbill valves shall be defined by “Hydraulic Code”.

5. The inlet ports/nozzles shall discharge an elliptically shaped jet. The nozzle must have been modeled by an independent laboratory using Laser Induced Fluorescence (LIF).

6. Manufacturer shall have conducted independent hydraulic testing to determine headloss and jet velocity characteristics on a minimum of eight (8) sizes of duckbill valves ranging from 2” through 48”. The testing must include multiple constructions (stiffness) within each size and must have been conducted for free discharge (discharge to atmosphere) and submerged conditions.

7. Manufacturer shall have conducted an independent hydraulic test where multiple valves (at least four) of the same size and construction (stiffness) were tested to validate the submitted headloss characteristics and to prove the repeatability of the manufacturing process to produce the same hydraulic characteristics.

8. Manufacturer shall have conducted independent hydraulic testing to study the flow distribution characteristics of duckbill valves installed on multiport manifolds.

9. Manufacturer to have conducted Finite Element Analysis (FEA) on various duckbill valves to determine deflection, stress, and strain characteristics under various load conditions. Modeling must have been done for flowing conditions (positive differential pressure) and reverse differential pressure.

10. Manufacturer must have conducted in-house backpressure testing on duckbill valves ranging from ¾" to 48".

11. Manufacturer shall have at least fifteen (15) years experience in the manufacturing of "duckbill" style elastomeric valves.

12. Manufacturer must have duckbill valves installed on manifold piping systems in at least 100 distribution system reservoirs.

13. Manufacturer must have representative inspection videos showing the duckbill valves discharging water into the reservoir during an initial fill (unsubmerged). Manufacturer must also have representative underwater inspection videos showing the operation of the valves when submerged. Representative videos can be submitted upon request from the engineer.

14. The duckbill style nozzles shall be one-piece elastomer matrix with internal fabric reinforcing designed to produce the required discharge velocity and minimum headloss requirements as stipulated in the Submittals section. The flange portion shall be an integral portion of the nozzle with fabric reinforcing spanning across the joint between the flange and nozzle body.

15. The elastomer used in construction of the duckbill valves must have been tested by an accredited independent laboratory that confirmed there is no degradation in the elastomer when exposed to chlorine and chloramine per the ASTM D471-98 "Standard Test Method for Rubber Property – Effect of Liquids."

16. The manufacturer's name, plant location, serial number and product part number which designates nozzle size, material and construction specifications shall be bonded onto the surface of the nozzle:

B. Waterflex Outlet Check Valves:

1. The outlet flow valves shall be perforated disc type with elastomeric membrane.

2. The valves shall be NSF61 Certified. NSF61 approved/Certified materials will not be accepted in lieu of valve certification.

3. The perforated disc shall be fabricated of stainless steel 304 plate with or without welded support gussets depending on maximum backpressure. The disc shall be flanged and drilled to mate with ANSI B16.1, Class 125/ANSI B16.5 Class 150 flanges. The disc shall have three (3) tapped holes used for fastening the membrane and support rod to the disc with stainless steel 304 bolts, nuts, and lock washers. The top of the disc shall be tapped and supplied with lifting eyebolt for installation.

4. The membrane shall be circular, one piece rubber construction with fabric reinforcement. The diameter of the membrane shall allow adequate clearance between the membrane O.D. and the pipe I.D. The membrane shall be vulcanized with a specified convex radius to produce a compression set to allow the membrane to seal against the perforated disc at low reverse differential pressure.

5. The support rod shall be stainless steel 304 and drilled with three (3) longitudinal holes to allow fastening of rod to membrane and perforated disc.

6. When line pressure inside the valve exceeds the backpressure outside the valve, the line pressure forces the membrane to open, allowing flow to pass through the perforations in the disc. When backpressure exceeds the line pressure, the membrane seats on the perforated disc preventing backflow.

7. The valve allows flow out of the reservoir during draw cycles and prevents flow into the reservoir during fill cycles.

8. The elastomer used in construction of the membrane must have been tested by an accredited independent laboratory that confirmed there is no degradation in the elastomer when exposed to chlorine and chloramine per the ASTM D471-98 "Standard Test Method for Rubber Property – Effect of Liquids."

9. The manufacturer's name, plant location, serial number and product part number which designates membrane size, material and construction specifications shall be bonded onto the surface of the membrane

C. Polyvinyl Chloride (PVC) Pipe and Fittings:

1. All PVC pipe and PVC fittings shall be a minimum Schedule 80 in accordance with ASTM D1785-83.

2. PVC pipe and fittings shall be NSF61 approved for potable water.

3. PVC pipe compounds shall be in accordance with the standards listed in Section 3.0: Referenced Standards.

4. PVC solvent and solvent joints shall be in accordance with the standards listed in Section 3.0: Referenced Standards.

5. Field solvent welding will not be allowed unless approved by the Engineer.

6. All pipe joints that are to be field connected shall be PVC Van Stone-type flanges. Flange drilling to be in accordance with ANSI B16.1/B16.5.

7. All fittings shall have the same pressure rating as the pipe unless otherwise noted

D. High Density Polyethylene (HDPE) Pipe and Fittings:

1. Two (2) Inches and Smaller – Pipe shall be manufactured from a PE4710 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350-99 with a cell classification of PE345464C. Pipe shall have a manufacturing standard of ASTM D2737 (CTS). Pipe shall be DR 9 (200psi WPR) unless otherwise specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, and per AWWA C901, have nominal burst values of three (3) times the Working Pressure Rating (WPR) of the pipe. Pipe shall also have the following agency listing of NSF 14.

2. Four (4) Inches and Larger - Pipe shall be manufactured from a PE4710 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350-99 with a cell classification of PE345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe O.D. sizes 4” to 24” shall be available in steel pipe sizes (IPS) and ductile iron pipe sizes (DIPS). Pipe O.D. sizes 26” to 54” shall be available in steel pipe sizes (IPS). Pipe shall be DR 17 (100psi WPR) for pipe sizes up to 36” unless otherwise specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, listed as NSF 14, and per AWWA C906 Pressure Class (PC) 100 have a nominal burst value of three and one-half (3 ½) times the Working Pressure Rating (WPR) of the pipe.

3. Pipe fittings and flanged connections, to be joined by thermal butt-fusion, shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.

4. Sidewall fusions for connections to outlet piping shall be performed in accordance with HDPE pipe and fitting manufacturer’s specifications. The heating irons used for sidewall fusion shall have an inside diameter equal to the outside diameter of the HDPE pipe being fused. The size of the heating iron shall be ¼ inch larger than the size of the outlet branch being fused.

5. Field fusion welding will not be allowed unless specified or approved by the Engineer.

6. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe.

7. Butt Fusion Fittings - Fittings shall be PE4710 HDPE, Cell Classification of PE345464C as determined by ASTM D3350-99, and approved for AWWA use. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half (3 ½) times the Working Pressure Rating (WPR) of the fitting.

8. Electrofusion Fittings - Fittings shall be PE4710 HDPE, Cell Classification of PE345464C as determined by ASTM D3350-99. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half (3 ½) times the Working Pressure Rating (WPR) of the fitting.

9. Flanged pipe sections for mechanical joining shall be comprised of HDPE flange adapters and Stainless Steel 304 slip-on backup rings. Flange adapters shall conform to PE4710 HDPE, Cell Classification PE345464C as determined by ASTM D3350-99.

E. Ductile Iron Pipe and Fittings:

1. Flanged ductile iron pipe shall be Class 53 and conform to AWWA C115 / ANSI A21.15.

2. Flanges shall be faced and drilled after being screwed onto the pipe and be 90 degrees with the longitudinal axis of the pipe.

3. Flanged ductile iron fittings shall conform to AWWA C110 / ANSI A21.10.

4. Pipe and fitting flanges shall be drilled to ANSI B16.1 Class 125 standards.

5. All flanged pipe and fittings shall be cement-mortar lined conforming to AWWA C104 / ANSI A21.4.

6. All flange pipe and fittings shall be shop-coated with an NSF61 Certified primer, 3-5 mils DFT. Paint shall be Tnemec 20 Pota-Pox or Tnemec N140 Pota-Pox Plus unless otherwise specified. Coating shall be in accordance with coating manufacturer's specifications.

F. Carbon Steel Pipe and Fittings:

1. Carbon steel pipe and fittings shall conform to the associated standards listed in Section 2.0: Reference Standards.

2. Dimensions for carbon steel fittings shall conform to AWWA C110, unless otherwise specified.

3. Pipe and fittings shall be Schedule Standard wall thickness conforming to ANSI B36.10-1985.

4. All flanges shall be carbon steel ring flanges conforming to AWWA C207 Class D, unless otherwise specified on the drawings. Flange drilling pattern shall be in accordance with ANSI B16.1/B16.5 standards.

5. Ring flanges shall be continuously welded on both sides.

6. Welding of carbon steel pipe and fittings shall be in accordance with the Reference standards.

7. All butt welds shall be fully penetrated with gas shielding to the interior and exterior of the joint.

8. Welded cross-sections shall have a thickness equal to or greater than the welded material.

9. Field welding of carbon steel pipe and fittings will not be allowed unless approved by the Engineer.

10. All welded joints shall be free of sharp edges and burrs.

11. Coating of the inside of carbon steel pipe and fittings is not required, unless otherwise specified.

12. Coating of the outside of carbon steel pipe and fittings shall be performed in the field, by the contractor, following installation of the manifold piping system. Surface preparation and coating procedures shall be in accordance with standards listed in Coatings specification

G. Stainless Steel Pipe and Fittings:

1. Stainless steel pipe and fittings shall conform to the associated standards listed in Section 3.0: Reference Standards.

2. Dimensions for stainless steel fittings shall conform to AWWA C110, unless otherwise specified.

3. Piping shall be Schedule 10s stainless steel 304L fabricated from material per ASTM-A240.

4. All flanges shall be plate ring flanges, unless otherwise specified on the drawings. Flange drilling pattern shall be in accordance with ANSI B16.1/B16.5 standards.

5. Ring flanges shall be continuously welded on both sides.

6. All welded joints shall be free of sharp edges and burrs.

7. All shop welds shall be manually scrubbed or brushed with non-metallic pads or stainless steel wire brushes to remove weld discoloration. Welds to be chemically passivated with nitric or citric acid.

8. Field welding of stainless steel pipe and fittings will not be allowed unless approved by the Engineer.

H. Flange Gaskets:

1. Flange gaskets shall be full-faced and shall be in accordance with ASTM D1330.

2. Flange gasket drilling pattern shall conform to ANSI B16.1/B16.5.

3. Flange gaskets shall be 1/8” thick.

4. Gasket material shall be EPDM.

I. Fasteners:

1. Hex head bolts and nuts shall be stainless steel 304 conforming to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2.

2. Plastic insulating sleeve/washers shall be utilized to isolate dissimilar bolt and flange metals where required.

J. Pipe Supports:

1. For field welded, plain end, carbon steel pipe, the pipe supports shall be carbon steel in accordance with the associated standards and be welded directly between the tank floor, shell, access tube, or wet riser and the carbon steel piping. The pipe supports shall be flat plates, structural angle iron or channel.

2. For flanged pipe in carbon steel tanks, the pipe supports shall be carbon steel with a stainless steel 304 U-bolt in accordance with the associated standards. For flanged pipe in concrete or bolted tanks, all components of the pipe supports shall be stainless steel 304 in accordance with the associated standards.

3. The pipe supports shall consist of five components:

   a. A base plate. For all-stainless steel pipe supports, the base plate will have four thru holes for expansion anchors and a pipe welded to the base plate with a hex nut welded to the top of the pipe to serve as a guide for the all-thread of the top-works weldment.

   b. For carbon steel supports, a top-works weldment that consists of structural channel and angle iron. The angle iron has predrilled holes for the U-bolt. The TMS piping shall rest on the angle iron and the U-bolt is used to retain the TMS pipe.

   c. For stainless steel supports, a top-works weldment that consists of structural angle iron with predrilled holes for the U-bolt. The TMS piping shall rest on the angle iron and the U-bolt is used to retain the TMS pipe. All-thread rod shall be welded to the bottom of the angle iron and shall thread into the hex nut of the base plate weldment. The top-works weldment can be rotated into or out of the hex nut to provide height adjustability.

   d. U-bolt with four hex nuts.

   e. An 1/8” thick EPDM strip with a length equivalent to the circumference of the pipe. The strip shall be placed between the pipe and the angle iron and U-bolt.

4. For steel tanks, the channel of the top-works weldment shall be field fit and modified to the required length. The channel shall then be field welded to the base plate.

5. For steel tanks, the base plate shall be field welded to the tank floor or shell. The location of the base plate shall avoid welded joints in the floor/shell plates.

6. For concrete tanks, the support shall be anchored to the concrete floor with stud type expansion anchors, the pull-out rating of the combined anchors shall be a minimum of 10 times greater than the static weight of the vertical pipe section.

7. Plastic insulating sleeve/washers shall be utilized to isolate dissimilar metals where required.

K. Coatings:

1. Following installation of the manifold system, all carbon steel and ductile iron pipe, fittings, bolted connections, pipe supports, and appurtenances shall be coated according to the interior tank paint specification as specified by the Engineer.

2. Surface preparation and coating procedures shall be provided by the Engineer and the coating supplier.

3. Tideflex and Waterflex Valves shall not be coated. The valves shall either be masked or be mounted after coating of the tank and piping. Contractor to ensure masking materials are removed after coating.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND MATERIAL HANDLING

A. Individual nozzles and outlet valves shall be packaged separately from the piping equipment.

B. All flanges shall be protected by using plastic inserts or plank wood, pipe sections are to be fully supported to prevent pipe deflection or damage to fittings or connections.

C. All equipment shall be shipped on pallets capable of fully supporting the pipe sections across their entire length. Pallets should be accessible for fork lift transport or strap and hoist means without causing any load to the pipe equipment.

D. All stainless steel components shall be stored separately away from any carbon steel components or other materials that could stain or deface the stainless steel finish from run-off of oxidized ferrous materials.

E. All pipe equipment should be covered and stored in areas free from contact with construction site sediment erosion to prevent accumulation of materials within the pipe and fittings.

F. Duckbill nozzles should be protected from contact with rigid objects during handling and storage. The contractor shall be responsible for replacing any duckbill nozzles or elastomeric components that are damaged after arrival on the site through installation and start-up of the system.

3.2 INSTALLATION

A. Installation of the manifold system shall be in accordance with the installation plans and guidelines provided by the HMS manufacturer, and as specified in the installation section of the IOM manual, and the requirements defined in these specifications.

3.3 INSTALLATION INSPECTION AND START-UP TESTING PROCEDURES

A. The HMS manufacturer’s authorized representative shall provide one (1) day inspection to verify that the system has been installed in accordance with the design specifications and installation drawings. It is recommended the flow testing described below is conducted the same day once the representative confirms proper installation of the system.

B. The inspection representative shall provide signed inspection documents confirming the date of the inspection and approval of the installation.

C. Start-Up Flow Testing.

  a. Following installation of the complete manifold piping system, the contractor shall open the upstream isolation valve to allow flow into the tank through the manifold system. The isolation valve must be opened slowly to prevent surge or over-pressurization of the manifold system. The isolation valve must be fully opened to inspect the flow characteristics of the manifold system.

  b. The contractor shall take videos and photos during the filling operation and submit them to the HMS manufacturer. Videos and photos are to confirm:

    1) There is no leakage in the piping system.

    2) That all of the duckbill inlet nozzles are discharging flow into the tank. The only exception is for a system where the duckbill nozzles are at different elevations. If the water level is not at the elevation of higher duckbill nozzles, those may not discharge flow until the water level approaches those nozzles.

END OF SECTION

SECTION 46 00 03 - DISINFECTION AND VOC TESTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clean, flush and disinfect all surfaces with which the process water may come in contact in the following equipment, structures, tanks, pipelines, and accessories, including:

   a. Pumping structures
   b. Water storage facilities:
   c. Large pipelines:
   d. Small pipelines:

2. Bacteriological testing.

1.2 REFERENCES

A. American Water Works Association (AWWA):

1. C651 AWWA Standard for Disinfecting Water Mains
2. C652 AWWA Standard for Disinfection of Water Storage Facilities
3. C655 AWWA Field Dechlorination
4. C670 AWWA Online Chlorine Analyzer Operation and Maintenance

1.3 SCHEDULING

A. Schedule and coordinate the work with the Owner and Engineer. Once disinfection has been satisfactorily accomplished, no further entry to the interior of the facilities will be allowed unless entry must be made to perform repairs, in which case repeat disinfection on a localized basis at no additional cost to the Owner. The Contractor shall be responsible for maintaining security of the disinfected facilities.

B. Disinfect equipment, tanks and pipelines following successful pressure testing.

1.4 SUBMITTALS

A. Submit in accordance with the General Conditions (Volume 1).

B. Submit a Disinfection Plan including the procedures, methods, materials and schedules proposed for disinfecting the required surfaces and disposal of disinfection water. Comply with Sections 3 and 4 of AWWA C652.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Certify that disinfectants meet or exceed AWWA C652 requirements.

1. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

2. Certify that disinfectants meet or exceed AWWA C652 requirements.

3. Test and Evaluation Reports: Indicate results of bacteriological and residual chlorine laboratory test reports.

4. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

5. Qualifications Statement:

    a. Submit qualifications for applicator.

1.5 QUALITY ASSURANCE

Laboratory testing requirements – if any - related to disinfection will be coordinated with the Owner. Maintain 2 copies of each standard affecting Work of this Section on Site.

PART 2 PRODUCTS

2.1 MATERIALS

A. Potable Water: Use potable water to flush and disinfect: the MF equipment and systems, the RO equipment and systems, all piping and systems from the RO units to the Product Water Pump Station and Product Water Pipeline; and all other small and ancillary equipment and piping systems.

B. Chlorine: See the respective AWWA Standards and paragraph 3.02 below for forms of chlorine that may be used for disinfecting operations.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide all necessary appurtenances required for the disinfection procedures including taps, temporary piping, connections and shutoff valves. Submit data on appurtenances which will be permanently installed for review by the Engineer.

B. The Contractor is advised that precautions taken to keep surfaces clean during construction and avoiding the entry of deleterious substances on the work during construction will facilitate achieving the disinfection requirements of this project.

C. Prior to disinfecting, thoroughly clean accessible surfaces of dust, dirt, foreign matter and deleterious substances. Remove any oil by contact with absorbents. Use water sprays, steam cleaning, vacuum cleaning, swabbing, hand brushing or a combination of methods and rinsing to effect the cleaning, but do not use any method that will be detrimental to the finish surfaces. Flush inaccessible surfaces clean.

3.2 APPLICATION

A. After completing all construction activities, including painting and application of elastomeric membranes and after allowing a minimum of ten days for the paint and/or elastomeric membranes to cure, disinfect the required surfaces with chlorine solutions in accordance with the following procedures. Following disinfection and flushing, the Owner will take water samples for chlorine residual and bacteriological analysis of the water. If the specified chlorine residual and bacteriological requirements are not satisfied, repeat disinfection procedure until the requirements are met. The Contractor shall pay for the additional sampling and testing at no additional cost to the Owner, until disinfection requirements are met.

B. Water Storage Facilities:

1. Standard: AWWA C652 as amended herein.

2. Forms of Chlorine: Use sodium hypochlorite or calcium hypochlorite.

3. Method: 2 (Brush or Spray).

    a. A solution of at least 200 ppm of available chlorine shall be applied directly to the surfaces of the facilities that will be in contact with process water when the facility is full to the overflow elevation.

    b. After the surfaces have been thoroughly coated and in contact with the strong chlorine solution for 30 minutes, treated water (with distribution system chlorine residual) shall be admitted into the structure.

4. Testing and Verification: After chlorination and before placing the water storage facility in service, water sample(s) will be collected from the full facility and tested for the presence of coliforms and the chlorine residual will be measured.

    a. The facility may be placed into service if the test for coliform is negative and the chlorine residuals are at acceptable distribution system levels.

b. If any of the samples show the presence of total coliform bacteria, one or more of the following procedures shall be followed before placing the facility in service:

    1) Repeat samples shall be collected and tested until two consecutive samples are negative.

    2) Repeat disinfection process and resample.

C. Large Pipelines:

1. Standard: AWWA C651 as amended herein.

2. Forms of Chlorine: Sodium hypochlorite or calcium hypochlorite.

3. Disinfection Procedure: Continuous feed and soak method.

    a. The pipelines shall be completely flushed and then filled with the disinfection water, removing air pockets. The disinfection water shall be chlorinated to at least 25 ppm and no more than 35 ppm.

    b. Confirm the chlorine residual in the pipelines with an initial sample immediately after filling the system with disinfection water.

    c. After a 24-hour holding period, the free chlorine residual shall not be less than 10 ppm.

    d. Flush the system with potable water and take bacteriological samples.

4. Testing and Verification: After completing the disinfection procedure and before approving the pipeline for release, two sets of samples will be collected from the pipeline and tested for the presence of total coliform bacteria. Samples will be collected either at least 16 hours apart, or both sets will be collected 15 minutes apart (with the sample tap left running between sampling) after at least 16 hours after completing the disinfection procedure without flushing the pipeline.

    a. The pipeline may be placed into service if none of the samples show the presence of total coliform bacteria.

    b. If any of the samples show the presence of total coliform bacteria, one or more of the following procedures shall be followed before placing the facility in service, repeat disinfection process and resample.

D. Small Pipelines:

1. Preparation: Provide the system with a 1-inch minimum service cock or valve or other means to inject chlorine solution at a point within 2 or 3 feet of its junction with the supply source. When system is complete, thoroughly flush it by fully opening every outlet until clear water flows from all of them.

2. Disinfecting Agent: Sodium hypochlorite or calcium hypochlorite in sufficient quantities to produce chlorine concentration of at least 50 parts per million in the system.

3. Disinfecting Procedure:

    a. Connect a hand-operated pump, or other means of injecting the disinfecting agent, to one-inch minimum service cock or valve or other injection device. Pump must provide a pressure greater than that of supply of system.

    b. With system completely full of water and supply valve open, proceed to adjust every outlet of system so that a trickle of water flows from each.

    c. Inject disinfectant slowly and continuously at an even rate, not in slugs, until a test at each outlet shows a free chlorine residual concentration of at least 50 parts per million.

    d. Close all outlets and valves, including valve connecting to supply line and one-inch minimum service cock on solution injection connection. Maintain condition for 24 hours. After 24 hours, test for residual chlorine at each outlet. The free residual chlorine concentration indicated should be not less than 10 ppm. If the indicated free chlorine concentration is less than 10 ppm, repeat disinfection procedure until an approved result is obtained.

    e. When the above procedure has been completed to the satisfaction of the Engineer, flush out entire system with fresh water until tests at all outlets show a residual of not more than 0.5 ppm.

3.3 FIELD QUALITY CONTROL

A. Chlorine Residual Testing: AWWA C651, Appendix A, DPD Drop Dilution Method, except where otherwise specified. Testing shall be performed by the Contractor.

B. Bacteriological Analyses of Water: After the completion of disinfecting procedure, including the final flushing as described in AWWA C651 and heretofore, the Owner will obtain water samples from this system for bacteriological analyses.

C. Requirements for satisfactory disinfection of process equipment, tanks, pipelines and associated elements are:

1. Bacteriological analyses indicate that water samples are negative for coliform organisms; and

2. Heterotrophic plate count (standard plate count) is less than 100 colony forming units per milliliter.

3. If bacteriological analyses do not satisfy the above requirements, then repeat disinfection procedure until these requirements are met.

D. Testing for Volatile Organic Compounds:

1. VOC Testing shall be performed in conjunction with quick turnover so as to allow residual trace VOCs to enter into the distribution in small doses.

2. If any test fails, repeat the test procedure in five days time from the initial test at no additional cost to the Owner. The cost of the shall be at the Contractor's expense.

3.4 DISPOSAL OF DISINFECTION SOLUTION

Dechlorinate and dispose of disinfection solution into the sanitary sewer system. Take care to assure that chlorinated water is not spilled into drains.

3.5 PROTECTION OF DISINFECTED STRUCTURES

If required to re-enter a disinfected structure, the work shall be conducted using techniques and work methods as necessary to maintain the disinfected status. This shall include use of disinfected foot coverings, tools, and the like. In the event the Contractor contaminates the facilities, additional flushing and disinfection of the affected system shall be performed at no additional cost to the Owner.

END OF SECTION

SECTION 46 10 00 - MANGANESE AND IRON TREATMENT PACKAGE SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED (OWNER FURNISHED CONTRACTOR INSTALLED FILTER SYSTEM)

A. Two (2) skid mounted vertical pressure vessel systems:

1. South Plant: four 48-inch diameter filters with 60-inch sidewalls
2. North Plant: eight 48-inch diameter filters with 60-inch sidewalls.

B. Filter internals.

C. Filter media.

D. Face piping and valves.

E. Automatic backwash controls.

F. Installation inspection, start-up and training assistance.

1.2 RELATED WORK NOT INCLUDED

A. Electrical work is specified in the construction documents.

1.3 SUBMITTALS AND SHOP DRAWINGS

A. At a minimum, the following information shall be submitted by the filter manufacturer:

1. Catalog cut sheets for all filter internals including media.
2. Elevation drawing for filter internals including media loading schedule.
3. Catalog cut sheets for all control valves and actuators.
4. Catalog cut sheets for all specified instrumentation and control components.
5. Materials of construction for all major components.
6. Elevation and plan views of the filter system including the location and orientation of all nozzles, manways, and connections.

1.4 OPERATION AND MAINTENANCE MANUALS

A. The filter manufacturer shall submit at least two (2) copies of Operation and Maintenance Manuals. One hard-copy and one electronic copy.

B. At a minimum, the following information shall be included:

1. Manufacturer’s instructions for equipment installation, startup, operation, preventative maintenance, servicing, and troubleshooting procedures.

2. Filter system data sheets and final as-built drawings of all equipment.

3. Name, address, and telephone number of factory-trained service technician.

PART 2 OWNER PROVIDED EQUIPMENT

2.1 FILTER TANKS

A. Tanks shall be of electric welded pressure vessel quality low carbon steel construction rated for 100 psig working pressure and hydrostatically tested at 100% above the working pressure. Sidewalls shall be built of Grade A-572 steel and tank heads and hand-holes shall comply with ASME Code requirements. Sidewalls shall be at least ¼" gauge and heads shall be at least ¼" gauge.

B. Tanks shall have stainless steel grooved coupling connections on the service inlet and outlet. Manifolds shall have a flanged connection on the system inlet and outlet.

C. Access opening for tanks shall include one 11" x 15" manhole in the top head and one 8" circular access ports in lower sidewall of tank as close to lower head as possible to allow for under drain servicing or media removal.

D. Support for tanks shall be structural steel angle legs welded to lower section of the sidewall. The support and anchoring of filter vessels and accessories shall be designed by an Oregon State Licensed Structural engineer, and stamped drawings must be submitted to the owner, and accepted by the permitting agency prior to installation of the filters.

E. Four filter vessels shall be mounted to a common 4" x 6" x ¼" tubular steel frame (skid) with forklift brackets and four crane lifting hooks. Filter vessels shall be mounted so that they can be removed individually with the use of standard hand tools and a forklift or similar lifting device. The skid will be sandblasted, and epoxy coated. There will be 2" x 4" x ¼" stainless steel plates mounted on the underside of each skid to maintain a separation between the skid and the concrete floor of at least 1/8 of an inch.

F. Seismic anchorage shall be provided and integral to the filter skids. Anchors shall be placed in the general locations shown on the drawings. Anchor plates shall be welded to the skids and factory coated with the exterior coating system described in section 2, below. Provide a copy of the Oregon State licensed structural engineer's report prior to shipment.

2.2 COATINGS

A. Immersed steel surfaces on tanks of all diameters shall be sand blasted to a near white metal surface finish per (SSPC-SP10) finish. Non-immersed steel surfaces shall be Commercial Blast Cleaned as per SSPC-SP6.

B. All filter vessel immersion service surfaces and manifold immersion surfaces shall be coated with 3M Corporation ScotchKote 134, a fusion bonded epoxy coating, certified to ANSI/NSF Standard 61 for contact with potable water, applied in accordance with the Equipment Supplier's recommendations.

C. The exterior finish shall be applied in at least two coats and may be achieved in more than two coats. Exterior surfaces will be coated by 3M Corporation ScotchKote 134 and 2-3 mils DFT of Tnemec, Inc. Series 1074, Endura-Shield II or equivalent.

D. Touch up paint shall be supplied for all coating systems and colors used. Paint shall be in sealed containers from the Equipment Supplier clearly labeled with the color, system, location to be used, and shelf-life expiration date. Touch up paint shall be compatible with the coating systems and be able to be field applied without special tools, knowledge, or equipment.

2.3 INTERNAL DISTRIBUTION

A. The filter system shall be a "down-flow" type with untreated water entering the top of the filter and flow through the filter tank and out the bottom of the tank.

B. The upper distribution system shall be of the baffle type to evenly distribute the water over the entire media surface area.

C. The lower distribution system shall be of a proven design to provide a uniform backwash flow across all the filter media. For 48-inch diameter filters, the under drain will be constructed with ten individual stainless-steel wedge wire radial outlets with openings of not more than 0.010". The radial arms shall be secured to a stainless-steel hub-base by nipples threaded into stainless steel pipe couplings welded to the hub. Each radial arm shall have adequate outlet orifices for the stated flow located beneath the wedge wire (the specific design requirement is that each arm be capable of handling 37.5 gpm of water with a pressure loss not to exceed 2 psig). The distribution system shall be embedded in a layer sub-fill of 3/8" x 3/4" washed gravel topped with 2" of #8 garnet or gravel to support the filter bed.

2.4 MAIN OPERATING VALVES

A. The main operating valve on each tank shall be an industrial automatic multi-port diaphragm type, slow opening and closing, free of water hammer. The diaphragm assembly shall be fully guided on its perimeter when pressure activated from one position to another to assure a smooth reliable shut-off without sticking. There shall be no contact of dissimilar metals within the valve and no special tools shall be required to service the valve. The valve shall be capable of being operated pneumatically. The operating pressure shall be equal to the filter inlet system pressure. Main operating valves shall be Bermad IR-350A. Substitutions will not be allowed.

2.5 PIPE AND FITTINGS

A. Raw (6”), finished (6”), and backwash (4”) water manifolds and piping shall be Schedule 40 steel with a wall thickness of 0.25 inches or greater. Pipe sizes shall be as shown on the plans. Immersed portions of manifolds shall be coated with ScotchKote 134, certified to ANSI/NSF Standard 61 in the same manner specified for filter vessels in Section 2, above except that manifolds with diameters smaller than 3" may be made of Type 316L stainless steel and left uncoated.

B. Tubing between the main operating valves and the pilot control valves shall be ¼” OD and rated for 300 psi as manufactured by Parker or approved equal.

C. A 2” threaded connection shall be provided on the inlet manifold as shown for mounting of an air relief valve.

2.6 FLOW CONTROL

A. An adjustable backwash flow control valve and a backwash flow meter shall be included. The backwash flow meter must read instantaneous flow within the range of expected backwash flows and must have a 4-20 mA output signal. Backwash flow will be provided internally to the system (i.e. no additional flow from the well or distribution system shall be used during backwash). Proper filter bed fluidization during backwashing shall be required. Backwash flow rates shall be determined at system start-up.

2.7 CONTROLS

A. A factory-mounted and wired cycle controller shall incorporate an adjustable time switch with multi-ported pilot valves to control all steps of automatic backwash. Provision for push-button initiated backwash shall be included, as will provisions to accommodate remote initiation of backwash. The controller to be used is an Alex-Tronic F-12, or similar, which requires a 120 VAC connection which provides a local panel indication of backwash status and alarm.

B. The multi-ported pilot control valve shall be pre-connected to automatically pressure activate the operating control valve through the steps of backwash and return to service. The control panel shall always indicate the cycle of operation. In case of power failure, a complete backwash cycle can be performed by manual operation of the pilot control valve.

C. Electrical lockouts to prevent more than one unit from backwashing at the same time, except when the system is manually overridden are included.

D. Electrical time switch control shall be fully adjustable to initiate backwash at regular frequencies from hourly to once every 48 hours and at a set pressure differential. The capability for backwash, initiated from a remote location, by an electrical signaling device shall be included.

2.8 FILTER MEDIA

A. The filter media shall be NSF/ANSI Standard 61 listed as a manganese dioxide media. The size of the media shall be 0.42mm to 0.85mm (20 to 40 US Mesh). The media shall be manganese dioxide ore or a coated manganese dioxide product with a backwashing flow rate required to get 20% bed expansion during backwashing. Alternative media will not be accepted unless the equipment supplier demonstrates with an independent pilot test that the media will meet the treatment requirements. Iron and manganese shall be removed to a level below one half of the established maximum contaminant level (MCL). Particle retention shall be ten (10) micron and larger for particles other than iron and manganese.

B. Each filter shall be provided with gravel under-bedding to cover the hub and lateral underdrain including an 1/8" x 1/16" barrier gravel between the gravel and the catalytic filter media.

C. The media layers shall be graded as follows.

Layer	Depth	Size	CF required (total/per vessel) 12-54"	CF required (total/per vessel) 16-48"
Bottom	Cover Underdrain	½" x ¼"	108/9	112/7
Second	3"	¼" x 1/8"	48/4	56/3.5
Third	3"	1/8" x 1/16"	48/4	56/3.5
Top	42"	Manganese dioxide-based media	672/56	704/44

D. The gravel shall be free from clay, loam, dirt, calcareous or other foreign material and shall consist of round or sub-angular particles being relatively free of flat or elongated particles.

E. The gravel shall be shipped bagged for field installation by the General Contractor. The bottom layer of the screened support gravel shall be placed by hand to avoid damage to the underdrain diffusers. Each layer shall be placed and leveled before the installation of the next layer is started.

F. The filter media shall be ANSI NSF certified for drinking water use as a manganese dioxide (MNDOX) media and packaged in one-ton supersacks for installation by the Contractor.

2.9 REGENERATION SYSTEM

A. Chlorine, in the form of sodium hypochlorite solution injected in the raw water, shall be the oxidant used in this system and a free chlorine residual equal to or greater than 0.5 mg/L shall be maintained in the product water leaving the treatment unit. No oxidant other than chlorine shall be used in this system. A small amount of permanganate may also be added to prevent silica adsorption, if required.

2.10 ACCESSORIES

A. Liquid filled pressure gauges with +/- 0.5 % full scale accuracy in corrosion resistant frames shall be provided (0-100 psig) for inlet and outlet manifold of the system. Gauges shall be 4½" in diameter with integral surge suppression snubbers and will be mounted above the control panel.

B. Sampling ports shall be provided for the product water from each filter vessel as well as composite sampling ports for raw and finished water. A sampling port shall also be included for sampling backwash effluent.

C. Two ¾" threaded half couplings shall be provided on the inlet and outlet manifold for such use as the customer may deem appropriate. These shall be plugged at time of delivery.

D. One pressure relief valve shall be provided with each filter bank of 4 and 8 tanks.

E. One site glass will be provided for the backwash discharge line for each filter banks of 4 and 8 tanks.

F. An air relieve valves shall be provided on the inlet piping header for each filter bank of 4 and 8 filters.

2.11 OPERATING REQUIREMENTS

A. Each filter system shall consist of vertical pressure filters (eight at the north site and four at the south site), factory assembled, pre-piped and wired, skid mounted for installation. The filter shall successfully achieve the performance listed below when operated at the design water flow rate of 800 gpm at the north site and 400 gpm at the south site. The normal design conditions are summarized in the table below for 48”.

Table 1. Equipment Design Criteria Summary	**North WTP**	**South WTP**
Plant Capacity (gpm)	800	400
Operating Pressure, psig	75	75
Run Time (hours/day)	24	24
Average Day Run Time (hours/day)	12	12
Vertical Pressure Filters		
Diameter of Vessels, ft	4	4

Surface areas, per vessel, sq ft	12.3	15.3
Number of Vessels	8	4
Loading Rate, gpm/sq ft	8.13	8.13
Media Depth, in	42	42
Total Media, Cubic ft	344	172
Total Media Weight, lbs	41,261	20,630
Backwash		
Backwash Flow Rate, Each Vessel, gpm	Maximum 375	Maximum 375
Backwash Frequency, Hrs	24	24
Backwash Duration, min	5	5
Total Backwash Volume, Gal/BackWash	14,760	7,380
Number of Backwashes Per Day	1	1
Backwash % of Production	1.3%	1.0%

B. Raw water quality:

The expected water quality is shown in Table 2.

Table 2. Expected Water Quality	South Plant	North Plant
Operating Flow (gpm)	400	800
Raw Water Quality		
pH, S.U.	6.4-7.2	7.5
Temperature, ^{o}C	11	11
Total Dissolved Solids, mg/L	552	1090
Total Hardness, mg/L as $CaCO_3$	205	358
Iron, Total, mg/L	0.3	0.4
Manganese, Total, mg/L	0.10	0.15
Calcium, mg/L	73	131
Alkalinity, mg/L as $CaCO_3$	98	89
Silica, mg/L		
Chloride, mg/L	228	495
Treated water Quality Objectives		
Minimum Free Chlorine Residual, mg/L	>0.5	>0.5
Maximum Manganese, mg/L	<0.02	<0.02
Maximum Iron, mg/L	<0.1	<0.1

Finished water quality:

Iron	≤0.15
Manganese	≤0.025

C. It is the responsibility of the system manufacturer to select and size all components of the treatment system. The component sizes shall meet or exceed those given herein.

2.12 SAMPLE COCKS

A. Sampling ports shall be provided so that representative water samples may be secured at the following points: untreated inlet water, treated filter effluent (both combined and for each filter), and backwash waste outlet.

PART 3 EXECUTION

3.1 INSTALLATION AND STARTUP

A. The General Contractor shall provide all field labor and equipment for installation of the filter system on a constructed or existing concrete foundation. The filter manufacturer shall deliver the system to the site and the General Contractor shall unload, assemble, and install the complete filtration system including the filter skids (six – two (2) vessel skids), media, piping, valves, and accessories. Electrical and mechanical connections to the equipment and any instruments or monitoring devices shall be provided by an Electrical Contractor subcontracted by the General Contractor as specified elsewhere.

B. All site piping shall be flushed and disinfected prior to input into the water treatment equipment. The general contractor shall be responsible for disinfection of the media, face piping, and pressure vessels prior to initiating full start-up.

C. The filter manufacturer shall provide the services of a factory trained Field Representative for a period of eight (8) days over a minimum of two (2) trips including two (2) days for delivery and installation inspection, six (6) days for start-up and for operator training. All laboratory analysis during the startup period will be provided by the Owner.

D. All startup and/or disinfection chemicals shall be provided and disposed of by the General Contractor.

PART 4 PAYMENT

4.1 GENERAL

A. Iron and manganese filtration equipment will be pre-purchased by the Owner and installed by the contractor for the construction of the water treatment plant.

4.2 OTHER DOCUMENTS

Iron and Manganese Selection Documents bid proposal and drawings of the proposed system are enclosed and are incorporated into this specification by reference.

END OF SECTION

SECTION 46 20 00 - MISCELLANEOUS CHEMICAL FEED EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

The Contractor shall furnish and install miscellaneous chemical feed equipment as listed below.

This section includes materials, testing, and installation of chemical feed systems for sodium permanganate, phosphoric acid, and sodium hypochlorite. Components include:

A. Skid frame to secure and contain sodium hypochlorite chemical feed system

B. Metering pumps to pump each chemical from the bulk storage tank to the point of application.

C. Interconnecting piping, located within the skid assembly for the sodium hypochlorite system.

D. Isolation and control valves, located within the skid assembly for the sodium hypochlorite system.

E. Pulsation dampeners, calibration columns, backpressure valves, pressure relief valves, and pressure gauges.

F. Electrical power and control wiring and conduit between the above components

G. Bulk Sodium Permanganate tank

H. Bulk Phosphoric Acid tank

I. Below slab secondary containment piping

1.2 SUBMITTALS

A. Submit shop drawings.

B. Submit structural drawings showing the design of the fabricated skid. Show support systems for pumps and piping. Show materials of construction by ASTM reference and grade. Show sizes of members. Show welding, bolting, or other assembly arrangements.

C. Submit installation and arrangement drawings showing dimensions and locations of equipment on the fabricated skid. Show locations of pumps, piping, electrical conduits and equipment, pipe and valve supports, and control panels.

D. Submit electrical wiring drawings showing wiring and conduit, controls, interlocks, terminals, and power disconnects. Show number and sizes of power and control wiring. Label each terminal showing which control or electrical power wire connects to each terminal.

E. Submit operations and maintenance manuals.

F. Submit shop drawings for the individual pieces of equipment per those equipment specifications.

G. Submit data as a single complete package for pumps, piping, structural skid or base design, valves and actuators, motor control center components, control panels, instrument components, power and instrumentation conduits and wiring, and other items.

H. As part of the shop drawing submittal package for the chemical feed systems, submit proposed format for reporting the results of the factory testing. Describe procedure for performing the pressure testing of the skid piping and how results (including correcting defective piping components) will be tabulated or reported. Include the format for reporting the results of factory testing for individual system components and pieces of equipment, as described in the specifications for those components or pieces of equipment.

I. At least 30 days prior to factory testing, provide the Owner with written notification stating the schedule of the factory test so that the Owner can plan in advance to witness the testing.

J. Submit report on results of factory testing. Do not ship systems until the Owner's Representative has reviewed the report.

1.3 MANUFACTURER AND SYSTEM RESPONSIBILITY

A. The Contractor shall assign the design and fabrication of the chemical feed system to a single system manufacturer. Assemble the complete system on a single fabricated skid or base. Assemble and factory test as a complete system, including pumps, piping, valves, controls, and motor starters. The packaged chemical feed system manufacturer shall coordinate the skid components such as pump-to-motor couplings and motor power rating such that the system is completely integrated with compatible components.

B. The packaged chemical system manufacturer shall determine and verify quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and the packaged chemical system manufacturer shall review and coordinate each submittal with the requirements of the contract documents.

1.4 MANUFACTURER’S SERVICES

A. Provide three labor days to check the installation and advise during start-up, testing, and adjustment of the systems.

B. See the individual equipment specification sections for additional labor days for manufacturer's services for the pieces of equipment.

PART 2 MATERIALS

2.1 PUMP MANUFACTURERS

ProMinent Fluid Controls, Inc., Grundfos, or equal, preapproved by the Engineer.

2.2 FABRICATED SKID OR BASE--GENERAL REQUIREMENTS

A. Design skid or base and the associated supports and anchor bolts to support the equipment per CBC, Section 1613 and ASCE 7, Chapter 15:

B. Provide a common drip or drain pan having a minimum depth of 2 inches under all the pumps to collect leakage. Construct pan of 3/8-inch-thick (minimum) HDPE or 3/8-inch thick (minimum) FRP. Resin shall be Ashland Derakane 411 or 470, Reichhold Dion 9800, or Ashland Hetron 922. The pan shall extend under the pumps and tanks so that any leakage is contained within the skid or base. Slope the pan at least 1:20 toward a single side of the skid, where a drain opening of at least 1/2 inch shall be provided to effect drainage. Pipe joints and pipe flange faces, including pump suction and discharge connections, shall be within the drain pan or drain collection area.

C. Provide the skid or base with four lifting lugs, one at each corner, designed to lift the weight of the complete skid or base with all equipment attached to it. Alternatively, provide the base with cutouts, designed to lift the weight of the complete skid or base with equipment attached to it, for forklift tangs or cables.

D. Provide a design such that each pump is individually bolted to a baseplate. A single common baseplate, or individual pump baseplates, may be provided, but each pump shall be individually bolted so that it is removable.

E. Each pump shall be removable by disconnecting only the piping connected to its inlet and outlet connections. It shall not be necessary to disconnect or remove any adjacent piping or electrical conduit or wiring in order to remove or replace any pump.

2.3 FABRICATED THERMOPLASTIC OR FRP SKID OR BASE

A. Skid or base shall be fabricated with FRP. Use a combination of wide flange members, C-channels, hollow structural fiberglass tubing, and plates or sheets to construct the skid or base. Minimum plate, sheet, or member thickness shall be 1/2 inch. Provide reinforcing gussets inside the superstructure, beneath the deck, to provide increased stiffness.

B. Alternatively, fabricate skid and base using thermally welded PVC or high-density polyethylene plastic. Use plates or sheets to construct the skid or base. Minimum plate, sheet, or member thickness shall be 5/8 inch. Provide reinforcing gussets, as needed, beneath the deck to provide increased stiffness. Plates shall be heat welded to form permanent continuous bond. Design and construct skid such that the thermoplastic structural members and sheet material are supported so that the skid does not bend or sag. Thermoplastic welding shall conform to the applicable ASTM standards for the material used. Welds shall have a smooth and uniform finish.

C. Fasteners for skids in chemical service other than sodium hypochlorite shall be stainless steel and shall comply with ASTM A193, Grade B8M or ASTM F593, Type 316. Nuts shall be ASTM A194, Grade 8M or ASTM F594, Type 316. Use ASTM A194 nuts with ASTM A193 bolts; use ASTM F594 nuts with ASTM F593 bolts. Provide washer for each nut and bolt head. Washers shall be of the same material as the nuts.

D. Fasteners for skids in sodium hypochlorite service shall be titanium. Bolts shall be titanium, in accordance with ASTM F468, Grade Ti1, Ti2, or Ti7. Nuts shall conform to ASTM F467, same material as the bolts. Alternatively, use FRP fasteners or FRP encapsulated steel fasteners.

2.4 STORAGE TANKS

A. Tanks shall be translucent HDPE with level indicators. Manufacturer must guarantee compatibility of tank for long term storage of the intended chemical, and tanks must be NSF/ANSI 61 approved for use with drinking water systems.

B. Tanks shall open from the top and this top opening shall remain accessible for refilling chemical tanks. Tanks must be capable of fully closing when not in use.

C. Storage tanks at each treatment plant include:

1. Sodium hypochlorite storage tank – Provided by owner
2. Brine storage tank – Provided by owner
3. 30–55-gallon 40% sodium permanganate storage tank
4. 30–55-gallon 85% phosphoric acid storage tank

D. The 30-55 gallon storage tanks for sodium permanganate and phosphoric acid shall be Stenner STS30N-02 or approved equal. If proposed tank does not include a pump mount connection, Contractor shall propose alternate tank mounting to be pre-approved by the Engineer.

2.5 METERING PUMPS

See Section 46 30 00.

2.6 ISOLATION AND PRESSURE-RELIEF VALVES WITHIN THE SKID OR BASE

Piping Service	Valve Type
Sodium Permanganate Phosphoric Acid Sodium Hypochlorite	Double Union CPVC Ball Valves

A. Provide Double Union CPVC Ball Valves: Isolation valves shall be vented CPVC ball valves, 3 inches and smaller, for chemical service shall be rated at a pressure of 150 psi at a temperature of 105°F and rated at a pressure of 85 psi at a temperature of 140°F. Provide machined vent hole, deburred, in the ball to allow gases to vent. Body, ball, and stem shall be CPVC conforming to ASTM D1784, Type 4, Grade 1. Seats shall be Teflon. O-ring seals shall be Viton. Valve ends shall be of the union design with two-way blocking capability. Ends shall be socket welded except where threaded or flanged-end valves are specifically shown in the drawings. Valves shall have handle for manual operation. Valves shall be Plast-O-Matic “Z-MBV-Vent,” Asahi/America Type 21, or equal.

B. Provide pressure-relief and backpressure valves in discharge piping of metering pumps.

C. Provide an isolation valve on the suction and discharge piping of each pump. Provide an isolation valve for each calibration column. Provide an isolation valve for each drain/flush connection.

2.7 PULSATION DAMPENERS

Provide a pulsation dampener on the discharge piping of the metering pumps. The pulsation dampener shall be of the appendage type having a gas-charged bladder in a pressure vessel. Dampener shall be a pressure vessel per the ASME Pressure Vessel Code, Section VIII. Sizing shall result in no more than ±5% variation in average pressure in the discharge line. Variation shall be checked and confirmed on pressure gauge installed upstream of discharge dampener. Mount a gas charging valve and liquid-filled pressure gauge on each dampener. Pulsation dampeners shall be Greer Bladder Accumulator, Pulsafeeder Pulsatrol, Blacoh, or equal.

2.8 CALIBRATION TUBE

A. Provide a clear calibration tube in the piping between the metering pumps and the suction inlet. Provide isolation valve between the tube and the piping.

B. Calibration cylinder and fittings shall be made of inert clear PVC, shall have a cap, and have calibration marks. Provide at least 10 calibration lines, with a minimum of one line every 100 mL. Provide columns with NPT or PVC union connections at the bottom and also the top for vent pipe connection.

C. Capacities shall allow for a 1-minute test.

2.9 MISC EQUIPMENT

A. Approximately 80 feet of 2” Schedule 80 PVC tubing with threaded fittings to vent chlorine tank outside wall of building, total for both WTPs. Provide casing through wall.

B. Approximately 65 feet of 2” Schedule 80 PVC tubing with long sweep radius bends for under slab chemical containment conduit (see drawings), total for both WTPs.

C. All non-metallic piping, tubing and fittings on sodium hypochlorite system as shown on the drawings.

D. All non-metallic piping, tubing and fittings on permanganate feed system as shown on drawings.

E. All non-metallic piping, tubing and fittings on phosphoric acid feed system as shown on drawings.

F. Injectors can be mounted on double strap saddles with ¾” tap.

G. Cam lock fittings for chlorine fill lines, one per treatment plant.

H. Chemical feed tubing shall be 3/8” OD x ¼” ID tubing for chlorine and permanganate suction and feed lines. Tubing shall be rated for max. of 200 PSI and chemically resistant. Tubing shall be encased in conduit as shown on drawings.

2.10 WIRING AND CONDUIT WITHIN THE SKID OR BASE

A. Power wiring for 120-volt circuits shall be No. 12 AWG with No. 12 AWG ground. Install wiring per the NEC.

B. Color-code control wiring in switching and control assemblies per ICEA Method 1, NEC applications, Option A. Jacket shall be black PVC. Lay out conductors neatly so they may be followed by eye form one terminal to another. Wiring shall be vertical or horizontal. Color-coding shall be such that electrically common interconnections of devices are the same color. The colors may be used more than once but not in the same circuit or cable grouping.

C. Power and control cable shall be copper, insulated for 600 volts, 75°C wet and 90°C dry locations, UL Type THWN or XHHW, and shall comply with UL 83. Insulation jacket shall be nylon. Install bare or green insulated copper conductors in power circuits for grounding connections.

2.11 FACTORY TESTING

A. Each chemical feed system shall be subjected to a non-witnessed factory performance test. Test each package system by using water. Provide a separate water supply test tank and operate the control system by simulating the external control signals. Verify that the control system automatically controls the packaged system in response to the specified external control signals. Verify that metering pumps respond to the external flow-pacing signals.

B. Verify that the various specified alarm signals are generated and transmitted from the system control panel. Simulate metering pump running, flow switch activation, and high and low pressure alarms.

C. Pressure test skid piping (except for overflow and vent piping) to a pressure of 150 psi for duration of 2 hours. There shall be no leakage at any pipe joint or connection to any valve or piece of equipment. Repair or replace any defective pipe joint or connection and retest.

PART 3 EXECUTION

3.1 ASSEMBLING SKID OR BASE

A. Assemble and mount components on the fabricated skid or base at the factory. Provide a 4 inch minimum clearance between pipes and around equipment.

B. Design skid to provide access to the manual stroke control knobs located with the metering pumps.

C. Design skid to provide clearance for and access to the automatic stroke positioners located with the metering pumps.

D. The front of the skid shall be clear of any piping or conduits to allow for maintenance access to the skid components.

3.2 ASSEMBLING SKID PIPING AND ELECTRICAL CONDUIT

A. Provide separate supports for pulsation dampener and calibration tube. Do not mount unsupported devices directly on the piping.

B. Provide fiberglass with Type 316 stainless steel fasteners and hardware for the piping. Provide a support for each pipe at its termination point at the edge of the skid, within 3 inches of any isolation valve.

C. Route electrical conduit around the ends and sides of the skid or base. Do not install conduit overhead. Install wiring on the skid or base in aluminum rigid conduit with a minimum size of 3/4 inch. Install power and control wiring in separate conduits. Terminate conduits at the control panel.

D. Do not run any conduit or piping beneath the drain pan.

3.3 ASSEMBLING AND MOUNTING TANK-MOUNTED PUMPS

A. Pump shall be mounted to the chemical tank with the manufacturer provided mounting plate. Ensure compatibility between tank mounting and the pump mounting plate.

1. If proposed tank does not allow for tank-mounting of pumps, submit relevant pump mounting information and equipment to Engineer for pre-approval. Pump shall be mounted above the respective chemical tank, no higher than 5 feet above floor level. Provide a 4 inch minimum clearance between pipes and around equipment.

B. Mount pump in such a way to provide access to the manual stroke control knobs located with the metering pumps.

C. Mount pump in such a way to provide clearance for and access to the automatic stroke positioners located with the metering pumps.

3.4 ASSEMBLING PIPING AND ELECTRICAL CONDUIT FOR TANK-MOUNTED PUMPS

A. Do not mount unsupported devices directly on the piping.

B. Route electrical wiring around the ends and sides of the pump and tank. Do not install wiring or conduit overhead.

3.5 ISOLATION VALVE LOCATIONS

Provide isolation valves at the following points:

A. Inlet connection to each pump.
B. Outlet connection from each pump.

3.6 PRESSURE-RELIEF VALVE LOCATIONS

Provide pressure-relief valve on the discharge piping of each metering pump. Size valve to match the associated metering pump capacity.

3.7 PIPE TERMINATIONS

Locate connections to skid drain pan, metering pump suction and discharge piping as shown on the plans.

3.8 FIELD TESTING

A. Test each package system by using the actual chemical for the system. The Contractor shall provide sufficient chemical for a test period as specified in the General Conditions (Volume 1). Fill each tank and operate the control system. Verify that the control system automatically controls the packaged system in response to the specified external control signals. Verify that metering pumps respond to the external flow-pacing signal.

B. Verify that the various specified alarm signals are generated and transmitted from the system control panel. Verify metering pump running, tank overflow, tank high and low alarm levels, drain pan liquid level, flow switch activation, and high and low pressure alarms.

END OF SECTION

SECTION 46 30 00 - CHEMICAL FEED PUMPS

PART 1 GENERAL

1.1 SCOPE

At each of the two treatment plants, the Contractor shall furnish and install a chemical feed skid with two chlorine feed pumps with capacities as shown below. The contractor shall also furnish and install a chemical feed pump for sodium permanganate and a chemical feed pump for phosphoric acid with capacities as shown below at each treatment plant. Miscellaneous fittings shall also be provided as listed. The electronic metering pump shall be drive capable of accepting a 4-20mA signal from a pump control unit supplied by the same manufacturer as the pump supplier and shall include accessories as noted below.

1.2 PRESUBMITTALS FOR BIDDING APPROVAL

If products other than the listed acceptable product are to qualify for bidding, the following prebid submittals are required.

A. Exceptions to these specifications along with justification for each exception.

B. Manufacturer and type designation.

C. Catalog and/or specification data confirming conformance to specified design, material, and equipment requirements.

D. Installation requirements.

E. Operation and maintenance information per the General Conditions (Volume 1).

1.3 SUBMITTALS FOR CONSTRUCTION

A. Submit shop drawings in accordance with the General Conditions (Volume 1).

B. Submit dimensional drawings.

C. Submit manufacturer's catalog data and detail drawings showing metering pump parts and describe by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show stroke speed at the specified flow. Show linings and coatings. Identify each metering pump by tag number to which the catalog data and detail sheets pertain.

D. Submit proof of NSF 61 certification for the metering pumps when pumping the chemical listed in the Service Conditions.

1.4 MANUFACTURER'S SERVICES

A. Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

B. Three labor days to check the installation and advise during start-up, testing, and adjustment of the equipment.

PART 2 MATERIALS

2.1 MANUFACTURERS

The electronic-actuated diaphragm metering pump shall be the Grundfos DDA, ProMinent Delta, or equal, preapproved by the Engineer.

2.2 PUMP DESIGN AND CONSTRUCTION

A. The diaphragm-metering pump shall be an electronic pulsing or solenoid driven, positive displacement, disc or tubular diaphragm pump. Pump materials of construction are designated in the subsection on "Service Conditions."

B. Provide the pump with a dial knob for manual stroke length adjustment. The stroke adjustment system shall allow 0% to 100% of full stroke length while the pump is operating.

C. Provide the pump with a separate dial knob for stroke frequency adjustment (10% to 100% of the maximum strokes per minute).

D. The metering pump drive shall be totally enclosed with no exposed moving parts. The solid-state electronic pulser shall be fully encapsulated with no exposed printed circuit etch and be supplied with quick connect terminals at least 3/16 inch (4.75 mm) wide. Electronics shall be housed in a chemical-resistant enclosure at the rear of the pump for maximum protection against chemical spillage.

E. Pressure-relief bypass shall automatically release chemical to pump suction when discharge pressure exceeds the value specified in the subsection on “Service Conditions.” Alternatively, provide a design in which the pump ceases its stroking action when the backpressure exceeds the strength of the magnetic force developed by the power coil.

F. The pump housing shall be of chemical-resistant glass-fiber reinforced thermoplastic.

G. Metering pump valves shall be ball type, with balls seating on combination valve seat and seal ring. Valve seat and seal rings shall be renewable by replacing only the combination seat-seal ring.

2.3 POWER SUPPLY

Power supply shall be 120 volts, single phase, 60 hertz.

2.4 SUCTION AND DISCONNECTIONS

The suction and discharge connections shall accept polyethylene tubing via compression connections.

2.5 EXTERNAL INTERFACE SIGNALS

A. Provide interface to accept a remote start/stop signal to the metering pump in the remote mode.

B. Provide a remote status indication of “pump running” with an isolated contact closure, rated for 5 amperes at 120-volt ac.

C. Provide a remote status indication of local/remote switch position with an isolated contact closure, rated for 5 amperes at 120-volt ac.

D. Provide a percent of speed with 4- to 20-mA d-c output corresponding to 0% to 100% speed for remote indication of metering pump pump.

E. Provide a 4- to 20-mA input signal for stroke speed control.

2.6 LIQUIDS PUMPED

Liquids pumped are described below. See the subsection on “Service Conditions” to determine which pumps handle the particular liquids described.

A. Sodium Hypochlorite (0.8% solution)

Specific gravity	1.0 to 1.2
Viscosity	1 centipoise
Temperature	45°F to 120°F

B. Sodium Permanganate (40%)

Specific gravity	1.39
pH	5-8
Viscosity	1 to 60 centipoise
Temperature	45°F to 120°F

C. Phosphoric Acid (86%)

Specific gravity	1.68
pH	Highly Acidic

Viscosity	2 to 10 centipoise
Temperature	45°F to 120°F

2.7 SPARE PARTS

A. 1 spare pump of the same make/model as the Sodium Permanganate and Phosphoric Acid pumps.

B. Provide the following spare parts for each pump:

Quantity	Item
1	Diaphragm
2	Ball check valve assemblies
1	Seat and seal ring assembly

C. Pack spare parts in a wooden box; label with the job location, pump type and model, manufacturer's name and local representative's name, address, and telephone number and attach list of materials contained within.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Provide the manufacturer's recommended lubricants for each piece of equipment.

3.2 SERVICE CONDITIONS

A. Pump hydraulic performance conditions and design data shall be as shown below.

B. Sodium Hypochlorite Pump Tag Numbers: WTR22MP_01, WTR22MP_02, WTR12MP_01, WTR12MP_02

Location	Hypochlorite Storage Area (North)	Hypochlorite Storage Area (South)
Liquid pumped	Sodium Hypochlorite	Sodium Hypochlorite
Capacity range	9- 18 gph	2 – 9 gph
Maximum design discharge pressure	150 psig	150 psig
Pressure-relief valve setting	165 psig	165 psig
Maximum required suction lift	0 feet	0 feet
Remote run/stop signal required?	Yes	Yes
Remote status indication of pump running required?	Yes	Yes
Remote status indication of local/remote operation required?	Yes	Yes
4- to 20-mA output signal for remote indication of pump speed required?	Yes	Yes

Location	Hypochlorite Storage Area (North)	Hypochlorite Storage Area (South)
4- to 20-mA input signal for remote control of pump speed required?	Yes	Yes
Toggle switch for selecting internal manual stroke frequency/external remote signal?	Yes	Yes
Pump ball check valve construction	Ceramic	Ceramic
Seat and seal ring construction	PTFE	PTFE
Pump head construction	PVDF	PVDF
Fittings and connections at pump head	PVDF	PVDF
Diaphragm construction	PTFE	PTFE
Manufacturer and model	Grundfos DDA 120-7	Grundfos DDA 60-10
Number of Pumps	2	2

C. Sodium Permanganate Pump Tag Numbers: WTR22MP_03, WTR12MP_03

Location	Sodium Permanganate storage area (North)	Sodium Permanganate storage area (South)
Liquid pumped	Sodium Permanganate	Sodium Permanganate
Capacity range	0.1 – 0.6 gph	0.1 – 0.6 gph
Maximum design discharge pressure	150 psig	150 psig
Pressure-relief valve setting	165 psig	165 psig
Maximum required suction lift	0 feet	0 feet
Remote run/stop signal required?	Yes	Yes
Remote status indication of pump running required?	Yes	Yes
Remote status indication of local/remote operation required?	Yes	Yes
4- to 20-mA output signal for remote indication of pump speed required?	Yes	Yes
4- to 20-mA input signal for remote control of pump speed required?	Yes	Yes
Toggle switch for selecting internal manual stroke frequency/external remote signal?	Yes	Yes
Pump ball check valve construction	Ceramic	Ceramic
Seat and seal ring construction	PTFE	PTFE
Pump head construction	PVDF	PVDF
Fittings and connections at pump head	PVDF	PVDF
Diaphragm construction	PTFE	PTFE
Manufacturer and model	Grundfos DDA 7.5-16	Grundfos DDA 7.5-16
Number of Pumps	1	1

D. Sodium Permanganate Pump Tag Numbers: WTR22MP_04, WTR12MP_04

Location	**Phosphoric Acid storage area (North)**	**Phosphoric Acid storage area (South)**
Liquid pumped	Phosphoric Acid	Phosphoric Acid
Capacity range	0.1 – 0.6 gph	0.1 – 0.6 gph
Maximum design discharge pressure	150 psig	150 psig
Pressure-relief valve setting	165 psig	165 psig
Maximum required suction lift	0 feet	0 feet
Remote run/stop signal required?	Yes	Yes
Remote status indication of pump running required?	Yes	Yes
Remote status indication of local/remote operation required?	Yes	Yes
4- to 20-mA output signal for remote indication of pump speed required?	Yes	Yes
4- to 20-mA input signal for remote control of pump speed required?	Yes	Yes
Toggle switch for selecting internal manual stroke frequency/external remote signal?	Yes	Yes
Pump ball check valve construction	Ceramic	Ceramic
Seat and seal ring construction	PTFE	PTFE
Pump head construction	PVDF	PVDF
Fittings and connections at pump head	PVDF	PVDF
Diaphragm construction	PTFE	PTFE
Manufacturer and model	Grundfos DDE 7.5-16	Grundfos DDE 7.5-16
Number of Pumps	1	1

3.3 FIELD TESTING

Operate each pump, using the fluid they are to normally pump, for eight consecutive hours during which time no repairs shall be required. Assure that manual stroke length and frequency adjustments on the pumps perform over the specified adjustment range. Assure that diaphragms do not leak or tear. Repair or replace any leaking diaphragms. Assure that backpressure and pressure-relief valves have been provided and set as specified. Repair or replace any valves not set or operating as specified.

END OF SECTION