

CONTRACT DOCUMENTS FOR

**JORDAN VALLEY WATER TREATMENT PLANT
FINISHED WATER RESERVOIR PROJECT**

PROJECT NO.: 3963

November 2015

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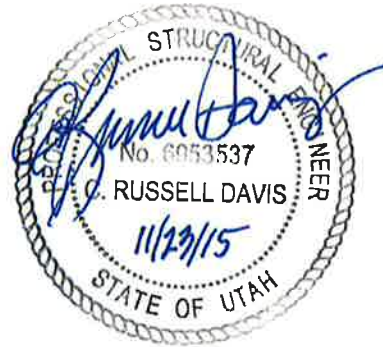
SEAL SHEET



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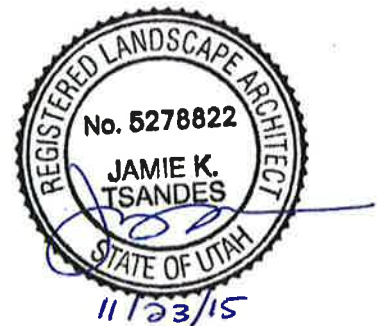
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[ELECTRICAL/INSTR. AND CONTROLS]



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Appendix B – Geotechnical and Geologic Investigations

DIVISION 09
FINISHES

**SECTION 09 90 00
COATINGS AND PAINTINGS**

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section covers surface preparation, furnishing, and application of architectural paint and special protective coatings, complete.
- B. Shop or existing surface preparation methods, cleanliness, and existing paint, rust, and mill scale removal is not known nor documented. Contractor shall be solely responsible for determining work effort, abrasive blast requirements, and any other factors that may affect work productivity as required for providing the specified surface preparation cleanliness; regardless of prior system preparation or coating application.

1.2 ABBREVIATIONS

ANSI	American National Standards Institute
AWWA	American Water Works Association
FRP	Fiberglass Reinforced Plastic
HCl	Hydrochloric Acid
MDFT	Minimum Dry Film Thickness
MDFTPC	Minimum Dry Film Thickness Per Coat
Mil	Thousandths of an Inch
MIL-P	Military Specification - Paint
OSHA	Occupational Safety and Health Act
PSDS	Paint System Data Sheet
SFPG	Square Feet Per Gallon
SFPGPC	Square Feet Per Gallon Per Coat
SP	Surface Preparation
SSPC	Steel Structures Painting Council

1.3 CONTRACTOR SUBMITTALS

- A. Product Data: Furnish the following Data Sheets:

1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers. A sample PSDS form is appended at the end of this section.
 2. The required information shall be submitted on a system-by-system basis.
 3. The Contractor shall also provide copies of the paint system submittals to the coating applicator.
 4. Indiscriminate submittal of manufacturer's literature only is not acceptable.
- B. Where ANSI/NSF Standard 60 and 61 approval is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits on size of tank or piping, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.
- C. Provide TCLP test data for lead and other regulated heavy metals in non-recyclable, slag type abrasive blast media to be used on the project. Acceptable abrasive test data shall indicate the abrasive manufacturer, location of manufacture, and media gradation and type. Surface preparation will not be permitted to begin until acceptable test data has been submitted.
- D. Quality Control Submittals: Furnish the following:
1. Applicator's Experience: List of references substantiating the requirements as specified.
 2. Factory Applied Coatings: Manufacturer's certification stating factory applied coating systems meets or exceeds requirements specified herein.
 3. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturer's written confirmation that materials are compatible.

1.4 QUALITY ASSURANCE

- A. The paint manufacturer shall provide a representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract.
- B. Applicator's Experience: Minimum of 5 years' practical experience in application of specified products.
- C. Continuity of Contractor: Contractor's site supervisor shall be coordinated with the Engineer. Any replacement of the supervisor on site will require notification of Engineer 72 hours in advance, and will be subject to approval by the Owner.
- D. Inspection:
1. Inspect and provide substrate surfaces prepared in accordance with these specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied.
 2. Provide Engineer minimum 3 days' advance notice prior to start of surface preparation work or coating application work.
 3. Perform work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence. Approval to perform work in the

Engineer's absence is limited to the current day unless specifically noted to extend beyond the completion of the workday.

4. Inspection by the Engineer, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve the Contractor of responsibility to perform the work in accordance with these specifications.

1.5 PAINT DELIVERY, STORAGE, AND HANDLING

- A. Delivered paint to the project site in unopened containers that plainly show, at the time of use, the designated name, date of manufacture, color, and name of manufacturer.
- B. Stored paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the paint manufacturer.
- C. Shipping:
 1. Where precoated items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
 2. Use nonmetallic or padded slings and straps in handling.
 3. Items will be rejected for excessive damage.

1.6 WARRANTY

- A. Warranty: The Contractor and coating manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of 2 years commencing on the date of final acceptance of the work.

PART 2 - PRODUCTS

2.1 PAINT AND COATINGS MANUFACTURERS

- A. A manufacturer letter code as follows will be found following the generic descriptions of materials outlined in the Specifications. Address is that of the general offices. Contact these offices for information regarding the location of representative nearest the project site.
- B. Manufacturer Code A - Coatings Manufacturers (Able to supply most heavy-duty industrial coatings and architectural paints):
 1. Carboline Coatings Company, St. Louis, MO.
 2. ICI Devoe Coatings Company, Louisville, KY.
 3. International Coatings, Louisville, KY
 4. Pittsburgh Paints (PPG), Pittsburgh, PA
 5. Sherwin Williams, Cleveland, OH
 6. Tnemec Coatings, Kansas City, MO
- C. Manufacturer Code E - Fusion Bonded Coating Applicators:
 1. 3M Co., St Paul, MN.

2.2 PAINT MATERIALS

- A. Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds. Specific information may be secured through the local office of the Air Pollution Control Officer.
- B. Materials Including Primer and Finish Coats: Produced by same paint manufacturer.
- C. Thinners, Cleaners, Driers, and Other Additives: As recommended by paint manufacturer of the particular coating. Where coatings are required to meet ANSI/NSF Standard 60 and 61, addition of thinners, driers, and other paint additives not approved under the ANSI/NSF certification letter will not be permitted without written approval from the Engineer.
- D. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - 1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
 - 2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 100 g/L.
 - 3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 - 4. Flat Topcoat Paints: VOC content of not more than 50 g/L.
 - 5. Nonflat/High-Gloss Topcoat Paints: VOC content of not more than 150 g/L.
 - 6. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 - 7. Floor Coatings: VOC not more than 100 g/L.
 - 8. Shellacs, Clear: VOC not more than 730 g/L.
 - 9. Shellacs, Pigmented: VOC not more than 550 g/L.
 - 10. Primers, Sealers, and Undercoaters: VOC content of not more than 100 g/L.
 - 11. Dry-Fog Coatings: VOC content of not more than 150 g/L.
 - 12. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
 - 13. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
- E. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - 1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 - 2. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein.
 - b. Acrylonitrile.
 - c. Antimony.
 - d. Benzene.
 - e. Butyl benzyl phthalate.
 - f. Cadmium.
 - g. Di (2-ethylhexyl) phthalate.
 - h. Di-n-butyl phthalate.
 - i. Di-n-octyl phthalate.

- j. 1,2-dichlorobenzene.
- k. Diethyl phthalate.
- l. Dimethyl phthalate.
- m. Ethylbenzene.
- n. Formaldehyde.
- o. Hexavalent chromium.
- p. Isophorone.
- q. Lead.
- r. Mercury.
- s. Methyl ethyl ketone.
- t. Methyl isobutyl ketone.
- u. Methylene chloride.
- v. Naphthalene.
- w. Toluene (methylbenzene).
- x. 1,1,1-trichloroethane.
- y. Vinyl chloride.

F. Paint products are listed according to their approximate order of appearance in the paint systems. The letter designating the manufacturer code refers to Article PAINT AND COATING MANUFACTURERS.

Product	Definition
Potable Grade, Polyamide Epoxy Coatings	Amine or polyamine epoxy coating, approved for potable water contact in conformance to ANSI/NSF Standard 60 and 61, suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Polyamide, Epoxy	Polyamine or polyamide epoxy, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFT per coat. MANUFACTURER CODE: A
Polysiloxane	Acrylic polysiloxane hybrid coating, single component, suitable for shop or field application at 32 degrees F, minimum, recoat window of not less than 12 months with preference for products with unlimited overcoat capability, solids content of 85% minimum, high gloss, and tintable colors. Tinted colors shall be capable of storage for 30 days or longer prior to application. Coating shall be capable of spray, roller, or brush application on all metal substrates and specified prime and intermediate coats. MANUFACTURER CODE: A
Polyamide, Anti-Corrosive, Epoxy Primer	Polyamide or Polyamine epoxy primer, two parts, containing rust-inhibitive pigments MANUFACTURER CODE: A
Organic Zinc Rich Primer	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 lbs.; metallic zinc content per gallon MANUFACTURER CODE: A
Inorganic Zinc Primer	Solvent or water based, 14 lbs. metallic zinc content per gallon minimum; unlimited recoat window, follow manufacturer's recommendation for top coating. MANUFACTURER CODE: A
Rust-Inhibitive Primer	Single-package steel primers with anti-corrosive pigment loading; may be alkyd, vinyl, epoxy ester, chlorinated rubber.

Product	Definition
	MANUFACTURER CODE: A-B
Alkyd Enamel	Optimum quality, gloss finish, medium long oil. MANUFACTURER CODE: A-B
Wash Primer	Vinyl butyral acid or equivalent coating for enhancing finish coat adhesion to galvanized steel surfaces. MANUFACTURER CODE: A
Aliphatic Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish, suitable for continuous dry service at 200 degrees F without discoloration or peeling. MANUFACTURER CODE: A
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy or polyurethane resin, suitable for this intended service.

2.3 COLORS

- A. Provide as selected by the Owner.
- B. Formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gas likely to be present at the project.
- C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matches.
- D. Equipment Colors:
 1. Equipment shall be meant to include the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
 2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as itemized below:
 - a. Dangerous parts of equipment and machinery: OSHA Orange
 - b. Fire protection equipment and Apparatus: OSHA Red
 - c. Radiation hazards: OSHA Purple
 - d. Physical hazards in normal operating area: OSHA Yellow
 3. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.
- E. Pipe Identification Painting:
 1. Color code non-submerged metal piping except electrical conduit, in accordance with Section 40 05 06 – Piping Identification Systems. Paint fittings and valves the same color as the pipe.
 2. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 9 feet on center, with identification labels applied to each exposed run of pipe as specified herein.
 3. Pipe supports: Galvanized steel does not require painting. Mild steel, painted No. 70 light gray as specified in ANSI Z35.1, as manufactured by:
 - a. Tnemec Co., No. 2050
 - b. Or equal.

4. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe located outside of buildings and enclosed structures will not require painting, except as noted.

F. Labels for Piping: Provide pipe labels in accordance with Section 40 0506 – Piping Identification Systems.

2.4 QA/QC TESTING AND INSPECTION

A. General

1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance.
3. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.
4. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this specification.

B. Surface Profile Testing

1. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP287.
2. Tester tape shall be suitable for the intended profile height.
3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.

C. Adhesion testing: As specified in Section 09 97 01, where directed by the Engineer for assessing coating application problems.

D. Holiday Testing

1. Holiday tests on polyurethane coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE SP 0188 and these specifications.
2. Coating thickness used for high voltage holiday testing setting shall be the average dry coating thickness.

E. Dry Film Thickness Testing

1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off, eddy current, or ultrasonic equipment.
2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

PART 3 - EXECUTION

3.1 GENERAL

- A. The intention of these specification is for all new, interior and exterior, wood, masonry, concrete, and metal, whether atmospheric or submerged exposure surfaces be painted, whether specifically mentioned or not, except as modified herein. Concealed structural steel surfaces shall receive prime coat only unless modified herein.
- B. Surface preparation and coating application shall be in conformance with these specifications and the coating manufacturer's written product data sheets and written recommendations of the manufacturer's technical representative. Where conflicts occur between the manufacturer's recommendations and these specifications, the more stringent of the two shall apply unless approved by the Engineer.
- C. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.

3.2 REGULATORY REQUIREMENTS

- A. Meet federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.
- B. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application and dust prevention including, but not limited to the following Acts, Regulations, Standards, and Guidelines:
 - 1. Clean Air Act
 - 2. National Ambient Air Quality Standard
 - 3. Resource Conservation and Recovery Act (RCRA)
- C. Comply with applicable federal, state, and local regulations for confined space entry.
- D. Provide and operate equipment that meets explosion proof requirements.

3.3 ENVIRONMENTAL CONDITIONS

- A. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.
- B. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere around electrical or mechanical equipment unless otherwise permitted by the Engineer.
- C. Do not apply paint when:
 - 1. Surface temperatures exceeds the maximum or minimum temperature recommended by the paint manufacturer,
 - 2. In dust, smoke-laden atmosphere, damp or humid weather, or under conditions which could cause icing on the metal surface.

3. When it is expected that surface temperatures will drop below 5 degrees above dew point within 8 hours after application of coating.

3.4 DEHUMIDIFICATION

- A. Where environmental conditions cannot be met or controlled, CONTRACTOR shall provide and operate desiccant dehumidification equipment to maintain environmental conditions for 24 hours a day during abrasive blasting and coating application and cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.
- B. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and painted. System shall provide ventilation within the environmentally controlled areas and shall meet the following requirements:
 1. Two air exchanges per hour, minimum
 2. Maintenance of personnel exposure limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
 3. Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.
- C. Dehumidification equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather conditions for the project schedule. Design to include evaluation of existing conditions, humidity, and temperature within the environmentally controlled area, proper air exchange requirements, ventilation requirements, ducting requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.
- D. Submit written recommendations from dehumidification subcontractor for bulkhead locations, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein.
- E. Dehumidification equipment subcontractor shall either operate the equipment or provide training to Contractor on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8 hour days to insure proper operation of the equipment, achievement of desired environmental control, and to insure Contractor can properly setup, operate, monitor, and maintain the equipment.
- F. Dehumidification shall be operated in a manner that prevents all condensation or icing throughout surface preparation and coating application and cure.
- G. Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the Engineer.

- H. Contractor shall monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature both outdoors and within the environmentally controlled area at the start, midpoint, and end of each work shift, minimum, but not more than 5 hours between measurements.
- I. Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.

3.5 VENTILATION AND ILLUMINATION

- A. Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.
- B. Ventilation shall be used to control potential dust and hazardous conditions within the tank. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to non-hazardous conditions.

3.6 SURFACES NOT REQUIRING PAINTING

- A. Unless otherwise stated herein or shown, the following areas or items will not require painting:
 - 1. Concrete and masonry surfaces
 - 2. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
 - a. Required for electrical insulation between dissimilar metals.
 - b. Aluminum is embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
 - c. Color coding of equipment and piping is required.
 - 3. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for architectural painting or color coding.
 - 4. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches, acoustical tile, cabinets, elevators, building louvers, wall panels, etc.; color coding of equipment is required.
 - 5. Non-submerged electrical conduits attached to unpainted concrete surfaces.
 - 6. Heating and ventilation ducting, unless otherwise specified.
 - 7. Cathodic protection anodes.
 - 8. Items specified to be galvanized after fabrication unless specifically required elsewhere or subject to immersion.
 - 9. Insulated piping and/or insulated piping with aluminum or stainless steel jacket will not require exterior coating, except as required for architectural painting or color coding.

3.7 PREPARATION OF SURFACES

- A. Surface Preparation Inspection:

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied.
2. Provide Engineer minimum 3 days' advance notice prior to start of surface preparation work or coating application work.
3. Perform such work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

B. Metal Surface Preparation:

1. General:
 - a. Do not perform a surface preparation blast prior to submission of samples. Workmanship for metal surface preparation as specified shall meet current Steel Structures Painting Council (SSPC) Specifications as follows:
 - 1) Solvent Cleaning: SP 1
 - 2) Hand Tool Cleaning: SP 2
 - 3) Power Tool Cleaning: SP 3
 - 4) White Metal Blast Cleaning: SP 5
 - 5) Commercial Blast Cleaning: SP 6
 - 6) Brush-Off Blast Cleaning: SP 7
 - 7) Pickling: SP 8
 - 8) Near-White Blast Cleaning: SP 10
 - 9) Bare Metal Power Tool Cleaning: SP 11
 - b. All surface preparation shall be assumed to be on a SSPC Grade A steel surface condition, unless specifically noted otherwise.
 - c. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.
 - d. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
 - e. Hand tool clean areas that cannot be cleaned by power tool cleaning.
2. Welds and adjacent areas:
 - a. Prepared such that there is:
 - 1) No undercutting or reverse ridges on the weld bead.
 - 2) No weld spatter on or adjacent to the weld or any other area to be painted.
 - 3) No sharp peaks or ridges along the weld bead.
 - b. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
3. Preblast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent cleaned with suitable solvents and clean cloths.
 - d. Round or chamfered all sharp edges and grind smooth burrs, jagged edges, and surface defects.

4. Blast Cleaning Requirements:
 - a. General:
 - 1) Type of Equipment and Speed of Travel: Designed to obtain specified degree of cleanliness.
 - 2) Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
 - 3) Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.
 - 4) Do not reuse abrasive, unless abrasive is a recyclable abrasive.
 - b. Shop Blasting
 - 1) Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the work during surface preparation and shop application of paints. Work shall be subject to the Engineer's approval before shipment to the jobsite.
 - 2) Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning. Blast clean and prime in accordance with these Specifications.
 - c. Field Blasting
 - 1) Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures, shall meet requirements of Steel Structures Painting Council.
 - 2) Field blasting in areas with electrical or mechanical equipment, within buildings shall be performed with dustless abrasive systems such as "Sponge-Jet", dry ice abrasive blasting.
5. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.
 - b. Paint surfaces the same day they are sandblasted. Reblast surfaces that have started to rust before they are painted to original cleanliness prior to occurrence of flash rusting.

C. Masonry Surface Preparation:

1. Complete and cure for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Cleaned masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
 - a. Brush-off blasting.
 - b. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.

6. Masonry Surfaces to be coated: Uniform texture and free of surface imperfections which would impair the intended finished appearance.
7. Uncoated or Clear Coated Masonry surfaces: Free of discolorations and be uniform in texture after cleaning.

D. Concrete Surface Preparation:

1. Do not begin until 30 days after the concrete has been placed.
2. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.
3. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC SP-13, Surface preparation of Concrete.
4. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.
5. Bug holes, air pockets, and other voids in the concrete will be filled or patched in chemical exposure areas, secondary containment, and where specifically required.
6. Concrete Surface Preparation Inspection:
 - a. Adhesion Testing:
 - 1) Tensile testing of the surface preparation shall be performed by the Engineer as necessary using Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D4541 using 2-inch diameter dollies for concrete surface adhesion testing.
 - 2) Concrete surface or applied coating shall be scored for concrete adhesion testing on high cohesive strength or elastomeric coatings or coatings greater than 35 mils in thickness.
 - 3) Adhesive failure greater than 50 percent of the dolly surface area shall indicate inadequate surface preparation.
 - 4) Cohesive failures which results in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.
 - 5) Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.
 - b. Concrete Soundness:
 - 1) Concrete soundness shall be determined using the scratching or hammer impact methods as defined in SSPC SP-13.
 - c. Moisture Content:
 - 1) Moisture shall be tested as Specified in SSPC SP-13 and shall not exceed the moisture content recommended by the coating manufacturer.

E. Plastic Surface Preparation:

1. Hand sand plastic surfaces to be coated with a medium grit sandpaper to provide tooth for the coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so the surface is roughened without removing excess material.

F. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet SSPC-SP 7, Brush-off Blast Cleaning and shall achieve a profile on the coating equivalent to 80 grit sandpaper with no exposed metal.
2. Where metal substrate is exposed, Contractor shall apply full coating system as specified for new metal surfaces.
3. Repair or replace surfaces damaged by blast cleaning, where damage is defined as visible metal substrate. If less than 5 percent of prepared surface has the metal substrate visible, the coating shall be repaired by application of a brush applied intermediate coat. If greater than 5 percent the coating shall be fully removed to meet the specified surface cleanliness and recoated with the specified coating system.
4. Abrasive: Either conventional abrasive blasting with sand, grit, or nut shells or specialized abrasive blasting. Abrasives shall be 60 mesh grit, maximum.
5. Select various surface preparation parameters such as size and hardness of the abrasive, nozzle size, air pressure, and nozzle distance from the surface such that the surface is cleaned without pitting, chipping, or other damage.
6. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
7. The Engineer shall approve trial blast cleaned area and shall used area as a representative sample of surface preparation.

G. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by the use of solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action.
2. Method meets SSPC-SP 1.

3.8 PROTECTION OF MATERIALS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.9 PAINT MIXING

A. Multiple-component coatings:

1. Prepare using all of the contents of the container for each component as packaged by the paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed shall not be used beyond their pot life.
4. Provide small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by the paint manufacturer.

6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
 7. Fast set or plural component products shall be applied using an appropriate multipart pump that properly mixes both components at the recommended ratio using equipment recommended by the coating manufacturer. Hot mixing of fast set or plural component products will not be permitted.
- B. Keep paint materials sealed when not in use and provide nitrogen blanket on fast set, plural, or moisture cured coatings on opened product containers when stored or not in use more than 8 hours.
- C. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

3.10 APPLICATION OF PAINT

- A. General:
1. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to the succeeding coat.
 2. Apply coatings in accordance with the paint manufacturer's recommendations. Allow sufficient time between coats to assure thorough drying of previously applied paint.
 3. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
 4. Paint units to be bolted together and to structures prior to assembly or installation.
 5. Shop Primed or Factory Finished Surfaces:
 - a. Inspection: Schedule with Engineer in advance for shop primed or factory-finished items delivered to jobsite for compliance with these Specifications.
 - b. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
 - c. For two-package or converted coatings, consult the coatings manufacturer for specific procedures as relates to top coating of these products. Where scarification of the existing coating is required, Contractor shall prepare the surface in accordance with Brush-off Blasting Cleaning this section.
 - d. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply a mist coat of specified primer, 1.0 mil dry film thickness.
 - e. After welding, prepare and prime holdback areas as required for the specified paint system. Apply primer in accordance with manufacturer's instructions.
 6. Manufacturer Applied Paint Systems:
 - a. Repair abraded areas on factory-finished items in accordance with the equipment manufacturer's directions.
 - b. Carefully blend repaired areas into the original finish.
- B. Application Safety
1. Performed painting in accordance with recommendations of the following:
 - a. Paint manufacturer's instructions.
 - b. NACE contained in the publication, Manual for Painter Safety.
 - c. Federal, state, and local agencies having jurisdiction.
 2. Contractor will be solely and completely responsible for condition of the project site, including safety of all persons (including employees) and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. Safety provisions will conform to U.S. Department

- of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal, state, county, and local laws, ordinances, and codes.
3. Contractor will comply with all safety-training requirements promulgated or required for this project.
- C. Film Thickness:
1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC.
 2. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer's recommended minimum thickness, whichever is greater. Where the manufacturer has not specified a minimum coating thickness on the product data sheets, the minimum recommended coating application thickness shall apply.
 3. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.
- D. Stripe Coats:
1. Surfaces that are subject to immersion, condensing environments, or where specified shall be stripe coated on all angles, edges, corners, threads, welds, and similar type surfaces.
 2. Stripe coat shall be an extra coat of the intermediate or topcoat material and shall be applied between the prime and intermediate coats.
 3. The stripe coat shall be a separate coat of paint from coats specified under the coating system.
 4. Stripe coats shall be alternated in color similar to a full coat.
- E. Number of coats:
1. Apply specified number of coats, minimum, irrespective of the coating thickness.
 2. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
- F. Porous Surfaces, Such as Concrete, Masonry:
1. Prime Coat:
 - a. May be thinned to provide maximum penetration and adhesion.
 - b. Type and Amount of Thinning: Determined by the paint manufacturer and is dependent on surface density and type of coating.
 - c. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of the coating.
- G. Existing Coated Surfaces:
1. General:
 - a. Shop primed or coated surfaces shall be reviewed with the Engineer to determine the extent of coating damage and suitability of the finish coats to adhere to the shop applied coats.
 - b. If a cured epoxy, polyurethane, or plural-component material is to be top coated, contact the coating manufacturer concerned for additional surface preparation requirements. At a minimum, existing coated surfaces shall be

- sanded to remove all gloss and roughen the existing surface for adhesion of subsequent coats.
- c. Profile on plural component or two component coatings shall be as specified for by the manufacturer or equivalent of 80 grit sandpaper; whichever is more stringent.
- d. Surface preparation recommendations of the manufacturer shall be subject to approval of the Engineer.
- e. All existing coated surfaces, where demolition of equipment was specified or required, shall be surface prepared, touch-up coating repairs completed, and a cosmetic overcoat applied using the specified coating system on all existing coated surfaces associated with the demolition work, unless otherwise specified.
- f. Existing coatings on immersed equipment shall be removed to bare metal and recoated with the specified coating system where demolition work was specified.
- g. Apply sealer/primer where recommended by coating manufacturer for coating compatibility.
- 2. To be Recoated or Final Coated:
 - a. Detergent wash and freshwater rinse.
 - b. Perform touch-up repairs of existing coating.
 - c. Asphaltic varnish coated ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.
- 3. Touch-up Repairs:
 - a. Clean loose, abraded, or damaged coatings to substrate by Power Tool (SP 3).
 - b. Feather surrounding intact coating.
 - c. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
 - d. Apply one full finish coat of the specified primer or finish coat(s) overall.
- 4. Application of a Cosmetic Coat:
 - a. The exact nature of shop-applied coatings is not known in all cases.
 - b. Check compatibility by application to a small area prior to starting the coating.
 - c. If lifting or other problems occur, request disposition from the Engineer.
 - d. Cured epoxy, polyurethane, plural component materials or any other coating system that has exceeded its maximum recoat window shall be prepared as specified this section.
- H. Damaged Coatings, Pinholes, and Holidays:
 - 1. Feather edges and repaired in accordance with the recommendations of the paint manufacturer.
 - 2. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by the coating manufacturer.
 - 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.
- I. Unsatisfactory Application:
 - 1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.

2. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.
3. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
4. Repair defects in coating system per written recommendations of coating manufacturer and as approved by the Engineer.
5. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

3.11 COATING INSPECTION

A. General

1. Film thickness measurements and electrical inspection of the coated surfaces:
2. Perform with properly calibrated instruments.
3. Recoat and repair as necessary for compliance with the Specifications.
4. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.
5. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
6. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper mileage in these areas.

B. Coating Thickness Testing:

1. Engineer shall conducted coating thickness testing as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.
2. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge as specified.
3. Check each coat for the correct mileage. Do not make measurement before a minimum of 8 hours after application of the coating.
4. Tests for concrete coating thickness shall be with a Tooke Gauge, which is a destructive test. Contractor shall repair coating after thickness testing.

C. Coating Continuity Testing

1. Holiday detect coatings with high voltage units in accordance with NACE RP0188. High voltage detector shall have adjustable voltages in 100 volt increments and shall be operated in accordance with the manufacturer's instructions and the specified standard.
2. Use of an electrical holiday detector, low voltage, wet sponge type holiday detector will be permitted for coating systems less than 20 mils total dry film thickness and are not for immersion or condensing environments.
3. Holiday detect coatings on pipe for buried application with high voltage spark tester in accordance with NACE RP0274.

3.12 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroyed at the end of each day.

- B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroyed in a legal manner.
- C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.
- D. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.13 MANUFACTURER' SERVICES

- A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

3.14 PROTECTIVE COATING SYSTEMS AND APPLICATION SCHEDULE:

- A. Unless otherwise shown or specified in these Specifications painted or coated the work in accordance with the following application schedule.
- B. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the work in question.

System No.	Title
1	Submerged Metal – Potable Water
2	Concrete Encased Metal
4	Exposed Metal - Highly Corrosive
5A	Exposed Metal - Mildly Corrosive
5B	Exposed Metal – Mildly Corrosive, Existing
8	Buried Metal - General
10	Galvanized Metal Conditioning
11	Galvanized Metal Repair
21	Epoxy Floor, Concrete
27	Aluminum And Dissimilar Metal Insulation
29	Fusion Bonded Coating

- C. System No. 1 Submerged Metal – Potable Water:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
	Potable Grade, Polyamide Epoxy Coating	3 coats, 3 MDFTPC

2. Application:

- a. All metal surfaces, new and existing, below a plane 1 foot above the maximum liquid surface, metal surfaces above the maximum liquid surface which are a

part of the immersed equipment, concrete embedded surfaces of metallic items under submerged conditions, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel, except reinforcing steel, unless otherwise specified:.

b. Use on the following areas:

1) Reservoir:

a) All pipe and metal surfaces (except SST)

2) Piping:

a) Lining for welded steel pipe 10-inches diameter and smaller.

b) Interior of access manways.

3. Special Requirements:

a. (1) All existing immersed metal surfaces with an existing coating system, excluding new shop primed or coated equipment, shall be abrasively blasted to bare metal and recoated with this system.

D. System No. 2 Concrete Encased Metal:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Polyamide Epoxy	2 coats, 12 MDFT

2. Application:

a. Metal surfaces encased in concrete, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel excluding reinforcing steel; and the following specific surfaces unless otherwise specified.

b. Aluminum surface in contact with concrete or grout or embedded in concrete

3. Special Requirements:

a. May be used in lieu of System No. 27 at Contractor's option.

b. Shop coated surfaces shall be prepared as specified.

E. System No. 4 Exposed Metal - Highly Corrosive:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Organic Zinc Rich Primer	1 coat, 2.5 MDFT
	Polyamide Epoxy	1 coat, 5 MDFT
	Polysiloxane	2 coats, 6 MDFT

2. Application:

a. Exposed metal surfaces, new and existing, located inside of structures, manholes, vaults, and the following specific areas unless otherwise specified.

b. Use on the following areas:

1) FWR Inlet Valve Vault and Building

2) Bluffdale Meter Vault

3) Drain Vault

4) Underdrain Vault

5) All underground vaults and manholes.

c. Use on the following surfaces:

1) All trusses and exposed galvanized steel roof decking.

2) All process air lines at the Process Building]

3. Special Requirements:
 - a. The surface preparation and primer shall be shop applied to all surfaces prior to installation.
 - b. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.
 - c. Insulated piping shall be primed and epoxy coated prior to installation of insulation.
 - d. All existing exposed metal surfaces with an existing coating system, including new shop primed or coated equipment, shall be prepared as specified under "Coating Application, Existing Coated Surfaces" and final topcoat applied per this system.
 - e. Aliphatic polyurethane will not be allowed as a substitute for polysiloxane due to restrictive overcoat requirements.
 - f. Dry film coating thickness of polysiloxane, including touch up repairs, shall not exceed the manufacturer's recommended maximum film thickness.

F. System No. 5A Exposed Metal - Mildly Corrosive:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Inorganic Zinc Rich Primer	1 coat, 2.5 MDFT
	Polysiloxane	2 coats, 6 MDFT

2. Application:

- a. Exposed metal surfaces, new and existing, located outside of structures and exposed to weather and the following specific surfaces unless otherwise specified.
- b. Use on the following items or surfaces:
 - 1) Exposed surfaces of air vent piping, unless hot dip galvanized.
 - 2) Hollow metal doors and frames.

3. Special Requirements:

- a. Surface preparation, primer, and one of two topcoats shall be shop applied to all surfaces prior to installation with final topcoat to be field applied for color uniformity after all touchup repairs have been completed.
- b. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.
- c. Polysiloxane coating to overlap buried pipe coating a minimum of 4 inches below top of concrete.
- d. Aliphatic polyurethane will not be allowed as a substitute for polysiloxane due to restrictive overcoat requirements.
- e. Dry film coating thickness of polysiloxane, including touch up repairs, shall not exceed the manufacturer's recommended maximum film thickness.

G. System No. 5B Exposed Metal - Mildly Corrosive, Existing:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Inorganic Zinc Rich Primer	1 coat, 2.5 MDFT
	Aliphatic Polyurethane	2 coats, 6 MDFT

2. Application:

- a. Exposed metal surfaces, new and existing, on the following specific areas or surfaces unless otherwise specified.
- b. Use on the following items or surfaces:
 - 1) JA2 and SWA Interconnection vault piping where existing coating has been damaged for valve installation.
 - 2) New valve in JA2 and SWA interconnection vault.
- 3. Special Requirements:
 - a. Existing coating system on the vault piping was specified as an organic zinc rich primer, epoxy intermediate coat, and aliphatic polyurethane top coat. Actual applied materials are not known nor is surface preparation of the pipe known.
 - b. Contractor shall verify compatibility of new coating materials with existing materials and provide all surface preparation as required by the coating manufacturer and these specifications, whichever is more stringent, to achieve coating compatibility and proper adhesion of applied coatings to new and existing coated surfaces.
 - c. Surface preparation and primer shall be shop applied to all new metal surfaces prior to installation with remaining topcoat to be field applied for color uniformity after all touchup repairs have been completed.
 - d. All existing coated surface shall be pressure washed to remove dust, debris, and other contaminants prior to beginning of surface preparation work.
 - e. Damage to other coatings or surfaces, not included in the work area, shall be repaired as the sole expense of the contractor.

H. System No. 8 Buried Metal - General:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel Blast (SP 10)	Wax Tape Coating System	Wax tape as specified in Section 09 97 01

2. Application:

- a. All buried pipe shall be coated as specified under Section 09 97 01 - Pipeline Coatings.
- b. All buried, below grade portions of steel items, except buried stainless steel or ductile iron, and the following specific surfaces unless otherwise specified.

3. Special Requirements:

- a. Metallic air vent pipe, buried, may be coated with System No. 1 at Contractor's option.

I. System No. 10 Galvanized Metal Conditioning:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer	1 Coat, 0.4 MDFT
Followed by Hand Tool (SP 2) or Power Tool (SP 3)	Finish Coats to Match Existing Paint	As Required to Match Surrounding Area

2. Application:

- a. All galvanized surfaces requiring painting and the following specific surfaces unless otherwise specified.

3. Special Requirements:

- a. Sweep blast as specified this section, may be used in lieu of hand or power tool cleaning of galvanized surfaces provided CONTRACTOR can demonstrate that damage to the zinc coating will not result. ENGINEER approval of sweep blasting locations, methods, and surface cleanliness and profile results is required.
- b. See applicable coating systems for finish coating system and coating requirements based on area and/or surface to be coated.

J. System No. 11 Galvanized Metal Repair:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2), or Power Tool (SP 3), or Brush-off Blast (SP 7)	Organic Zinc Rich Primer or Inorganic Zinc Rich Primer	1 Coat, 3 MDFT

2. Application:

- a. All galvanized surfaces which are abraded, chipped, or otherwise damaged and are not specified to be coated.

K. System No. 21 Epoxy Floor, Concrete:

1. Surface Preparation and Coating System

Surface Prep.	Paint Materials	Min. Coats, Cover
Concrete	Polyamide Epoxy	1st coat (thinned) 2 coats Total system 80 SFPG

2. Application:

- a. Use on the following areas:
 - 1) The floors of all cast-in-place or precast concrete vaults.
 - 2) All other areas as shown on the Drawings or specified to receive, epoxy floor coating, concrete.
 - 3) Concrete floors of masonry buildings.

3. Special Requirements:

- a. Epoxy coating to be applied a minimum of 6-inches onto walls, pipe supports, and any other metallic component attached to the floor or wall within the 6-inch limit.
- b. All areas above the 6-inch limit shall be masked off, provide a straight line demarking coated versus uncoated areas.
- c. Abrasively blast miscellaneous metal surfaces to an SSPC SP-10, near white blast, as specified this section.
- d. Prime coat of epoxy shall be a thinned coat of the epoxy coating to fill and seal the concrete before the final coats applied, per the coating manufacturer's requirements.

L. System No. 27 Aluminum and Dissimilar Metal Insulation:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer	1 coat, 0.4 MDFT
	Bituminous Paint	1 coat, 8 MDFT

2. Application:
 - a. Use on all non-submerged concrete embedded aluminum surfaces, and the following specific surfaces unless otherwise specified.
 - b. Use on the following surfaces:
 - 1) All concrete embedded components of vault hatches
 - 2) All concrete embedded surfaces where electrical isolation from concrete reinforcement is required.

M. System No. 29 Fusion Bonded Coating:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10) or Acid Pickling (SP 8)	Fusion Bonded 100% solids Epoxy or Polyurethane	1 or 2 coats, 10 MDFT

2. Application:
 - a. Use where specified.
 - b. Concrete embedded anchor bolts, except threads.
 - c. Removable handrail sleeves.
3. System Notes:
 - a. System 1 may be used as alternative coating system at Contractor's option.

3.15 ARCHITECTURAL PAINT SYSTEMS:

System No.	Title
109	Concrete Masonry, Semi-Gloss
110	Masonry Sealer

A. System No. 109 Concrete Masonry, Semi-Gloss:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Masonry	Block Filler	1 coat, 75 SFPG
	Acrylic Sealer	2 coats, 100 SFPGPC

2. Application:
 - a. All interior surfaces of masonry walls.

B. System No. 110 Masonry Sealer:

1. Refer to Section 07 19 00 Water Repellents
2. Application: All exterior surfaces of masonry walls.

END OF SECTION

Paint System Data Sheet

Attach products' Technical Data Sheet (if applicable) to this sheet for each paint system:

Paint System Number (from Specification):		
Paint System Title (from Specification):		
Coating Manufacturer:		
Name of Representative:		
Surface Preparation Specification:		
Paint Material (Generic)	Product Name/Number (Proprietary)	Minimum Coats, Coverage

Additional Information Required (check applicable items):

- ☐ ANSI/NSF Certification letter for each paint material listed above requiring ANSI/NSF Standard 60 and 61 approval.

- ☐ Manufacturer's minimum and maximum recommended coating thickness per coat and for total coating system.

- ☐ Immersion coating cure requirements from minimum coating application temperature to 100 deg F in 15-degree temperature increments.

SECTION 09 97 01
PIPELINE COATINGS AND LINING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the work necessary to apply external coating and internal lining on steel pipe, field coating of joints, and field repair of coating damage, complete.
- B. Steel pipe will be supplied from the fabricator with either a tape wrap or plural component epoxy coating system, and where specifically required the dielectric coating system shall be over coated with cement mortar. The yard piping for this project consists primarily of fittings and special fabrications, with very few straight runs of pipe. For this reason all buried steel pipe is expected to be supplied with the specified plural component epoxy coating system, with no cement mortar over coat.
- C. Exposed steel pipe will be coated as specified in Section 09 90 00 - Coatings and Painting, unless specifically specified otherwise.
- D. Hand applied tape wrap shall not be allowed under any conditions.

1.2 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 20 – Submittal Procedures.
- B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.
- C. Quality Control Submittals: Furnish the following:
 - 1. Applicator's Experience with list of references substantiating compliance.
 - 2. Coating manufacturer's certification stating the applicator meets or exceeds their coating application requirements and recommendations.
 - 3. Coating manufacturer shall provide a copy of the manufacturer's coating application quality assurance manual.
 - 4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers' that the two coating materials are compatible.

1.3 QUALITY ASSURANCE

- A. Coating Applicator's Experience and Certification:
 - 1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system.
 - 2. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.

3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.
- B. Coating and/or lining manufacturer technical representative shall be present for a minimum of one day technical assistance and instruction at the start of coating and/or lining operations within the shop. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.
 - C. Coating and/or lining manufacturer's technical representative shall be onsite for one working day, minimum, at the start of each construction season to inspect coating application and procedures in the field. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.
 - D. Coating and/or lining manufacturer shall include 8 hours per month of field or shop coating technical support when requested by the Engineer.
 - E. Technical representative shall provide a written report to the Engineer for each visit. Report shall include copies of test data collected, description of observations, and all recommended corrective actions. Report shall be submitted within 5 working days after the visit. When deemed necessary by the Engineer, work will not be permitted to proceed until the recommended corrective actions have been implemented. After all corrective recommendations have been completed; the manufacturer representative shall return and certify that the application complies with the manufacturer's coating application recommendations.
 - F. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating or lining as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this project.

1.4 ABBREVIATIONS

MDFT	Minimum Dry Film Thickness
mil	Thousandths of an Inch

1.5 DEFINITIONS

- A. Manufacturer's Representative: Employee of coating manufacturer who is factory trained and knowledgeable in all technical aspects of their products and systems. Sales representatives are not acceptable as a technical representative unless written authorization from the coating manufacture is provided which states the sales representative has full authority to act on the behalf of the coating manufacturer.

1.6 REFERENCE STANDARDS

- A. This specification recognizes AWWA, NACE, and SSPC standards as minimum industry standards and they are referenced for purpose of conformance, except where modified in this

section. The requirements of this specification section have been written to a higher design standard with the intent of achieving a long term coating performance of 100 years.

AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4-inch and Larger- Shop Applied.
AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines.
AWWA C216	Heat-shrinkable Cross-linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
AWWA C217	Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
NACE RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
SSPC-SP-1	Solvent Cleaning Surface Preparation
SSPC-SP-2	Hand Tool Cleaning Surface Preparation
SSPC-SP-3	Power Tool Cleaning Surface Preparation
SSPC-SP-5	White metal Abrasive Blast Surface Preparation
SSPC-SP-6	Commercial Abrasive Blast Surface Preparation
SSPC-SP-10	Near White Metal Abrasive Blast Surface Preparation
SSPC-SP-11	Power Tool Cleaning to Bare Metal

1.7 SPECIAL WARRANTY REQUIREMENTS

- A. The Contractor and coating applicator shall warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of two (2) years commencing on the date of final acceptance of the work.

1.8 OBSERVATION OF WORK

- A. The Contractor shall give the Owner Representative a minimum of 14 days advance notice of the start of any work to allow scheduling for shop or field observation.
- B. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application work.

- C. Provisions shall be made to allow Owner's representative full access to facilities and appropriate documentation regarding coating application.
- D. Observation by the Owner's representative or the waiver of observation of any particular portion of the work shall not be construed to relieve the Contractor of his responsibility to perform the work in accordance with these Specifications.
- E. Materials shall be subject to observation for suitability as the Owner's representative may determine, prior to or during incorporation into the work.

PART 2 - MATERIALS

2.1 GENERAL

- A. Coatings and linings will be stored and handled per manufacturer's written directions.
- B. Exterior and interior pipe and fitting surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer's, and these specifications, whichever is more stringent.
- C. Pipeline coating or lining shall be the product of a single manufacturer. Product substitutions during the project will not be permitted without Engineer approval.

2.2 SHOP-APPLIED EXTERIOR COATINGS

A. General

- 1. Steel pipe shall be coated in accordance with plural component epoxy or AWWA C214, except as modified herein.
- 2. Mortar over coat of dielectric coating shall be provided over tape wrap coating system (AWWA C214) and where specified or indicated on the Drawings. Steel pipe specified to receive a cement mortar overcoat shall be shop-coated with the required coating system and a 3/4-inch thick, minimum, cement mortar overcoat as specified herein.
- 3. Pipe that is atmospherically exposed shall be shop primed as specified herein and Section 09 90 00 - Coatings and Painting.
- 4. Buried dielectrically coated pipe and fittings passing through a concrete structure wall or floor shall be coated for a minimum of two-inches beyond the interior wall or floor surface.

B. Polyethylene Tape Wrap:

- 1. Pipe shall be coated with an 80 mil (nominal), tape-coating systems applied in accordance with AWWA C214, except as modified herein.
 - a. Primer: Polyken 1019, 1027, 1029, or as recommended by the coating manufacturer.
 - b. Weld Stripe Tape: Polyken 931 (no backing), 25 mils nominal, 4-inches wide minimum.
 - c. Inner Wrap: Polyken 989 YGIII, 20 mils nominal, corrosion protection layer.
 - d. Middle Wrap: Polyken 955 YGIII, 30-mils nominal, mechanical protection layer.
 - e. Outer Wrap: Polyken 956 YGIII, 30 mils nominal, mechanical protection layer.

- f. Surface Preparation:
 - 1) Steel Pipe: SSPC-SP5, White Metal blast, 2.5 mils blast profile, minimum.
 - 2. Tape Coating:
 - a. Tape layers shall have adhesive for the full width of the tape. Adhesive shall have the ability to stick to itself and to the proceeding tape layer or pipe.
 - b. Each layer shall be a different color or shade with the outer layer white.
 - c. Outer wrap shall have sufficient ultraviolet (UV) inhibitors to resist above grade exposure for a minimum of 12 months or the proposed storage and construction time, whichever is greater.
 - d. Tape width shall be 12-inches maximum. Wider tape will be conditionally allowed if the coating applicator can demonstrate that proper tensioning can be maintained and mechanical wrinkling prevented throughout the coating application. If at anytime during the pipe fabrication tape quality becomes inconsistent with a wider tape, the Engineer can require the remainder of the pipe to be coated using the maximum specified tape width.
 - e. Tape coated steel pipe shall be provided with a cement mortar overcoat as specified in this section.
- C. Plural Component Epoxy:
 - 1. General:
 - a. Plural component, epoxy coating system shall be applied as specified herein with the exception that AWWA C210 is incorporated by reference for product qualification and application requirements only.
 - b. Where there is a conflict between C210 and this specification, the more stringent requirement shall apply.
 - 2. Shop Surface Preparation:
 - a. Steel pipe: SSPC-SP5, White Metal blast, 3.00 mil profile, minimum, or as required by the manufacturer, whichever is greater.
 - 3. Shop Applied Coating Requirements:
 - a. Thickness: One coat, 35 mils total dry film thickness, minimum, or as required to meet limits specified for holiday and coating defects, this section.
 - b. Epoxy: Self-priming, plural component, 100 percent solids, non-extended epoxy, suitable for burial or immersion, and meeting the requirements of AWWA C210 and the following, whichever is more stringent:
 - 1) Resistance to Water Immersion (ASTM D870) or Wet Adhesion
 - a) Acceptance criteria:
 - i. Not greater than 10 percent loss of substrate adhesion when compared to substrate adhesion in an unexposed area of the same sample with adhesion tests completed within 12 to 24 hours after test termination. Average of three pulls per exposure area.
 - ii. No blistering or underfilm corrosion when viewed at 10x magnification.
 - b) Adhesion Testing:
 - i. Method: ASTM D4541, Method E
 - ii. Equipment: Type V, Delfesko Automatic AT Positest
 - iii. Dollies: 20 mm and 14 mm, scored to metal substrate

- iv. Test Speed: 100 psi per second (both 14 and 20 mm)
- c) Test Duration: 30 and 60 days
- 2) Cathodic Disbondment (ASTM G95)
 - a) Acceptance criteria: 8 mm, maximum
 - b) Potential: -3.00 volts
 - c) Test Duration: 28 days
 - d) Evaluation: Measured from original holiday radius to edge of staining on metal surface.
- 3) Water Absorption (ASTM D570)
 - a) Acceptance Criteria: 1.80 percent, maximum
 - b) Test Duration: 30 day and 60 day
- 4) Long-Term Adhesion Test:
 - a) Acceptance Criteria: Not more than 10 percent loss of adhesion over duration of test. Differential based on the highest average adhesion result to the lowest average adhesion result.
 - b) Test Duration: 1 day, 7 days, 3 weeks, 2 months, and then monthly for total test duration of 12 months.
 - c) Sample Preparation:
 - i. SSPC-SP5, white metal abrasive blast, 3.00 mils profile, minimum.
 - ii. Test area shall not exceed 18-inches by 18-inches.
 - iii. Steel plate shall be a curved steel plate with a minimum radius of 15 inches to minimize standing water on the test panel.
 - iv. Sample shall be exposed to ambient, outdoor conditions for the full duration of the test.
 - d) Test Procedure:
 - i. Long term adhesion shall be based on an 8 pulls per test period with the 3 lowest pulls discarded.
 - ii. Test results per each test period shall be an average of the five highest pulls.
 - iii. All adhesion pulls and their failure mode shall be recorded and those included in the average calculation shall be identified.
 - iv. All adhesion tests shall be repaired to prevent water runoff from affecting subsequent adhesion tests.
- c. Shall be one of the following products:
- d. Tnemec Series 431, Kansas City, MO
- e. Or approved equal.

D. Exterior Coating for Exposed Steel Pipe

- 1. All atmospherically exposed or vault piping shall be shop primed with the coating system as specified in Section 09 90 00 - Coatings and Painting.
- 2. Exposed pipe to be shop primed per Section 09 90 00 with intermediate and finish coats to be applied in the field after installation is complete.

3. Shop applied inorganic or organic zinc primer shall not be applied at thickness greater than recommended by manufacturer. Excess primer to be removed using method recommended by coating manufacturer.
 4. Manufacturer of shop-applied primer shall be coordinated with field application to provide a completed system by a single manufacturer. Engineer approval of a coating system with two or more coating manufacturer's will require written approval from all coating manufacturer's as to compatibility and acceptance under warranty..
- E. Cement Mortar Coating or Overcoat
1. Cement mortar overcoat shall be applied over tape wrap coating system (AWWA C214) on steel pipe in accordance with AWWA C205, except as modified herein.
 2. Holdback:
 - a. Mortar overcoat shall be held back of dielectric coating a minimum of 3 inches for overlap of field applied joint coating onto dielectric coating system.
 - b. Increase holdback to allow for coating shrinkage with Pritec coating system.
 3. Shop Applied Coating System:
 - a. Cement: Conform to ASTM C150, Type II.
 - b. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
 - c. Cement mortar mixture shall consist of 1 part cement to not more than 3 parts aggregate.
 - d. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities. Use no more than 4-1/2 gallons of water per sack of cement.
 - e. Cement mortar coating: Nominal 1-inch thick coating with permitted tolerance of $\pm 1/4$ -inch.

2.3 SHOP-APPLIED INTERIOR LININGS

- A. Cement Mortar Lining:
1. Clean and cement mortar line steel pipe and fittings in accordance with AWWA C205.
 2. Cement: Conform to ASTM C150, Type II.
 3. Shop applied cement mortar lining shall be uniform in thickness over the full length of the pipe joint.
 4. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
 5. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities.
- B. Liquid Applied Epoxy Lining:
1. Cement Mortar Lined Steel Pipe:
 - a. Provide liquid epoxy primer and lining in all cement mortar lined metallic pipe at insulating joints for a minimum of two pipe diameters centered over the insulated joint.
 - b. Epoxy lining shall be polyamine or polyamide cured, NSF approved for potable water contact in accordance with ANSI/NSF Standards 60 and 61, and capable of achieving full cure before placement in service or exposure to water.
 - c. Application:

- 1) Apply in two coats at equivalent spread rate for 6 mils dry film thickness per coat with coating application efficiency of 80 percent.
 - 2) Epoxy shall be applied over the cement mortar lining where specified for the pipeline lining material.
 - 3) Cement mortar shall be allowed to cure for a minimum of 15 days prior to surface preparation and coating application or 7 days with steam curing. Mortar lining shall be dry when epoxy lining is applied.
 - 4) Prepare the cement mortar lining by abrasive blasting to remove all laitance and provide a surface profile equivalent to 80 grit sandpaper.
2. Steel Pipe Lining:
- a. Where epoxy lining is specified or shown on drawings, epoxy lining shall be applied directly to the steel surface.
 - b. Surface Preparation: SP-5, White Metal Abrasive Blast
 - c. Epoxy Lining: Polyamine or polyamide high build epoxy, NSF 60 and 61 approved, suitable for continuous immersion, and capable of achieving full cure before placement in service or exposing to water.
 - d. Application: Apply in three coats at 5 mils minimum dry film thickness per coat with separate stripe coat at welds.

2.4 FIELD APPLIED COATINGS

A. General

1. All buried miscellaneous metal components installed on the pipeline and that is supplied bare or with a shop coating system that is not equal to the specified pipeline coating shall be coated in the field with one of the following coating systems.
2. Miscellaneous metal components shall include, but not be limited too, all exposed metals surfaces, including bolts, couplings, flanges, valves, adapters, pipe spools, and other miscellaneous metal components.
3. Coating system applied shall conform to the manufacturer's requirements and shall be applied in accordance with the application requirements of the coating system.

B. Petroleum or Wax Tape Coating:

1. Coating System:
 - a. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
 - b. Primer: petroleum or petrolatum wax
 - c. Filler Material:
 - 1) Filler materials shall be petroleum or petrolatum wax sealer/filler with closed cell plastic filler
 - 2) Provide filler material to fill and smooth all irregular surfaces, such that no tenting or voids remain under the applied wax tape.
 - d. Inner Tape: Petroleum or petrolatum wax impregnated fabric, 6-inch width maximum, 40 mils thick
 - e. Outer Wrap: PVC or tape suitable for application to inner tape.
 - f. Wax tape coating system shall be as manufactured by:
 - 1) Denso North American
 - 2) Trenton
 - 3) Or approved equal.
2. Application:

- a. Coating shall be in accordance with AWWA C217, except as modified herein.
- b. Wax tape coatings shall be field applied on all buried couplings, thrust restraint rods and brackets, valves, and on joints, fittings, or irregular shapes or complex configurations that are not suited for the use of heat shrink coating systems and is not cement mortar over coated.
- c. Do not use wax tape coating systems on vault piping, atmospherically exposed piping and appurtenances, or where subject to UV exposures.
- d. Use sand backfill to protect wax coating from damage.

C. Epoxy Coating:

1. Coating System:

- a. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
- b. Primer: As required by the coating manufacturer.
- c. High Build Epoxy Coating:
 - 1) Two component, high build polyamide or polyamine cured epoxy coating, suitable for direct burial or immersion, dries to touch in 2 or more hours, suitable for immersion or burial after full cure of coating.
 - 2) Acceptable manufacturers:
 - 3) ICI Devoe
 - 4) Sherwin Williams
 - 5) Carboline
 - 6) Or approved equal
- d. Fast Cure Epoxy Coating:
 - 1) Two component, 100% solids by volume, fast cure epoxy coating suitable for direct burial or immersion, dry to touch in less than 1 hour at 72 degrees, capable of curing while immersed or buried.
 - 2) Acceptable Manufacturers:
 - 3) TC 7010, Tapecoat Inc
 - 4) Protal 7125, North American Denso

2. Application:

- a. Epoxy coatings on interior of pipe shall be NSF approved coatings suitable for potable water contact in accordance with ANSI/NSF Standards 60 and 61, unless otherwise approved by the Engineer.
- b. Contractor shall ensure that epoxy coating selected is suitable for the application temperatures anticipated and that project schedule will allow adequate cure time before backfill or immersion based on surface temperatures at the time of application.
- c. Epoxy coating shall be used for coating concrete embedded surfaces to a distance of 4 inches outside the interior and exterior surfaces of concrete wall or floors. Epoxy coating at concrete penetrations shall be a minimum of 12 mils dry film thickness.

D. Heat Shrink Sleeves:

1. Coating System:

- a. Surface preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
- b. Filler Material:

- 1) Filler material shall adhere to the pipe and heat shrink sleeve. Size and type shall be as recommended by the sleeve manufacturer for type of pipe and joint.
- 2) Filler mastic for joints subject to weld after backfill shall exceed 500 degrees F melting temperature.
- c. Heat Shrink Sleeve:
 - 1) Heat shrink, cross-linked polyolefin wrap or sleeve with a mastic sealant, 85-mils nominal thickness, suitable for pipeline operating temperature, as recommended by the manufacturer.
 - 2) Provide standard recovery sleeve for welded or bell and spigot steel pipe joints. High recovery sleeves shall be provided for mechanical or bell and spigot ductile iron pipe, flange joints, and coupling style joints.
 - 3) Width of heat shrink sleeves shall be sufficient to overlap existing coating 2 inches minimum. Overlap on tape coated steel pipe shall be based on a sequential 2-inch wide step from outer wrap to middle wrap to inner wrap.
 - 4) Sleeve shall meet requirements for "Well After Backfill" when allowed and approved by Engineer.
- d. Coating Manufacturer's:
 - 1) Canusa,
 - 2) Raychem-Covalence,
 - 3) Or equal.
- e. Application:
 - 1) Heat shrink sleeves shall be applied to buried or concrete encased pipeline joints only. Application on vault piping or where exposed to the weather will not be allowed.
 - 2) Provide filler material for all rolled or Carnegie joints, flanges, and couplings and all step changes greater than 1/8-inch.
 - 3) Filler material shall be applied in a manner and of sufficient thickness that no tenting or voids remain under the heat shrink sleeve.
 - 4) Contractor to consider sleeve shrinkage and joint profile in determining sleeve width required. Overlapping of two or more heat shrink sleeves to achieve the necessary width on pipe joints will not be permitted without Engineer approval.
 - 5) All transitions from tape wrap to epoxy or other brush, roller, or spray applied protective coating system shall be coated at the transition with a heat shrink sleeve with minimum 3-inch overlap onto both coating systems.

2.5 SPECIALS, FITTINGS, AND CONNECTIONS

- A. Coating and lining application for special sections, connections, and fittings for steel or ductile iron pipe shall conform to coating system and application requirements as specified this section.
- B. Specials, fittings, and connections shall be defined as any pipe section with turnouts for blowoffs, interconnects, any valve, or other appurtenances; tees; crosses; wyes; laterals; manholes; mitered angles or elbows; and pipes which require special fabrication that

prevents mechanical production application of the specified coating system from end to end of pipe joint.

- C. In addition to the items listed as specials, the following items shall also be considered as specials:
 - 1. All pipe sections entering a structure.
 - 2. Pipe joints with pass through holes.
- D. Hand applied tape coatings will not be permitted on any pipe specials, valves, fittings, connections, and couplings.
- E. Specials, fittings, and connections shall be externally coated with a plural component epoxy coating system, applied from end to end of pipe joint on all specials, fittings, and connections.

2.6 EXTERIOR PIPE JOINT FIELD COATING

- A. Pipe joints shall be field coated after pipe assembly in accordance with AWWA C216, except as modified in this section.
- B. Field joint coating shall be compatible with the shop-applied coating system.
- C. All joints on pipe shall be coated with a heat shrink coating material.
- D. Field joint coating materials shall be as specified for Field Applied Coatings, this section.

2.7 FIELD APPLIED INTERIOR JOINT COATING

- A. Mortar Lining:
 - 1. After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout shall be tightly packed into the joint recess and flush with the interior surface. Excess shall be removed.
 - 2. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch.
 - 3. With pipe smaller than 24-inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.

2.8 REPAIR OF COATINGS AND LININGS

- A. General
 - 1. Coating or lining repair materials shall be compatible with the shop-applied coating or lining system and shall be approved by the coating or lining manufacturer.
 - 2. Repair materials shall be as required for the coating system and "major" or "minor" repair classification as defined this section.
- B. Coating Repair Materials
 - 1. Heat Shrink Sleeves (major repair):
 - a. Filler Mastic: Provide mastic filler to fill tape void as required.
 - b. Full Wrap Coating: Cross-linked polyolefin wrap with a mastic sealant, 85-mil thickness minimum, suitable for pipeline operating temperature, sleeve

- material recovery as recommended by the manufacturer. Sleeve length shall provide a minimum of 3 inches overlap onto intact pipe coating.
 - c. Manufacturer's: Canusa, Raychem (Polyken), or equal
 - 2. Heat-Applied Patches (minor repair)
 - a. Heat applied adhesive, polyolefin backed, mastic coated tape, 12-inches maximum size.
 - b. Patch shall provide a minimum of 2 inches overlap onto intact pipe coating; except for "Pritec" coated pipe shall have a minimum overlap of 3-inches in the circumferential direction.
 - c. CRP patch as manufactured by Canusa, PERP patch as manufactured by Raychem (Polyken), or equal.
 - 3. Plural Component Epoxy Coating or Lining
 - a. Major repairs in the shop will be completed using the coating material specified for the coating or the lining. Coating shall be reapplied using plural component spray equipment by a manufacturer certified coating applicator.
 - b. Major repairs in the shop or field shall be completed using heat shrink sleeves as specified this section.
 - c. Coating material for minor repairs shall be single use epoxy kits similar to the existing coating
 - d. Pinhole holidays or adhesion test coating repairs shall be with minor repair coating material specified or fast cure epoxy, such as Protal 7125 as manufactured by North American Denso, Inc.
- C. Exposed Pipe Coating System
- 1. Touch-up repair all damage to the primer and/or intermediate coats with the specified coating system prior to final coating of the pipeline in accordance with Section 09 90 00 – Coatings and Painting.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL LIMITATIONS

A. General

- 1. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
- 2. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
- 3. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees above the dew point of the ambient air.
- 4. Do not apply coatings when:
 - a. Surface and ambient temperatures exceeds the maximum or minimum temperatures recommended by the coating manufacturer or these specifications,
 - b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.

- c. When it expected that surface temperatures would drop below 5 degrees above dew point within 4 hours after application of coating.
 - d. Whenever relative humidity exceeds 85 percent for polyurethane coating application.
 - 5. Where weather conditions or project requirements dictate, Contractor shall provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as specified and in accordance with the manufacturers coating application recommendations.
 - 6. Work activities can be restricted by the Engineer until adequate temperature and humidity controls are in place and functioning within the environmental limits specified.
 - 7. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, surface preparation, holiday test and other parameters applicable to the type of coating.
- B. Temperature Control
- 1. In cold weather or if moisture collects on the pipe, preheat pipe to a temperature between 45 and 90 degrees and 5 degrees above dew point, whichever is greater.
 - 2. When temperatures are above or below the coating manufacturers recommended application temperatures, the CONTRACTOR will provide temperature controls as necessary to permit work to precede within the manufacturer's temperature limitations.
 - 3. Provide tenting, insulating blankets, baffles, or bulkheads as required to zone and control heating or cooling effectiveness.
 - 4. Heating shall be with indirect fired heaters that do not increase humidity levels within the work area. Heaters shall be sized for the area to be heated.

3.2 SURFACE PREPARATION

A. General

- 1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of coating manufacturer whose product is to be applied.
- 2. Visible oil, grease, dirt, and contamination shall be removed in accordance with SSPC-SP1, solvent cleaning.
- 3. Surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal shall be removed by filing or grinding prior to abrasive surface preparation.
- 4. Protect prepared pipe from humidity, moisture, and rain. All flash rust, imperfections, or contamination on cleaned pipe surface shall be removed by reblasting.
- 5. Priming and coating of pipe shall be completed the same day as surface preparation.

B. Weld Surface Preparation

- 1. Requirements:
 - a. Spray applied coating systems do not require weld grinding.
 - b. Grind welds flush on extruded polyolefin coated pipe as specified herein.

- c. Welds on tape wrap coated pipe shall be either ground flush or a weld stripe tape applied over the weld, at the pipe fabricator's option, unless otherwise specified.
 - 2. Weld Grinding:
 - a. Under the weld grinding option, welds higher than 1/32 inch above pipe surface shall be ground to a tolerance of +1/32 inch to 0-inch above the pipe surface as measured on the lowest side of the weld.
 - 3. Weld Stripe Tape:
 - a. Weld stripe tape will be applied to primed metal.
 - b. Tape will either have no polyethylene backing or will be double sided adhesive tape to permit adhesion of the inner corrosion protection layer to the weld stripe tape.
 - c. Apply tape with a pressure roller to fully conform the tape to the weld surface.
 - d. Adhesion of the weld stripe tape shall be as specified for the coating system.
- C. Steel Surface Preparation
- 1. Surface preparation of steel pipe shall be in accordance with SSPC surface preparation standards utilizing the degree of cleanliness specified for the coating system to be applied.
 - 2. Grit and/or shot abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion specified.
 - 3. Pipe cleaned by abrasive blasting with recyclable steel grit and/or shot or other abrasive shall be cleaned of debris and spent abrasive in an air wash separator.
 - 4. Polyurethane coated steel shall have a sharp angular surface profile of the minimum depth specified.
 - 5. After abrasive blasting surfaces and before coating application, the metal surface shall be cleaned of residual dust to a minimum of Grade 2 per ISO standard 8502-3, Test for the Assessment of Surface Cleanliness.
 - 6. Work shall be performed in a manner that does not permit the cleaned metal surface to rust back or flash rust.
 - 7. Rust back or flash rust shall be fully removed with the steel surface cleanliness equal to the metal surface cleanliness prior to rust back or flash rusting. Determination of the equivalent surface cleanliness shall be at the Engineer's sole discretion.

3.3 SHOP-APPLIED COATING SYSTEMS

- A. Tape Wrap Coating
- 1. Applicator shall provide a monitoring system approved by the tape manufacturer that constantly records pipe and tape conditions during coating application. Recorded monitoring parameters shall include, but not be limited too, pipe temperature; line speed, primer and tape roll body temperature, and tape tension.
 - 2. Pipe surface temperature shall be between 45 and 120 degrees and 5 degrees above dew point, whichever is greater.
 - 3. Tape roll temperature shall be in accordance with the manufacturer's recommendations, but shall not be less than 55 degrees for the inner wrap and 65 degrees for the outer wraps.
 - 4. Apply a uniform coat of primer as recommended by the manufacturer without skips, runs, or sags. Allow to properly dry prior to applying the tape as required by the tape

manufacturer and as necessary to achieve maximum tape adhesion. Rug type application will not be allowed.

5. If welds are not ground flush, apply a weld stripe tape to longitudinal or spiral pipe welds prior to application of the inner wrap.
6. Tape layers shall be applied continuously with the use of hydro-tension tape stands. Tension shall be maintained between the manufacturer's minimum and maximum tension recommendations or as required to achieve approximately 2.0 percent reduction in tape width.
7. Inner tape wrap shall adhere tightly to the pipe surface. Coating shall be 100 percent adhering to the metal surface and shall not have any visible damage, wrinkles, voids, disbondment, contamination, or holidays.
8. Tape coating adhesion testing shall be performed on the pipe as specified this section.
9. Holidays testing shall be conducted on the inner layer tape prior to proceeding with subsequent tape layers. All holidays detected shall be primed and patch using coating repair procedures specified herein.
10. Perform coating and lining repairs as specified in this section.

B. Plural Component Epoxy Coating

1. Applicator Qualifications:
 - a. Equipment will be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.
 - b. Equipment not meeting the written requirements of the coating manufacturer shall be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the Engineer.
 - c. Personnel responsible for the application of the coating system shall have certification of attendance at the coating manufacturer's training class within the last three years. The certified applicator shall be present during all coating application work and shall have responsibility for controlling all aspects of the coating application.
2. Pipe surface temperature shall be between 50 and 100 degrees or 5 degrees above dew point, whichever is greater.
3. Coating application shall be performed in an environmentally controlled shop area that meets or exceeds the written environmental application requirements of the coating manufacturer. Application in outdoor conditions will not be acceptable without adequate environmental shelter, environmental controls, and/or dehumidification.
4. Coating adhesion and holidays testing shall be tested as specified this section.
5. Coating manufacturer shall provide to the Engineer a copy of the manufacturer's coating application quality assurance manual prior to beginning coating application. Strict conformance to the requirements of the manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.
6. Unacceptable Coating Application
 - a. Coating applied under improper environmental conditions will be rejected.
 - b. Pipes that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected.
 - c. Coating which fails the adhesion or holiday testing as specified this section shall be rejected.

- d. Pipe coating that is subject to off ratio application, blistering, or is not applied in conformance with the coating manufacturer's written instructions or recommendations shall be rejected.
 - 7. Rejected coating shall be removed from the full length of the pipe to bare metal and reapplied using proper application methods in accordance with the coating manufacturer's written instruction and the requirements of these specifications.
 - 8. Perform coating and lining repairs as specified in this section.
- C. Cement Mortar and Overcoat Coatings
- 1. Dielectrically coated steel pipe, when specifically required or specified, shall have a cement mortar overcoat applied over the dielectric pipe coating in accordance with AWWA C205, except as modified herein.
 - 2. Cement Mortar Overcoat:
 - a. Cement mortar overcoat dielectrically coated steel pipe as specified in AWWA C205, except mortar coating shall be applied over exterior pipe coating.
 - b. Mortar coating shall be held back 3 inches, minimum, behind dielectric coating system cut back at joints.
 - c. Coating Defects:
 - 1) Cracking in the mortar "armor" coat less than 1/8-inch in width will be acceptable.
 - 2) Disbondment of the cement coating over a dielectric coating system should be anticipated and will not be grounds for repair or rejection of the pipe.
 - 3) Losses of cement mortar coating due to impact, movement, or shipping damage shall be repaired in accordance with C205.
 - d. Joint Coating:
 - 1) Joints do not require field application of cement mortar overcoat when properly coated with heat shrink sleeve joint coating system.

3.4 EXTERIOR COATING HOLDBACK

- A. Coating holdbacks shall be straight and cut through the full thickness of the coating.
- B. Cutbacks shall be completed in a manner that permits field coating of joints in accordance with the manufacturer's recommendations and as specified herein.
- C. Holdbacks shall be as required for pipe joints as listed below. Pipe manufacturer may adjust holdback limits as required for special joint assemblies, and with consideration for the joint coating provided and joint welding requirements.

Tape wrap coating	
Push-on joint, spigot	4-inches, minimum
Push-on, bell	Flush with bell end
Welded, spigot	3 inches, minimum
Welded, Bell	4-inches, minimum
Plural component epoxy coating	
Push-on joint, spigot	1-inch before centerline of gasket
Push-on, bell	Flush with bell end
Welded, spigot	3 inches, minimum
Welded, Bell	4-inches, minimum

D. Holdback Corrosion Protection:

1. Holding primer for corrosion protection of cutbacks or holdbacks shall be compatible with the specified joint coating system and weld after backfill requirements, where applicable.
2. Approved holdback primers are:
 - a. Tnemec Omnithane – Suitable for all joints, except joints subject to weld after backfill
 - b. Tnemec 90E-92 Ethyl Silicate Inorganic Zinc Primer – suitable for all joints, including weld after backfill joints.
 - c. ICI Devoe Cathacoat 304V Ethyl Silicate Inorganic Zinc Primer – suitable for all joints including weld after backfill joints.
 - d. Polyken Tape Primers – Not allowed
3. Primer shall not result in running or melting of the coating or cause toxic fumes when heated during welding on weld after backfill joints.
4. Application and thickness of holding primer shall be in accordance with the coating manufacturer's recommendations, but shall not impair the clearances required for proper joint installation.
5. Primer application on spigot end of weld after backfill pipe joints shall be held back a minimum of 1 inch from end of spigot to 2-inch maximum or as necessary to prevent toxic fumes during field welding.
6. Any corrosion within the holdback areas shall be abrasively blasted to near white metal in accordance with SP10 or power tool cleaned to bare metal in accordance with SP11 prior to applying joint coating.

3.5 PIPE LINING APPLICATION

A. Shop-applied Cement Mortar Lining:

1. Centrifugally line straight sections of pipe. Lining of special pieces or fittings shall be by mechanical, pneumatic, or hand placement. Provide cement mortar lining of uniform thickness. Finish to a smooth dense surface.
2. Steel plate specials larger than 16 inches in diameter shall have lining reinforced with 2-inch by 4-inch No. 13-gage welded steel wire mesh.
3. Centrifugally line straight sections of pipe. Lining of special pieces or fittings shall be by mechanical, pneumatic, or hand placement. Provide cement mortar lining of uniform thickness. Finish to a smooth dense surface.
4. Steel plate specials larger than 16 inches in diameter shall have lining reinforced with 2-inch by 4-inch No. 13-gage welded steel wire mesh.
5. Brace and support pipe during lining application to minimize pipe distortion or vibration. Bracing and supports shall not damage the pipe, coating, or lining.
6. Tightly close ends of pipe and fittings with plastic sheet caps. Plastic end caps shall be of sufficient thickness and strength to resist shipping, handling, and storage stresses.
7. Damage to the cement mortar lining, including disbondment, cracking, or blistering, caused by improper curing, shipping, handling, or installation shall be repaired in accordance with AWWA specifications and to the satisfaction of the Engineer.
8. Other requirements of mortar lining materials and processes: As specified in AWWA C205.

B. Liquid Epoxy Lining:

1. Where epoxy lining is specified or shown on drawings, epoxy lining shall be applied directly to the steel surface after abrasively blasting to SSPC SP-5, White metal blast.
2. Clean and coat the interior of cement mortar lined pipe at insulating joints or where specified with two coats of epoxy coating.
3. Epoxy coating applied at insulating joints shall be applied to both sides of the insulating joint for a minimum of one pipe diameter. If only one side of the joint can be coated the coating shall be applied for a minimum of two pipe diameters.
4. Mortar lining shall be allowed to cure 15 days or steam cured not less than 7 days prior to surface preparation of the mortar and epoxy coating application. Hand applied mortar lining shall be allowed to cure a minimum of 15 days or as required to meet the coating manufacturer's requirements for application on cement or concrete, whichever is greater.
5. Prepared mortar lining by abrasive blasting to remove all laitance and create a suitable anchor profile
6. Mortar lining shall be dry during epoxy lining application.
7. Epoxy coating shall be applied in two coats minimum, at a total coating thickness of 16 mils dry film thickness. Coating applied over cement mortar lining shall be applied in a manner that will minimize gassing and pinholes in the completed lining.

3.6 FIELD COATING JOINTS

A. Surface Preparation:

1. All joints shall be prepared as follows:
 - a. Remove all oil and grease contamination from pipe and adjacent coating in accordance with SSPC-SP1, Solvent cleaning.
 - b. Without Holdback Primer:
 - 1) Clean pipe surface and adjacent coating of all corrosion and other foreign contaminants in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal or abrasive blast joints in accordance with SSPC-SP10, near white metal blast.
 - 2) Clean the full circumference of the pipe and a minimum of 4 inches onto the existing coating.
 - 3) No profile is required with SP-11 preparation and heat shrink sleeve joint coating.
 - c. With Holdback Primer:
 - 1) All joints with a holdback primer shall be prepared by removing all oil and grease in accordance with SSPC-SP1, Solvent Cleaning, followed by spot preparation of visible corrosion or rust in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal.
 - 2) Clean the full circumference of the pipe and a minimum of 4 inches onto the existing coating.
2. Remove all loose or damaged pipe coating at joint and either repair the coating as specified herein or increase the length of the joint coating, where reasonable and practical.
3. Joint bonds shall be installed before application of joint coating as specified in Section 13 47 13 – Cathodic Protection. Joint bonds shall be low profile bonds and all gaps and crevices around the bonds shall be filled with filler mastic.
4. Contractor to electrically test completed joint coating for holidays with high voltage spark tester at Engineer's direction or if damage to the joint coating occurs..

B. Weld After Backfill Joint Requirements:

1. Post welding of joints (weld after backfill) is not allowed, unless approved by the Engineer and the welding procedure approved meets the most current requirements for weld after backfill coating protection, holdback coating temperature resistance, heat input monitoring, and welding procedures.
2. Post-welded or 'Weld after Backfill' joints are defined as welded pipe joints that have been coated and backfilled prior to completing interior welds.
3. Post welded joints shall be coated and protected as follows:
 - a. Joint coating shall be Canusa AquaWrap heat shrink joint sleeves only. Tape wrapped joints will not be acceptable.
 - b. Provide 6-inch wide Canusa AquaWrap protective layer centered over the interior weld location as recommended by the joint sleeve manufacturer. Heat resistant tape will not be acceptable.
 - c. Hold back primer shall be suitable for post weld conditions as specified this section and shall not exhibit any binder breakdown in the heat affected zone that causes loss of joint coating adhesion to the holdback primer.
 - d. Filler mastic materials shall be high temperature materials with 500 degree F melting point.
 - e. Joints shall be fully buried prior to welding, with not less than 12-inch cover of soil or flowable fill material on all sides. Sand or flowable fill backfill is preferred for weld after backfill joints.
4. Welding of the joints shall be in conformance with the Section 33 11 11, Steel Pipe, and as modified herein:
 - a. All welding shall be with two or more weld passes as required to meet the specified AWS qualified welding procedures and maximum coating temperature limitations. 'Weld after Backfill' procedures on wall thicknesses of $\frac{1}{4}$ inch or less must be approved by the Construction Manager based on field testing demonstrating the welding procedures can comply with the requirements of this specification.
 - b. Welding speed, amperage, and voltage shall be as required to maintain a maximum heat input of 24,000 joules or a maximum surface temperature at the coating/steel interface of 800 degrees F, whichever is least.
 - c. Maximum weld temperature and duration shall not result in carbonization of the joint coating adhesive. Carbonization is defined as the loss of volatile organic compounds that result in loss of tackiness, adhesion to the steel, and corrosion protection properties.
 - d. Finished joint coating shall not have any visual creases or folds in the joint coating backing material that extends through both the inner protective layer and outer joint sleeve.
5. If Contractor elects to post-weld any joints, Contractor shall demonstrate that the joint welding procedures will not significantly damage the coating by fully excavating the first two joints for evaluation of the joint coating condition. Engineer will randomly select up to three additional post-welded joints for excavation by Contractor for evaluation of joint coating condition. Joint coating will be destructively evaluated by the Engineer. Contractor will remove and replace joint heat shrink sleeve upon completion of the evaluation.
6. In the event that any excavated post welded joint exhibits any heat related damage as defined herein, Contractor shall modify and test a new post welding procedure prior to completing any additional post-welded joints. Contractor shall demonstrate that

the revised joint welding procedure will not significantly damage the coating by repeating the weld after backfill evaluation requirements defined this Section, including excavation of the three additional randomly selected joints for destructive evaluation.

C. Heat Shrink Sleeve Joint Coating:

1. Store, handle, and apply field heat shrink sleeve coatings in accordance with AWWA C216 and these specifications.
2. Store sleeves in shipping box until use is required. Keep dry and sheltered from exposure to direct sunlight. Store off the ground or concrete floors and maintain at a temperature between 60 and 100 degrees as recommended by the sleeve manufacturer.
3. Metal surface shall be free of all dirt, dust, and surface corrosion prior to sleeve application. Surface preparation shall be in accordance with the joint coating manufacturer's recommendations.
4. Where corrosion in the holdback area is visible, surfaces shall be prepared in accordance with SSPC-SP10, near white metal blast, or SSPC-SP11, power tool cleaning to bare metal.
5. Preheat pipe uniformly as recommended by the sleeve manufacturer. Monitor pipe temperature using a surface temperature gauge, infrared thermometer, or color changing crayons. Protect preheated pipe from rain, snow, frost, or moisture with tenting or shields and do not permit the joint to cool.
6. Fill all cracks, crevices, gaps, and step-downs greater than 1/8 inch with filler mastic. Application of filler material shall be in accordance with the manufacturer's instructions for the full circumference of the pipe.
7. Apply heat shrink sleeve when it is at a minimum temperature of 60 degrees and while maintaining the pipe temperature above the preheat temperature specified. Apply sleeve in accordance with the manufacturer's instructions and center the sleeve over the joint to provide a minimum 2-inch overlap onto the existing pipe coating.
8. Completed joint sleeve shall be fully bonded to the pipe and existing coating surface without voids. Mastic beading shall be visible along the full circumference of the sleeve. There shall be no wrinkling or excessive burns on the sleeves. Sleeves that do not meet these requirements shall be removed and the joint recoated as directed by the Engineer. Minor repairs may be repaired using heat applied patch material specified for minor coating repairs.
9. Allow the sleeve to cool before backfilling. In hot climates, provide shading from direct sunlight. Water quenching will be allowed only when permitted by the sleeve manufacturer.
10. Heat shrink joint coatings which have become wrinkled or disbonded because of prolonged exposure to UV light or thermal cycling shall be removed and replaced.
11. Double coating of defective or damaged heat shrink coatings will not be permitted. Any double coated heat shrink sleeves shall be immediately rejected and Contractor shall remove the existing coating and recoat the joint.

D. Cement Mortar Coating:

1. Pipe joints on cement mortar over coated steel pipe do not require cement mortar coating.

3.7 REPAIR OF COATING AND LININGS

A. General:

1. All areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects shall be repaired. Areas where no holidays are detected, but are visually damaged shall also be repaired.
2. Maximum defects allowable shall be as specified herein for the coating system.

B. Tape Wrap Coating Repairs:

1. General:

- a. No more than five repairs per joint of pipe will be permitted with tape wrap coating, excluding adhesion test damage. The coating on any pipe with more than five coating repairs or with more than two areas of coating damage greater than five square feet will be rejected.
- b. Pipes exceeding the maximum number or size of coating defects shall be stripped, reblasted, and recoated.
- c. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the Contractor's expense.
- d. The number of layers and total thickness of the tape repair coating shall be the same as the shop-applied coating; unless heat applied coating materials is used.
- e. Wipe the area to be repaired with solvent for a minimum distance of 4 inches outside the damaged area.

2. Defect Size:

- a. Minor repairs – Any repair that are less than 8 inches in the greatest dimension, measured after cutout of damaged tape layers. Damage to the corrosion protection tape layer will be considered minor if repairs are made using heat applied patch materials.
- b. Major repairs - repairs that exceed 8-inches in the greatest dimension or where damage to the inner tape layer has occurred and hand applied tape repairs will be used.

3. Minor Repairs:

- a. Complete minor repairs using a heat applied coating patch material.
- b. Cut patch material to overlap onto the undamaged coating a minimum of 2 inches on all sides with 1-inch radius on each corner of the patch.
- c. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
- d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.

4. Major Repairs (Over 24-inches Diameter):

- a. Cigarette wrap coating repairs shall be with heat shrink sleeves as specified for joints.
- b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
- c. Holiday test the inner wrap and if a holiday is detected cut outer layers back to fully exposed the holiday(s) and retest for holidays.
- d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.

- e. Width of sleeve shall be the width of the damaged area plus 4-inch overlap. Multiple sleeves may be used for larger repairs, but must be overlapped a minimum of 2 inches.
- 5. Major Repairs (24-inch Diameter or Less)
 - a. Cigarette wrap repairs on pipe less than 24-inches with heat shrink sleeves as specified for major repairs.
 - b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap. Holiday test the inner wrap and if a holiday is detected apply one extra layer of repair tape.
 - c. Clean surfaces by solvent wiping and applying primer over the inner tape layer for a minimum of 6-inches onto the outer wrap in all directions.
- C. Plural Component Epoxy Coating or Lining Repairs
 - 1. General
 - a. Complete coating or lining repairs in accordance with the coating manufacturers written instructions and these specifications, whichever is stricter.
 - 2. Defect Size:
 - a. Minor repairs - repairs that are less than 8-inches in the greatest dimension.
 - b. Major repairs - repairs that exceed 8-inches in the greatest dimension.
 - 3. Maximum Quantity of Defects Allowed:
 - a. Coating or lining repairs on any joint of pipe shall not exceed 1.5 per 100 square feet of surface area.
 - 1) Two or more minor repairs within 6-inches diameter circle will be considered a single repair.
 - 2) Repairs for adhesion testing will not be included in the total number of repairs.
 - b. Major repairs shall not exceed two per pipe joint and the combined area shall not be greater than 40 percent of the pipe.
 - c. Pipes exceeding the maximum number or size of coating defects shall be stripped of coating, reblasted, and recoated.
 - d. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the contractor's expense.
 - 4. Minor Repairs:
 - a. Minor repairs
 - 1) Surface Preparation: Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coat and feather the edges of the defect for a minimum of 2-inches around the defect.
 - 2) Shop Repair Materials:
 - a) Single use plural component epoxy coating kits using single use packaging that controls mix ratio.
 - b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
 - i. Protal 7125, North American Denso Inc, or equal
 - ii. Or equal.
 - c) Coating Manufacturer's plural component epoxy coating repair products subject to Engineer approval.

- 3) Field Repair Materials:
 - a) Heat applied coating materials; CRP Patch, Canusa; PERP Patch, Tyco Adhesives, or approved equal.
 - b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
 - i. Protal 7125, North American Denso, Inc,
 - ii. Or equal.
 - c) Single use plural component epoxy coating kits using single use packaging that controls mix ratio.
 - d) Coating Manufacturer's plural component epoxy coating repair products subject to Engineer approval.
 - 4) Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coating and feather defect edges minimum of 2 inches.
 - 5) Apply a single coat of the specified patch coating material at the specified coating thickness.
 - 6) Repair coating adhesion shall be 50 percent of the specified coating adhesion.
5. Major Repairs:
- a. Major repairs:
 - 1) Surface Preparation:
 - a) The metal surface and surrounding coating shall be abrasively blasted in accordance with SSPC-SP10, near white metal, or to equal in cleanliness and profile as the original surface preparation.
 - b) Existing coating shall be feathered and roughened to the equivalent of 40 grit sandpaper.
 - 2) Shop Repair Materials:
 - a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.
 - 3) Field Repair Materials:
 - a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.
 - b) Heat shrink sleeves as specified for pipeline joints.
 - b. One coat of the specified original coating material shall be applied over the repaired surface at the specified thickness.
 - c. Repair adhesion shall be equal to the specified coating adhesion.

3.8 INSPECTION AND TESTING

A. General

1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.

3. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this specification.
- B. Surface Profile Testing
1. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP287.
 2. Tester tape shall be suitable for the intended profile height.
 3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
 4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.
- C. Adhesion Testing
1. General
 - a. Adhesion testing shall be conducted at the shop prior to shipment. Pipe shipped without adhesion testing will be field-tested. Pipe rejected in the field will be returned to the shop for repair at the sole expense of the Contractor.
 - b. Coating adhesion testing shall be conducted on each pipe lot coated. The quantity of coating adhesion tests shall be the greater of the following:
 - 1) Two pipes will be tested for the first 3,000 square feet of coating application plus on additional pipe for each increment of 2,000 square feet of coating application in excess of the first 3,000 square feet
 - 2) Not less than 25 percent of each pipe produced within a lot.
 - c. A pipe lot is defined as the quantity of pipe that is coated by a single crew within a 12-hour or less work shift.
 - d. The pipe coating applicator shall repair all coating damage from adhesion testing.
 - e. Adhesion tests will be performed not less than 24 hours after coating application. Tests conducted prior to 24-hours will be acceptable only if the test meets or exceeds the adhesion criteria specified and the test was requested by the pipe fabricator.
 - f. Pipe will be randomly selected for adhesion testing.
 - g. Owner or Owner's Representative has the right to conduct additional adhesion testing as deemed necessary to assure the pipe meets or exceeds the requirements of this specification at any time and location.
 - h. Prior to beginning any QA/QC testing, the pipe fabricator, coating manufacturer, and Engineer shall review dolly attachment procedures, adhesion test procedures, and data recording requirements for the project and ensure that test personnel are qualified and capable of performing the testing in accordance with required test standards and these specifications.
 2. Rejection of Pipeline Coating or Lining
 - a. Each pipe that fails the adhesion criteria, as defined this section, shall be rejected.
 - b. If any pipe within a lot that fails to meet the adhesion criteria specified for the coating type, the pipe coating will be rejected and all pipes within the lot will be classified as rejected. Each remaining pipe within the rejected pipe lot will then be individually tested and rejected on a pipe-by-pipe basis in conformance with the test procedures and criteria specific to the coating type.

- c. All rejected pipe shall have the coating fully removed from the pipe and the pipe abrasive blasted and recoated.
- 3. Tape Coating Adhesion Testing:
 - a. Adhesion Acceptance Criteria:
 - 1) Inner tape coating shall have an adhesion to substrate of 20 pounds per inch width, minimum, for steel pipe when tape is pulled in a continuous manner at an angle of 180 degrees to the pipe surface.
 - b. Test Procedures
 - 1) Adhesion testing shall be conducted prior to application of the cement mortar overcoat, where applicable. Pipe that has been mortar coated prior to adhesion testing shall have the mortar coating removed by the Contractor as directed by the Engineer and of sufficient dimensional area to permit the adhesion test to be conducted.
 - 2) Adhesion tests shall be conducted at temperatures above 60 degrees and less than 75 degrees.
 - 3) Pulling tension shall be continuous, without stopping, and monitored throughout the length of the pull, which shall be not less than 12-inches in length.
 - 4) Adhesion test shall be prepared by making two parallel cuts through the coating, 1-inch apart, of sufficient length for the test pull. Peel the coating back at one end and attach the tension scale to the coating with a suitable clamp. Mark the coating at one (1) inch increments from 0 to 12 inches.
 - 5) The pull tension shall be recorded for each inch of pull. The two highest and two lowest readings shall be discarded and the remaining values averaged. Pull speed shall be between 5 and 10 seconds per inch. If significant elongation of the tape backing occurs, pull speeds may exceed 10 seconds per inch provided the minimum adhesion rating can still be achieved.
 - c. Adhesion Pull Records and Evaluation
 - 1) Failure shall be by cohesive failure of the adhesive only. Delamination failure, defined as separation of the adhesive from the backing material, will result in rejection of the tape lot.
 - 2) Intermittent skip failures will be counted as zero pounds of adhesion and included in the calculations for average coating adhesion.
 - 3) Adhesive failure, defined as separation of the adhesive from the metal substrate, will be rejected.
 - 4) Pipe that fails the test by delamination will be retested on two other pipes within the same lot of coated pipe. Failure of any two pipes within the lot will result in rejection of all pipes coated with the rejected tape lot.
- 4. Plural Component Epoxy Adhesion Testing:
 - a. General:
 - 1) Adhesion testing shall be performed in accordance with this specification section.
 - 2) Adhesion testing procedures and evaluations per AWWA C210 are specifically excluded under this specification.

- b. Coating and Lining Adhesion Acceptance Criteria
 - 1) Coating applied to each pipe is acceptable if first dolly pull test exceeds 1,750 psi, minimum.
 - 2) If first dolly pull is less than 1,750 psi, two additional tests shall be performed with acceptance based on "Best of Three" evaluation method defined herein.
- c. Pipe Lot Performance Criteria:
 - 1) Each lot of coated pipe shall be evaluated for general coating application based a median value for all coating or lining adhesion tests performed on a lot of pipe, which shall be greater than 2,000 psi.
 - 2) Any pipe lot failing the Pipe Lot Performance Criteria shall be classified as rejected until 100 percent of the pipe within the pipe lot has been tested for adhesion. Each pipe that fails the coating adhesion criteria shall be rejected.
- d. Test Procedures
 - 1) Coating adhesion testing shall be with self-aligning pneumatic pull off equipment, such as the Delfesko Positest AT-A, and test procedures in accordance with ASTM D4541, except as modified in this section.
 - a) All adhesion tests shall be performed at an applied load rate of 100 psi per second, plus or minus 10 psi. Automatic pull rate adhesion test equipment shall be used.
 - b) Adhesion tests shall be based on the ASTM D4541 using standard 20 mm dollies.
 - c) Adhesion testing shall be based on three tests. All three tests shall be conducted by the same person, test equipment, and test procedure, and must be completed within a 30 minute period.
 - d) All adhesion tests shall be conducted within an area not to exceed 6 inches by 6-inches.
 - e) All dollies shall be scored to metal substrate using manual methods and tools, normal to the pipe surface, and in a manner that does not stress or over heat the coating.
 - f) All adhesion tests shall be performed to glue or coating failure or test termination, whichever comes first.
 - 2) Dollies for adhesion testing shall attached to the coating surface using an two part epoxy or cyanoacrylate glue and allowed to cure for a minimum of 12 hours before testing or until full cure, whichever is greater. Glue type used shall be determined by the pipe fabricator and coating manufacturer for the pipe diameter, temperatures, and environmental conditions.
 - 3) Adhesion testing shall be performed at temperatures between 55 and 90 degrees F or at temperatures as recommended by the coating manufacturer. Testing up to 115 degrees F or below 45 degrees will be permitted if tests can demonstrate no statistically detectable effect on test results and subject to Coating Manufacturer and Engineer approval.
- e. Adhesion Test Evaluation and Records

- 1) The "Best of three" evaluation method shall be defined as two of three test values less than the Acceptance Criteria, which shall result in rejection of the pipe coating.
- 2) All adhesion tests shall be considered as valid and suitable for acceptance or rejection of the coating, except where retesting is allowed.
- 3) Adhesion test failure shall be by adhesive or substrate and cohesive failure as defined below:
 - a) Adhesive or substrate failure is defined as a percentage of separation of the coating from the steel substrate or between distinct coating layers.
 - b) Cohesive failure is defined as a percentage of failure within the coating, resulting in coating remaining both on the steel substrate and test dolly.
- 4) Retesting of coating adhesion tests will be allowed when any test is glue failure at 25 percent or more of dolly surface area and the test value is less than the Acceptance Criteria or the Minimum Criteria.
- 5) All coating adhesion retesting shall be within the same 6-inch by 6-inch test area as the original adhesion testing.
- 6) Disputed adhesion tests shall be retested as defined for adhesion retesting. Dolly attachment and adhesion retesting shall be witnessed by the Owner's representative.
- 7) Adhesion tests will be conducted on pipe coating and lining independently and will be accepted or rejected independently.
- 8) Records of all adhesion tests shall be maintained in an electronic spreadsheet that includes the following information:
 - a) Pipe identification,
 - b) Pipe coating date,
 - c) Adhesion test date,
 - d) Surface tested (interior or exterior),
 - e) Surface temperature at time of test,
 - f) Coating thickness,
 - g) tensile force applied,
 - h) Applied load rate per second,
 - i) Mode of failure, and
 - j) Percentage of failure types, previously defined, relative to dolly surface area,
 - k) Dolly size and attachment glue used.
 - l) If different coatings are tested, the records shall include coating manufacturer and product number.

f. Adhesion Test Repairs

- 1) Fabricator or contractor to complete adhesion repairs as specified this section.
- 2) Repair patches on the polyurethane coating shall be randomly selected for adhesion testing in a manner as described herein and at the discretion of the coating inspector conducting the adhesion tests. Adhesion of repairs shall be as specified for the type of repair.

D. Holiday Testing

1. Holiday test the inner layer of tape wrap coatings after application and prior to the subsequent tape layer in accordance with AWWA C214 and NACE Standard RP-0274.
 2. Holiday test extruded polyolefin coating after application in accordance with AWWA C215 and NACE Standard RP-0274, whichever is more stringent.
 3. Holiday tests on epoxy coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE Standard RP-0274 and these specifications.
 4. Coating thickness used for holiday testing shall be the minimum specified coating thickness.
- E. Dry Film Thickness Testing
1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off or eddy current equipment.
 2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

3.9 HANDLING, TRANSPORTATION, AND STORAGE

- A. Pipe shall be handled in such a manner as to protect the pipe and coating from damage.
- B. Coated pipe shall not be shipped or installed until coating has developed full adhesion and cure.
- C. During coating application, storage, loading, transportation, unloading, laying and installation, every precaution shall be taken to protect and prevent damage to pipe, lining, and coating. Forklift equipment shall have all bearing surfaces padded with suitable padding material. Lift pipe with web slings a minimum of 12-inch wide and of a type that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.
- D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. All pipe contact locations shall be heavily padded with carpet and strips of the outer tape wrap material (adhesive side against the carpet) during shipment to the project site and from the storage yard to the point of installation.
- E. Pipe shall not be stored on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Pipe shall not be laid on asphalt without suitable padding at all contact points.
- F. Pipe shall be inspected by the Contractor at the project site for damage. Any damage to the pipe, lining, or coating shall be repaired as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense to the Contractor.
- G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk on the coating except when

absolutely necessary and approved by the Engineer. When permitted, shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating shall be used.

H. Long-term Exposure:

1. Pipe shall either be provided with UV inhibitor for lengthy of above grade exposure or covered to prevent UV degradation of outer wrap.
2. Amount of UV stabilizers required will depend on the project location, laying schedule, anticipated length of exposure, and type of coating.
3. Manufacturer shall be consulted for recommended UV inhibitors requirements.
4. Protective covering can be colored plastic sheeting, canvas, or other UV blocking material. Clear plastic sheets are not acceptable.
5. Areas of coating that display UV degradation shall be removed and repaired at sole cost of the Contractor.

I. End Caps: Pipe ends of mortar lined pipe and fittings shall be tightly closed with a plastic wrap to aid in curing and to minimize drying out of and contamination of the lining. Plastic end cap shall consist of a minimum of one 10-mil sheet of polyethylene or other suitable material. End caps shall be substantial enough to resist shipment, handling, and storage loads and firmly attached in place. The plastic end cap shall remain intact and in place until pipe installation. Damaged or missing plastic end caps shall be repaired or replaced.

END OF SECTION

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DIVISION 10
SPECIALTIES

SECTION 10 44 13
FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install fire protection cabinets for the following:
1. Portable, hand-carried fire extinguishers.

1.2 RELATED SECTIONS

- A. Section 10 44 16 Fire Extinguishers

1.3 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
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ASTM A1008	Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
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ASTM D4802	Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
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- B. National Association of Architectural Metal Manufacturer's (NAAMM) standards, most recent editions:

AMP 500	Metal Finishes Manual
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- C. National Fire Protection Association (NFPA) standards, most recent editions:

NFPA 70	Standard for Electrical Safety in the Workplace and Handbook
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1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

- B. Product Data: Furnish for each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for cabinets.

1. Include rough-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

- C. Operation and Maintenance Data: Submit operation and maintenance data suitable for inclusion in facility operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: When such are used, listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Delivery Schedule: For fire protection cabinets, coordinate final fire extinguisher cabinet schedule with fire extinguisher schedule to ensure proper fit and function.
- C. Acceptance at Site: Inspect all boxes and packages upon delivery to the Project Site. Notify Engineer, in writing, if any loss or damage exists to products or components. Replace loss and repair damage to new condition in accordance with manufacturer's original specifications and specific instructions.

1.7 COORDINATION

- A. Coordinate type and capacity of fire protection cabinets with fire extinguishers to ensure fit and function.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with Contract Documents, the following manufacturers are acceptable:
 - 1. Fire Extinguishers:
 - a. Amerex Corporation.
 - b. J.L. Industries, Inc.
 - c. Larsen's Manufacturing Company.
 - d. Potter Roemer, LLC.
 - e. Engineer approved equal.

2.2 MATERIALS

- A. Steel Sheet: ASTM A1008, Commercial Steel (CS), Type B.
- B. Stainless Steel Sheet: ASTM A666, Type 304
- C. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), 1/4 inch, with Finish 1 (smooth or polished).

2.3 FIRE PROTECTION CABINET

- A. Cabinet Type: Surface mounted, suitable for fire extinguisher.
- B. Cabinet Construction: Non-rated.

- C. Cabinet Material: Stainless Steel sheet.
- D. Trim Style: Rounded edges, stainless steel sheet.
- E. Identification: Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
 - 1. Location: Applied to cabinet door:
 - 2. Application Process: Engraved or decal.
 - 3. Lettering Color: Black or Red.
 - 4. Orientation: Vertical.
- F. Door Style: Vertical duo panel with frame.
- G. Door Glazing: Clear transparent acrylic sheet.
- H. Door Hardware
 - 1. Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

2.4 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Provide factory-drilled mounting holes.
 - 3. Prepare doors and frames to receive locks.
 - 4. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 FINISH

- A. General
 - 1. Comply with NAAMM's AMP 500 for applying and designating finishes.
 - 2. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
 - 3. Finish fire protection cabinets after assembly.
 - 4. Notable variations in finish of same piece are not acceptable. Variations in appearance of adjoining components are acceptable if approved by Engineer and they are assembled or installed to minimize contrast.
- B. Stainless Steel Finishes
 - 1. Surface preparation: Remove tool and die marks and stretch lines, or blend into finish.

2. Grind and polish surfaces to produce uniform finish, free of cross scratches
 - a. Directional satin finish, No. 4.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fire protection cabinets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Fasten cabinets to structure, square and plumb, at locations indicated.

3.2 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory finished appearance, subject to approval of Engineer. Use only materials and procedures recommended or furnished by fire protection cabinet manufacturer.
- E. At direction of Engineer, replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install portable, hand-carried fire extinguishers.

1.2 RELATED SECTIONS

- A. Section 10 44 13 Fire Extinguisher Cabinets

1.3 REFERENCES

- A. National Fire Protection Association (NFPA) standards, most recent editions:

NFPA 10	Portable Fire Extinguishers
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1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Product Data: Furnish for each type of product indicated. Include information on rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguishers.
- C. Operation and Maintenance Data: Submit operation and maintenance data suitable for inclusion in facility operation and maintenance manuals.
- D. Warranty Documentation: Submit sample of manufacturer's warranty.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10.
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
- C. UL Listing: Provide fire extinguishers with UL Rating as noted for each type and size.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Delivery Schedule: For fire extinguishers, coordinate final fire extinguisher schedule with fire extinguisher cabinet schedule to ensure proper fit and function.

- C. Acceptance at Site: Inspect all boxes and packages upon delivery to the Project Site. Notify Engineer, in writing, if any loss or damage exists to products or components. Replace loss and repair damage to new condition in accordance with manufacturer's original specifications and specific instructions.

1.7 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with Fire Protection Cabinets to ensure fit and function.

1.8 WARRANTY

- A. Special Warranty: Provide manufacturer's stand form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within warranty period.
- B. Failures include, but are not limited to, the following:
 - 1. Failure of hydrostatic test according to NFPA 10.
 - 2. Faulty operation of valves or release levers.
- C. Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with Contract Documents, the following manufacturers are acceptable:
 - 1. Fire Extinguishers:
 - a. Amerex Corporation.
 - b. J.L. Industries, Inc.
 - c. Larsen's Manufacturing Company.
 - d. Potter Roemer, LLC.
 - e. Engineer approved equal.

2.2 FIRE EXTINGUISHERS

- A. Provide only new extinguishers of type, size, and capacity for each fire extinguisher cabinet and mounting bracket indicated.
- B. Multipurpose Dry-Chemical in Steel Container: UL-rated 4A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
- C. Valves: Manufacturer's standard.
- D. Handles and Levers: Manufacturer's standard.
- E. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine surfaces, areas, and finishes for compliance with conditions affecting fire extinguisher mounting.
- B. Preinstalling Testing: Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers
- C. Proceed with installation only after any unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

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DIVISION 23
HVAC

SECTION 23 00 00
HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all heating, ventilating, and air conditioning systems and equipment complete with all supports, mounting frames, duct work, piping, louvers, panels, filters, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation, appurtenances, complete and operable in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All Work and materials shall be in full accordance with the latest rules and regulations or publications of the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning Systems), the local Plumbing Code, the local Mechanical Code, the local Building Code, and all other applicable local codes. In the absence of applicable codes, the installation and workmanship shall follow the standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Shop drawings shall be submitted for equipment in accordance with Section 01 33 20 – Submittal Procedures.
- B. Equipment Numbers: Equipment is identified by assigned numbers for reference and location purposes in the Contract Documents. The appropriate equipment numbers shall be indicated on the Shop Drawings and on other submittals.

1.4 SPECIAL WARRANTY REQUIREMENTS

- A. The air conditioners, heaters, and all fans and blowers shall carry the manufacturer's standard warranties, and all such warranties shall be furnished upon final acceptance of the completed systems. All refrigerant compressors shall carry a 5 year warranty by the manufacturers.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Quality: All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be of the manufacturer's top line, industrial-commercial grade.

- B. Supports: All equipment and appurtenances shall be firmly anchored or connected to supporting members. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided by the heating and ventilating subcontractor, unless otherwise indicated. Vibrating equipment shall be supported on restrained spring-type vibration isolators.
- C. Noise/Vibration Control: The system shall be free of any objectionable vibrations and noise. Flexible connections shall be provided in all ducts and piping connections to fans, compressors, and any other vibrating equipment.

2.2 DUCTWORK AND MISCELLANEOUS ACCESSORIES

- A. Construction: Sheet metal ducts and plenums shall be constructed with airtight joints and seams in accordance with ASHRAE standards, SMACNA Duct Construction Manual, and SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems. All joints on concealed ducts shall be taped with pressureless tape and adhesive, except welded or soldered joints. Ductwork materials shall be galvanized steel or aluminum, unless otherwise indicated. Minimum duct gauges required are as follows:

<u>Maximum Size of Ducts (inches)</u>	<u>Galvanized Steel U.S. Standard Gauge</u>	<u>Aluminum B and S Gauge</u>
12 and less	26	24
13 through 30	24	22
31 through 54	22	20
55 through 84	20	18

- B. Supports: Supports for horizontal ducts and plenums shall be galvanized steel angles with hanger rods. Supports for vertical ducts shall be band iron strap or angle bracket type. Inlet ducts shall be amply braced to withstand maximum negative pressure.
- C. Duct Dimensions: All sheet metal duct dimensions shall be increased by 2 inches for 1 inch acoustically lined ducts.
- D. Insulation: The exterior of all concealed ductwork inside of buildings downstream of air conditioning or heating units, other than ducts located in air conditioned spaces, shall be insulated with 2 inch thick flexible glass fiber insulation with a UL-labeled vapor barrier. All joints shall be taped to provide a continuous vapor seal. The insulation shall be attached to the ducts with adhesive applied in a 50 percent coverage. Insulation also shall be secured to the bottom of rectangular ducts over 24 inches wide with mechanical fasteners spaced 12 inches on centers. Exposed ductwork inside buildings will be internally lined and will not require exterior insulation.
- E. Lining: The interior of supply and return ducts and plenums within 10 feet distance from fans and all ductwork exposed to the weather shall be lined. Duct lining shall be 1 inch thick fiber glass applied to the inside of the ducts with adhesive with 100 percent coverage and mechanical fasteners 12 inches on center in both directions starting approximately 6 inches

from ends of insulation. All exposed edges, ends, and rough surfaces shall be painted with adhesive or taped with 3 inch canvas tape dipped in adhesive.

- F. Balancing Dampers: Butterfly or multiblade dampers shall be provided as indicated or required for balancing air quantities to values indicated. A locking quadrant shall be provided on each manual damper, with easy access for operation.
- G. Motorized Dampers: Automatic control dampers shall be fabricated of 22 gauge galvanized sheet steel with 10 inch maximum blade width and 50 inch maximum blade length per section. Dampers shall be of the opposed-blade type for proportional action and parallel-blade type for two-position action. Blades shall be set in a suitable channel frame. Blades shall have neoprene-gasketed wall frames together with weather louvers. Damper operators shall be sized to provide modulating or two-position action as required. Intake and exhaust dampers shall close and return damper open on control failure. Operators shall be provided for all motorized dampers.
- H. Bird Screens: Removable bird screens shall be provided on all outside air intakes and exhaust air discharges to outside air. Screens shall be secured in frames of same metal as screens. Bird screens shall be 1/8 inch mesh by 14 gauge and shall be of same material and finish as duct, hood, louver or equipment to which the screens are attached.
- I. Flexible Connectors: Flexible duct connections shall be made with banded or flanged 8 ounce canvas, or reinforced plastic, or equal at each point where a blower unit is connected to a duct. A minimum clearance of 3 inches between the duct and source of vibration shall be maintained.
- J. Diffusers, Grilles, and Registers: All supply air registers and diffusers, return air, and exhaust grilles shall be of aluminum construction, with smooth corners, flanges, and sponge rubber gaskets. All supply and return air registers and diffusers shall have individually adjustable blades and volume control dampers. All ceiling-mounted outlets shall be off-white. Wall-mounted outlets shall be factory prime coated. All diffusers, grilles and registers, shall be Titus; Agitair; Krueger; or equal. See schedule on drawings for types.

2.3 FILTERS

- A. All ventilation supply fans and air conditioners shall be provided with filter compartments. The filters shall be of the disposable, medium efficiency, pleated, non-woven cotton media type, with media support grid and enclosing frame. Provide Cam-Farr 30/30 or equal.

2.4 PIPING

- A. All piping in connection with air conditioning work shall be in accordance with Section 15010 Mill Piping, Exposed and Buried. Where not indicated, the equipment drains shall be of Type "K" copper tube or Schedule 40 galvanized steel pipe.

2.5 CONTROLS

- A. General: All heating, cooling, ventilating, and air conditioning equipment shall be provided with manual or automatic control systems as indicated. Where various items of equipment are operating in conjunction with one another, they shall be controlled by an integrated

control system located in a control panel. Such systems shall have 12-hour timers and 7-day time clocks. Unless otherwise indicated, individual cooling fans shall be controlled from HAND-OFF-AUTOMATIC line voltage cooling thermostats, wall-mounted. Individual exhaust fans shall have manual switches for single or two-speed motors as indicated. Exhaust fans operating in conjunction with central ventilating or air conditioning systems shall be interlocked with these systems. Electric unit heaters shall have unit-mounted contactors, unless otherwise indicated, and they shall be controlled from wall-mounted line voltage heating thermostats.

- B. Thermostats: Room thermostats shall be of the modulating electric type, except where two-position action is required. Thermostats shall be located in air-conditioned spaces and shall have 60 to 80 degrees F dials. All thermostats shall have exposed adjustment dials and a thermometer on the front face. Mounting height shall be 4 feet. An insulating back shall be provided. Guards shall be provided for room thermostats installed in areas other than administrative offices or control rooms.
- C. Controllers and Timers: Motorized step controllers shall be selected to provide a dead band between heating and cooling functions. Each air conditioning unit shall be provided with a manual timer and a timeclock. Manual timer switch shall be 12-hour, spring-wound with "hold" feature to override the timeclock during off-hour operation. Timeclocks shall be 7-day programming type with spring reserve feature and trippers as required. All components of the control system shall be of the same manufacturer, except where a specific manufacturer is listed.
- D. Fan Timers: All fan timers shall be Tork 8001, no equal.
- E. Manufacturers: Control system components and thermostats shall be as manufactured by Honeywell; Johnson Controls Company; General Controls; Novar; or equal. All control wiring from thermostat to equipment, and appurtenances shall conform to Section 16050 Electrical General Provisions.

2.6 CONTROL PANELS

- A. General: Control panels shall contain all relays, control switches, transformers, pilot lights, timers, time clocks, step controllers, gauges, thermostats (unless otherwise indicated), and other accessories necessary for the particular system. Panels shall be aluminum with baked enamel finish, hinged front door, and locking handle. All manual switches and direct-reading gauges shall be flush-mounted on the front face, identified by engraved and riveted Bakelite or laminated plastic nameplates with white letters on black background. Manual switches shall be of heavy-duty, oiltight construction.
- B. Wiring: Control devices shall be prewired internally. All wires leaving the panel shall be terminated at separate numbered terminal strips. Individual connectors shall be provided for every item of mechanical equipment, all integral and remote pilot lights, and other devices described for each panel. Power and control circuit requirements shall be as indicated. All wires shall be identified by color coding or numerical tags at both ends. Each control device shall be wired without splices to the terminal strip. Integral circuit protection shall be provided for all panel-mounted control devices. Each panel shall be wired with a single 20-amp, 120-volt, ac feeder in accordance with Section 26 00 00 – Electrical General Provisions.

- C. Diagrams: Black and white graphic schematic diagrams shall be provided on the front face of each panel, showing all equipment within the respective systems. All pilot lights and temperature-indicating dials shall appear on the schematic in a location corresponding to the actual system location. Manual selector switches shall be directly below the equipment symbol being controlled. One spare light bulb shall be furnished for each four pilot lights, stored inside the panel in dummy light sockets secured to the back panel surface. Schematics shall be smooth laminated plastic or engraved Formica. Panel electrical wiring diagrams shall be secured to the inside of the panel door.

2.7 FANS

- A. General: Location, type, capacity, and motor horsepower of all fans shall be as indicated. Fans shall be complete with motors, adjustable motor bases, adjustable drives, safety cages, belt guards, flexible connections to supply and/or suction ducts, vibration isolators, and necessary accessories. All fans shall be suitable for continuous operation.
- B. Performance: Fans shall be guaranteed to deliver the quantities of standard air against the respective static pressure without deviating by more than 5 percent. Every fan wheel, regardless of size, shall be statically and dynamically balanced, and shall be free from objectionable vibration or noises.
- C. Ceiling Exhaust Fans: As specified in Drawings, Cook Model GC-142 or equal.
- D. Wall-Mounted Propeller Fans: Wall-mounted exhaust fans shall be belt type, motor-driven, unless otherwise indicated, and shall be supported on metal frames for mounting, with safety guards. Wall openings and louvers shall be of sufficient size for the fan capacity. Drives shall be belt type, rated for 1.5 service factor. Bearings shall be pre-lubricated ball bearing type.
- E. Inline Exhaust Fans: Inline exhaust fans shall be spun aluminum, duct mounted, and direct motor-driven. Spun aluminum housings shall be constructed of minimum 11 gauge marine alloy aluminum with inlet and outlet flanges. Straightening vanes shall be utilized for uniform airflow. The adjustable mounting brackets shall be constructed of minimum 8 gauge aluminum with extruded rubber isolation between bracket and fan housing. Unit shall bear an engraved aluminum nameplate indicating design CFM and static pressure. Wheel shall be a non-overloading design utilizing airfoil blades for maximum efficiency. The aluminum airfoil blades shall be welded to a spun aluminum dome. The dome shall be bolted to an aluminum hub assembly. The hub shall be keyed and locked to the motor shaft utilizing two setscrews. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.
 - 1. Manufacturers, or equal:
 - a. Loren Cook Company (Model CVD).
- F. Corrosion-Resistant Fans: All fans in corrosive atmospheres shall be constructed of materials that are-resistant to the corrosive factors in the environment in which they are installed or they shall be coated with a suitable protective coating in accordance with the manufacturer's printed recommendations.

2.8 LOUVERS

- A. At air openings in the outside wall where indicated on drawings, install AMCA rated drainable stationary extruded aluminum 6" deep weather louvers. Blades shall be on approximately 5" centers with integral downspouts to drain the water from the louver blades. Stationary louvers shall pass 1000 fpm free area velocity with less than 0.2" static pressure drop and shall carry less than .03 ounces of water per square foot when tested in accordance with AMCA Standard 500. Install screens on interior face and louver. Furnish with "Standard" frame suitable for building wall construction. Furnish with extended sill. Louvers shall be the Ruskin unit scheduled or equal from American Warming and Ventilating, Louvers and Dampers, Krueger or Cesco. Coordinate with the Architectural and Structural details for actual wall opening sizes. Finish shall be as selected by Owner. Submit color samples for final selection by the Owner. Contractor must coordinate louver size, flange type, and construction with structural and architectural openings to assure fit and appearance. Louvers shall be one piece.

2.9 MOTORIZED CONTROL DAMPERS

- A. Control dampers are furnished and installed by this Section. Dampers shall be supported, plenum openings shall be reinforced, the entire assembly shall be sturdy and operate smoothly. Dampers shall be low leakage type with spring loaded side seals, inflatable butyl or neoprene fabric edge seals, bronze or teflon bearings, reinforced extruded aluminum blades. Parallel action. Air leakage not to exceed 5 CFM per square foot at 4" upstream static pressure. Ruskin CD50 or Greenheck VCD-43.

2.10 CONTROL SEQUENCES:

- A. Inlet Valve Vault: The Inlet Valve Vault shall be heated by a wall mounted electric heater controlled by a wall-mounted thermostat to maintain heating setpoints set by the Owner. The Inlet Valve Vault shall be continuously ventilated when occupied, and ventilated via timer on a regular schedule when not occupied.

PART 3 - EXECUTION

3.1 GENERAL

- A. Roughing-In: Ascertain that all inserts, chassis, shafts, and openings are correctly located; otherwise all new openings required shall be cut at no increase in cost to the OWNER.
- B. Checking: Test and make tight all Work, furnish all equipment necessary to carry out the tests and thoroughly clean the system before starting same.
- C. System Balancing: After completion of all required Work, have the system, as a whole, checked and balanced by an independent air balancing company, registered by the Associated Air Balancing Council, with one member of the agency certified by the National Examination Board as a test and balance engineer. System balancing shall include the following:
 - 1. Adjusting fans, dampers, diffusers, registers and other devices so that the quantities of air, and refrigerant called for on the Drawings are supplied, returned, or exhausted.

2. Measuring and recording at least once the air temperatures delivered through each on full heating and full cooling. Make all necessary adjustments to obtain the indicated conditions.
3. Measuring and recording current on each fan and motor, and checking for proper operation of all equipment.
4. Adjusting any adjustable blade registers to the correct setting to obtain the design conditions.

END OF SECTION

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**SECTION 23 58 00
ELECTRIC HEATING SYSTEMS**

PART 1 - GENERAL

1.1 SUMMARY

- A. The subcontractor shall provide the electric heaters, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. Single Manufacturer: Where two or more heaters or appurtenances of the same type or size are required, they shall be furnished by the same Manufacturer.

1.2 SUBCONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01 33 20 – Submittal Procedures.

The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.3 WORKMANSHIP AND MATERIALS

- A. All Work shall be in strict accordance with the State Mechanical Code, the State of Utah, Salt Lake County, Herriman City, and any other authorities having jurisdiction. The subcontractor shall have the required certification and be thoroughly familiar with the local codes. The subcontractor shall obtain and pay for all necessary permits.
- B. Workmanship shall be first-class in every respect and all Work shall be performed by workers who are thoroughly experienced in this line of Work. The subcontractor's attention is called to the fact that neat and workmanlike appearance in the finished installation shall be required. Care shall be taken at all times to protect floors, stairways, and walls during the make-up, erection of piping and placing of equipment. The subcontractor shall remove all stains and repair all damage before final acceptance of the Work.
- C. All materials used in connection with the electric heating system Work shall be new, free from flaws and defects all fully equal to the quality specified, and where not specifically indicated shall be the best of their respective kinds, and shall conform to the applicable specifications and standards.
- D. If during the construction of this project the design/cm finds materials that have identifying marks removed, or lacking such marks completely, he may reject such items until the subcontractor has shown proof that said items conform to the letter and intent of the Specifications and the Contract Drawings. The adequacy and extent of such proof shall be determined by the design/cm.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

- A. Unit heaters shall be of the horizontal or vertical type as shown on the Contract Drawings, complete with motor, fan, wire guard, heating element, casing, vibration isolators and support brackets. Heaters shall include wall or ceiling mounting brackets.
- B. Fan casings shall be steel reinforced to provide a suitable support for the heating element and for attachment of the support brackets. Casings shall be finished with factory finish. All units shall be provided with their own wall mounting brackets.
- C. Fans shall be multi-blade propeller type units direct connected to the motor shaft and/or centrifugal fan and motor units all statically and dynamically balanced.
- D. Motors shall be especially designed for unit operation. Fan shafts shall be equipped with self-aligning ball or roller bearings and shall extend a sufficient length to receive the fan hub. The fan shall be keyed and locked to the fan shaft. Fan and motor unit shall be mounted on vibration isolators to prevent noise.
- E. Electric heating bank shall consist of metal sheath aluminum-finned heating elements. Automatic reset thermal over-heat protection shall be of the linear capillary type wired for instantaneous de-energizing. Heating bank to have protective air inlet louvers. Units shall be U.L. listed and meet the requirements of the National Electric code.
- F. Low voltage control transformers shall be furnished.
- G. All heaters shall be provided with power disconnect switches (field installed kits) and electric unit heaters shall have built in thermostat unless otherwise shown on the Contract Drawings.
- H. The heaters shall be manufactured by Reznor; Chromalox; or equal.
- I. **Inlet Valve Vault Electrical Room: Chromalox LUH-15-43-32-00, 15 KW, 480 V, 3-phase.**

2.2 ELECTRICAL AND MOTORS

- A. The electrical and motors for electric heating systems shall be as specified in Section 23 00 00 - Heating, Ventilating, and Air Conditioning of these Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All electric heating equipment shall be installed by a qualified subcontractor in strict accordance with the manufacturer's recommendations.

END OF SECTION

DIVISION 26
ELECTRICAL

SECTION 26 00 00
ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide electrical and appurtenant Work necessary for a complete and operable electrical system, in accordance with the Contract Documents.
- B. Make all field connections and terminations to all motors, switchgear, panels, control equipment and devices, instruments, and to all vendor-furnished packaged equipment. The requirements of this Section shall apply to all electrical items indicated in the various Sections of Division 16 unless otherwise indicated.
- C. Provide all materials and incidentals required to complete the electrical work. Typical materials which may be incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and all control wires required by vendor-furnished equipment to interconnect with other equipment all specifically indicated on the Contract Documents.
- D. All concrete work required for encasement, installation, or construction of the Work specified in the various Sections of Division 26 shall be 3,000 psi concrete, and the following requirements shall apply:
 - 1. Consolidation of encasement concrete around duct banks shall be by hand puddling, and no mechanical vibration shall be permitted.
 - 2. A workability admixture shall be used in encasement concrete, which shall be a hydroxylated carboxylic acid type in liquid form. Admixtures containing calcium chloride shall not be used.
 - 3. Concrete used to encase conduits shall be made with gravel containing rocks $\frac{3}{4}$ inch in size or less. It shall be wet enough to flow easily into the spaces around the conduits, but not so fluid as to float the conduits.
 - 4. Concrete for encasement of conduit or duct banks shall contain an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes and Standards

NEC National Electrical Code, latest edition

B. Government Standards

FS W-C 596E/GEN(1)	Connector, Plug, Receptacle and Cable Outlet, Electrical Power
FS W S 896E/GEN(1)	Switches, Toggle (Toggle and Lode), Flush Mounted (ac)
FS WW C 581D, E	Conduit, Metal, Rigid, And Intermediate; And Coupling, Elbow, and Nipple, Electrical Conduit: Steel, Zinc Coated

OSHA Safety and Health Standards, 29 CFR 1910 and 29 CFR 1926 as applicable

C. Commercial Standards

ANSI C80.1 Zinc Coated, Rigid Steel Conduit, Specification for

ANSI C80.4 Fittings for Rigid Metal Conduit and Electrical Metallic Tubing, Specifications for

ANSI/UL 467 Grounding and Bonding Equipment, Safety Standard for

ASTM B 3 Soft or Annealed Copper Wire

ASTM B 8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, and Soft

ASTM B 33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

ICEA S 61 402 Thermoplastic Insulated Wire and Cable

ICEA S 68 516, NEMA WC8 Ethylene Propylene Rubber Insulated Wire and Cable

NEMA 250 Enclosures for Electrical Equipment (1,000 volts maximum)

NEMA PB 1 Panelboards

UL 6 Rigid Metal Electrical Conduit

UL 514 Electrical Outlet Boxes and Fittings

D. All equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL) or an independent testing laboratory acceptable to the local Code-enforcement agency having jurisdiction.

E. The construction and installation of all electrical equipment and materials shall comply with all applicable provisions of the OSHA Safety and Health Standards (29CFR1910 and 29CFR1926, as applicable), State Building Standards, and applicable local codes and regulations.

1.3 PERMITS AND INSPECTION

A. Permits shall be obtained and inspection fees shall be paid for as indicated in Article 6.06 of the General Conditions.

1.4 CONTRACTOR SUBMITTALS

A. Shop Drawings and Catalog Data: Submit shop drawings and catalog data submittals in accordance with Section 01 33 20 – Submittal Procedures.

- B. Submit complete material lists for the Work of this Section. Such lists shall state manufacturer and brand name of each item or class of material. Submit shop drawings for all grounding work not specifically indicated.
- C. Shop drawings are required for materials and equipment listed in other sections. Shop drawings shall provide sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications. The following shall be included:
1. Front, side, rear elevations and top views with dimensional data.
 2. Location of conduit entrances and access plates.
 3. Component data.
 4. Connection diagrams, terminal numbers, wire numbers, internal wiring diagrams, conductor size, and cable numbers.
 5. Method of anchoring, seismic requirement; weight.
 6. Types of materials and finish.
 7. Nameplates.
 8. Temperature limitations, as applicable.
 9. Voltage requirement, as applicable.
 10. Front and rear access requirements.
- D. Catalog data shall be submitted to supplement all shop drawings. Catalog cuts, bulletins, brochures, or the like or photocopies of applicable pages thereof shall be submitted for mass produced, noncustom manufactured material. These catalog data sheets shall be stamped to indicate the project name, applicable Specification section and paragraph, model number, and options. This information shall be marked in spaces designated for such data in the stamp.
- E. Materials and Equipment Schedules: Furnish within 30 days, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
- F. O&M Manuals: Furnish manuals as part of the shop drawing submittals under "Operation and Maintenance Manuals" in Section 01 33 20 – Submittal Procedures.
- G. Record Drawings: In addition to the record drawings as a part of the record drawing requirements specified in Section Section 01 33 20 – Submittal Procedures, show depths and routing of all duct bank concealed below grade electrical installations. Said set of record drawings shall be available to the Engineer during construction. After final inspection, transfer all record drawing information using a red pen to a set of drawings which shall then be delivered to the Engineer. In addition, the record drawings shall show all variations between the Work as actually constructed and as originally shown on the Drawings, based upon information supplied by the Contractor.

1.5 QUALITY ASSURANCE

- A. Field Control of Location and Arrangement: The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Determine exact locations in the field based on the physical size and arrangement of

equipment, finished elevations, and other obstructions. Locations shown on the Drawings, however, shall be adhered to as closely as possible.

- B. All conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms, as shown. Where the Drawings do not indicate exact locations, such locations shall be obtained from the Engineer. Where equipment is installed without instruction and must be moved, it shall be moved without additional cost to the Owner.
- C. Workmanship: All materials and equipment shall be installed in accordance with printed recommendations of the manufacturer which have been reviewed by the Engineer. The installation shall be accomplished by workmen skilled in this type of work and installation shall be coordinated in the field with other trades so that interferences are avoided.
- D. All Work, including installation, connection, calibration, testing, adjustment, and paint touchup, shall be accomplished by qualified, experienced personnel working under continuous, competent supervision. The completed installation shall display competent work, reflecting adherence to prevailing industrial standards and methods.
- E. Protection of Equipment and Materials: Furnish adequate means for and shall fully protect all finished parts of the materials and equipment against damage from any cause during the progress of the Work and until acceptable by the Engineer.
- F. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts shall be kept clean and dry.
- G. Replace or have refinished by the manufacturer, all damaged materials or equipment, including face plates of panels and switchboard sections, at no expense to the Owner.
- H. Tests: Perform all tests required by the Engineer or other authorities having jurisdictions. All such tests shall be performed in the presence of the Engineer. Furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation. The following testing shall be accomplished:
 - 1. Insulation resistance tests under "Wire and Cable," below.
 - 2. Operational testing of all equipment furnished and/or connected in other Sections of Division 26, including furnishing of support labor for testing.
- I. Standard test reports for mass-produced equipment shall be submitted along with the shop drawing for such equipment. Test reports on testing specifically required for individual pieces of equipment shall be submitted for review prior to final acceptance of the project.
- J. Any test failure shall be corrected in accordance with the industry practices and in a manner satisfactory to the Engineer.

1.6 AREA DESIGNATIONS

- A. General: For purposes of delineating electrical enclosure and electrical installation requirements of this project, certain areas have been classified in the Contract Documents as defined below. Electrical installations within these areas shall conform to the referenced code requirements for the area involved.
- B. General Purpose Indoor Locations: Electrical work installed in areas which are not otherwise specifically classified shall be "General Purpose." Workmanship and enclosures shall comply with the general requirements of these Specifications. Electrical enclosures shall be NEMA Type 12.
- C. Outdoor and Damp Locations: In outdoor locations, raceway shall be rigid galvanized steel (GRS) conduit; entrances shall be threaded; and fittings shall have gasketed covers. Provisions shall be made to drain the fitting or conduit system. Threaded fastening hardware shall be stainless steel. Raceway supports such as hanger rods, clamps, and brackets shall be galvanized. Attachments or welded assemblies shall be galvanized after fabrication. Instruments and control cabinets shall be NEMA Type 4X. Switchboards, motor control centers, and panel enclosures shall be weatherproof NEMA Type 3R. Enclosures shall be mounted 1 inch from walls to provide an air space. Locations which are indoors and 2 feet below grade elevation or which are classified as damp locations on the Drawings shall have electrical installations which conform to the requirements for outdoor locations. "Damp locations" shall include pipe galleries, tunnels, vaults, and basements. All rooms housing liquid handling equipment are also classified as damp locations regardless of grade elevation.
- D. Vaults with forced air ventilation are not considered "damp locations". NEMA Type 12 panels will be required in these areas
- E. Splash Locations: Areas shown as splashproof shall have electrical installations as described for "outdoor locations."

1.7 CLEANUP

- A. In addition to the requirements of "Cleanup" in Section 01700 Project Closeout, all parts of the materials and equipment shall be thoroughly cleaned. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. All oil and grease spots shall be removed with a nonflammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Paint touchup shall be applied to all scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum cleaned before final acceptance.
- B. During the progress of the Work, clean the premises and leave the premises and all portions of the site free of debris.

1.8 DEMOLITION AND RELATED WORK

- A. The Contractor shall perform all electrical demolition work as indicated.
 - 1. Electrical equipment and components, terminal and relay cabinets, MCCs, shall be returned to the Owner in an orderly fashion to a designated location on the site.

2. Wire, conduit, junction boxes, fittings, supports and miscellaneous hardware removed a part of the demolition work shall not be reused and shall be returned to the Owner for their salvage use.
 3. Wires and/or conduits which need to be extended shall be terminated in a new terminal box with terminal strips. Terminal box shall be properly sized by the Contractor unless specified on drawings. Wires and terminals shall be properly identified before disconnection and after reconnection.
 4. Wiring in conduits located in or under slabs shall be removed. The conduit shall be plugged level with the floor where practical. In other cases, the conduit shall be cut three inches below the finished floor and the area shall be resurfaced.
 5. Openings in walls and platforms created by the removal of conduit or electrical equipment shall be patched with materials similar to those in surrounding work areas or as required to provide proper sealed conditions as reviewed and accepted by the Engineer.
 6. Electrical demolition works shall be as shown on the Drawings or as required by the Specifications.
 7. Exercise due care in the removal of the equipment made surplus by this project so as not to impair its resale value or reuse. The Owner has the right to salvage any wire or other electrical equipment removed from the project.
 8. Contractor shall be responsible for properly disposing of all electrical demolition materials, except those items to be salvaged to the Owner as directed by the Engineer.
- B. Installation of New Equipment in Existing Structures
1. Certain new equipment and devices' installation are required in existing structures. Under this phase of the Work the Contractor shall be required to remove existing equipment or devices, install new equipment as indicated, remove existing conductors from existing raceway, and pull new conductors in existing raceway, reconnect existing conductors or furnish and install new conduit and wires.
 2. Visit the site before bidding and carefully examine existing installation so that its proposal will reflect all the Work necessary to provide a complete installation so that the resulting installation will function as required. Include in the bid price all costs of labor and materials necessary to complete installations.
- C. Installation of Temporary Equipment
1. To facilitate continuous operation of existing equipment, provide temporary equipment indicated. Submit installation and connection details for review and acceptance. All costs associated with these temporary installations shall be part of the original Bid Documents, and without additional cost to the Owner.
 2. All cables, conduits, and fittings used in temporary connections shall not be reused to install permanent connections. Return the salvage items to the Owner.
- D. Plant Monitoring Power and Control Shutdowns
1. Continuance of plant operation during this demolition and expansion process is important. Therefore, carefully examine all Work to be done in, on, or adjacent to existing equipment. Work shall be scheduled, subject to Owner's approval, to minimize required plant shutdown time. Submit a written request, including sequence and duration of activities to be performed during plant shutdown.

2. Perform all switching and safety tagging required for plant shutdown or to isolate existing equipment. In no case shall the Contractor begin any Work in, on, or adjacent to existing equipment without written authorization.
- E. Modifications to Existing Electrical Facilities
1. Provide all modifications or alterations to existing electrical facilities required to successfully install and integrate the new electrical equipment. All modifications to existing equipment, panels, or cabinets shall be made in a professional manner with all coatings repaired to match existing. The total costs for all modifications to existing electrical facilities required for a complete and operating system shall be included in the original bid amount and no additional payment for this Work shall be authorized. Extreme caution shall be exercised in digging trenches in order not to damage existing underground utilities. Cost of repairs of damages caused during construction shall be the Contractor's responsibility.
 2. The Contractor shall be responsible for verifying all available existing circuit breakers in lighting panels for their intended use as required by the Drawings. It shall also be responsible for verifying the available space in substation switchboards to integrate new power circuit breakers. Expenses in time for all of this Work shall be included in the original bid amount.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All equipment and materials shall be new, shall be listed by UL, and shall bear the UL label, where UL requirements apply. All equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar items in the project shall be products of the same manufacturer. All equipment and materials shall be of industrial grade and standard of construction; shall be of sturdy design and manufacture; and shall be capable of reliable, trouble-free service.

2.2 GROUNDING

- A. General: All components of the grounding electrode system shall be manufactured in accordance with UL 467 and shall conform to the applicable requirements of National Electrical Code Article 250.
- B. Grounding cable shall be copper. Bare copper wire shall be annealed, No. 8 AWG minimum, if not called out in the Drawings.
- C. Ground rods shall conform to ANSI/UL 467 and shall be ¾-inch diameter copper-clad steel, sectional type, joined by threaded copper alloy couplings.
1. Grounding connectors shall be high-strength copper alloy suitable for direct burial.
 2. Wire connections shall be exothermic weld by Cadweld of Erico Products.
 - a. Manufacturers of grounding materials shall be Copperweld, Blackburn, Burndy, or equal.

2.3 UNDERGROUND DUCTS AND MANHOLES

- A. General: Where an underground distribution system is required, it shall be comprised of multiple runs of single bore nonmetallic ducts, with underground manholes and pullboxes. When nonmetallic ducts are required, they shall be rigid Schedule 40 PVC for concrete encasement.
 - 1. Manholes and pullboxes shall be of precast concrete. Concrete construction shall be designed for traffic loading.
- B. Covers shall be traffic type, except as shown otherwise. Manholes and pullbox covers designated as "HV" covers shall be identified as "High Voltage Electric," "P" shall be identified as "Secondary Electric," "C" as "Control" and "S" as "Signal." All covers shall be watertight after installation.
- C. Manholes and pullboxes shall be equipped with pulling-in irons opposite and below each ductway entrance.
- D. Manholes shall have concrete covers with 30- inch diameters lids. All covers and lids shall be bolted to cast-in-place steel frames with corrosion resistant hardware. Frames shall be factory-primed; covers shall be cast-iron and shall have pick holes or lifting handles.
 - 1. Manholes and pullboxes shall have cable supports so that each cable is supported at 3-foot intervals within the manhole or pullbox. Cable supports and racks shall be fastened with galvanized bolts and shall be fabricated of fiberglass or galvanized steel. Porcelain insulators for cable racks shall be provided.
 - 2. Manholes and pullboxes shall be Brooks, Quikset, U.S. Precast, or equal.
- E. The concrete envelope shall have a compression strength of 3,000 psi in accordance with the requirements of Section 03 30 00 - Cast-in-Place Concrete.

2.4 RACEWAYS

- A. General: Raceway shall be manufactured in accordance with UL and ANSI standards and shall bear UL label as applicable.
- B. Galvanized Rigid Steel (GRS) Conduit
 - 1. Rigid steel conduits and fittings shall be full weight, mild steel, hot-dip galvanized and zinc bichromate coated inside and outside after galvanizing.
 - 2. Rigid steel conduit shall be manufactured in accordance with UL Standard No. 6 and ANSI 80-1.
 - 3. Rigid steel conduit shall be manufactured by Triangle PWC, Republic Steel, or equal.
- C. Rigid nonmetallic conduit shall be Schedule 40 PVC.
 - 1. Nonmetallic conduits and fittings shall be UL listed, sunlight-resistant, and rated for use with 90 degrees C conductors.
 - 2. Nonmetallic conduits and fittings shall be manufactured by Carlon, Condux, or equal.
- D. Flexible metallic conduit shall be fabricated from galvanized interlocked steel strip. Liquid-tight flexible metallic conduit shall have an extruded PVC covering over the flexible steel conduit. For conduit sizes 3/4 inch through 1-1/4 inches, flexible conduits shall have

continuous built in copper ground conductor. Flexible conduit shall be American Brass, Anaconda, Electroflex, or equal.

- E. PVC-coated raceway system shall conform to Federal Specification WW C 581E, ANSI C80.1, and to Underwriter's Laboratories specifications.
 - 1. The zinc surfaces of the conduits and fittings shall remain intact and undisturbed on both the inside and the outside of the conduit through the preparation and application processing.
 - 2. A PVC coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic.
 - 3. The thickness of the PVC coating shall be a minimum of 40 mils.
 - 4. A PVC jacketed coupling shall be furnished with each length of conduit. A PVC sleeve equal to the OD of the conduit shall extend 1-1/2 inches from each end of coupling.
 - 5. PVC-coated conduits shall be as manufactured by Robroy, Occidental (OCCAL), or equal.

2.5 WIRE AND CABLE

- A. General: All conductors, including ground conductors, shall be copper. Insulation shall bear UL label and the manufacturer's trademark, type, voltage and temperature rating, and conductor size. Wire and cable shall be products of American, BICC/General, Rome Cable, Okonite, or equal.
- B. Control Cables: All control cables shall be rated for 600 volts and shall meet the following requirements:
 - 1. Control wires shall consist of No. 16 gage stranded copper conductors and shall be THWN rated for 90 degrees C at dry locations and 75 degrees C at wet locations.
 - 2. Control wires at panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations.
- C. Instrumentation Cables: Shielded instrumentation cables shall be rated at 300 volts and shall comply with the following requirements:
 - 1. Individual shielded cable shall consist of twisted 2 or 3 No. 18 gage, stranded, color coded, tinned-coated copper in accordance with ASTM B 33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes and B 8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, and Soft. Color coding shall be black-clear, or black-red-clear.
 - 2. Insulation thickness shall be 32 mils of polyethylene, insulated with 2.3 mils 100 percent aluminum foil/polyester shield and No. 18 stranded tinned copper drain wire, all under a 32 mil PVC jacket. The shield shall be continuous and shall be grounded only at the receiving end, or as indicated.
 - 3. Multi-individual shielded pair or triad instrumentation cable shall consist of individual shielded and twisted pair copper conductors with an ethylene-propylene insulation, and No. 18 AWG tinned stranded copper drain wire, an overall aluminum mylar shield and an overall chloro-sulfonated polyethylene compound jacket. The cables shall be suitable for cable tray installation and shall be flame retardant.

- D. Building Wire and Cable: Building wires and cables shall be rated at 600 volts and shall meet the following requirements:
1. Building wire shall be single conductor copper cable listed by UL as Type THWN rated 75 degrees C in wet locations and THHN rated 90 degrees C in dry locations.
 2. Building wire; **all conductors shall be stranded.**
 3. No wire smaller than No. 12 AWG shall be used unless specifically indicated.
- E. Cable Terminations: Cable terminations shall be in accordance with the following:
1. Compression connectors shall be Burndy "Hi Lug", Thomas & Betts "Shure Stake", or equal. Threaded connectors shall be split bolt type of high strength copper alloy.
 2. Spring connectors (wire nuts) shall be 3M "Scotch Lok," "Ideal Wing Nuts", or equal.
 3. Preinsulated fork tongue lugs shall be "Thomas & Betts" RC Series, Burndy, or equal.
 4. General purpose insulating tape shall be Scotch No. 33, Plymouth "Slip knot", or equal. High temperature tape shall be polyvinyl by Plymouth, 3M, or equal.
 5. Epoxy resin splicing kits shall be 3M Scotchcoat 82 Series, Burndy Hy Seal, or equal.
 6. Stress cone material for makeup of medium voltage shielded cable shall be by 3M- No substitutions.
 7. Motor load termination kits shall be 3M.

2.6 PULL AND JUNCTION BOXES

- A. Outlet, switch, pull and junction boxes for flush-mounting in general purpose locations shall be one-piece, galvanized, pressed steel. Ceiling boxes for flush-mounting in concrete shall be galvanized, pressed steel.
- B. Outlet, switch, pull and junction boxes where surface mounted in exposed locations shall be cast ferrous boxes with mounting lugs, zinc or cadmium plating, and enamel finish. Surface mounted boxes in concealed locations may be pressed steel.
- C. Control station, pull and junction boxes, including covers, for installation in corrosive locations shall meet the NEMA 4X requirements and shall be stainless steel or fiber glass-reinforced polyester and shall be furnished with mounting lugs.
- D. All cast boxes and pressed steel boxes for flush mounting in concrete shall be fitted with cast, malleable box covers and gaskets. Covers for pressed steel boxes shall be one-piece pressed steel, cadmium plated, except that boxes for installation in plastered areas and finished rooms shall be stainless steel over plaster rings. Stainless steel plates shall be Sierra S line, Hubbell, or equal. Cast boxes shall be as manufactured by Crouse-Hinds, Appleton, or equal.

2.7 CONDUIT FITTINGS

- A. General: Fittings shall comply with the same requirements as the raceway with which they will be used. Fittings for use with rigid steel conduit, shall be cast or malleable ferrous metal. Such fittings larger than one inch shall be "mogul size." Fittings shall be of the gland ring compression type. Covers of fittings, unless in "dry" locations, shall be closed with gaskets. Surface-mounted cast fittings, housing wiring devices in outdoor and damp locations, shall have mounting lugs.

- B. Insulated bushings shall be molded plastic or malleable iron with insulating ring, similar to O Z Type A and B, equivalent types by Thomas & Betts, Steel City, Appleton, O Z/Gedney, or equal.
 - C. Insulated grounding bushings shall be malleable iron with insulating ring and with ground lug, - by T & B, - no substitutions.
 - D. Crouse Hinds UNF or UNY unions shall be used at all points of union between ends of rigid steel conduits which cannot be coupled. Running threads and threadless couplings shall not be used.
 - E. Liquid-tight fittings shall be manufactured by T & B, no substitutions.
 - F. Hubs for threaded attachment of steel conduit to sheet metal enclosures shall be similar to Appleton Type HUB, equivalent types such as manufactured by T & B, Myers Scrutite, or equal.
- Transition fittings to mate steel to PVC conduit, and PVC access fitting, shall be as furnished or recommended by the manufacturer of the PVC conduit.
- G. Conduit sealant shall be Chico, or equal.
 - H. Expansion fittings shall be installed wherever a raceway crosses a structural expansion joint. Such fittings shall be expansion and deflection type and shall accommodate lateral and transverse movement. Fittings shall be O Z/Gedney Type "DX," Crouse Hinds "XD," or equal. These fittings are required in metallic and nonmetallic raceway installations. When the installation is in a nonmetallic run, a 3 foot length of rigid conduit shall be used to connect the nonmetallic conduit to the fitting.

2.8 WIRING DEVICES

- A. All wiring devices shall be a product of a single manufacturer and shall conform to applicable NEMA Standards and be UL listed. Devices shall be as manufactured by Hubbell, Sierra, Pass & Seymour, or equal. General purpose duplex receptacles and toggle switch handles shall be white. Special purpose receptacles shall have a body color as shown. Receptacles and switches shall conform to Federal Specifications W C 596E and W S 896E, respectively.
 - 1. Receptacles
 - a. General purpose duplex receptacles shall be grounding type, 125-volt, ac, 20-amperes, **backwired** NEMA Configuration 5-20R, such as Hubbell 5362, or equal.
- B. Convenience receptacles for installation in outdoor and corrosive areas shall be NEMA 5-20R configured and shall have stainless steel or nickel plated parts and plastic parts of Melanline.
 - 1. Receptacles at outdoor locations shall be UL-approved for weatherproof locations with plug inserted. These shall be Crouse-Hinds, Hubbell, Pin and Sleeve Series, or equal.
 - 2. Receptacles at damp or dry locations shall be Crouse-Hinds DS 23G, Pyle National N 1, or equal.
 - 3. Receptacles at corrosive locations shall be Hubbell 52CM62 15 ampere, 53CM62 20 ampere, or equal.

- C. Ground fault interrupter (GFI) receptacles shall be NEMA 5-20R configured and shall mount in a standard outlet box. Units shall trip at 5 milliamperes of ground current and shall comply with NEMA WD 1 1.10 and UL 943. GFI receptacles shall be capable of individual as well as "downstream" operation. GFI receptacles shall be Hubbell GF 5252, or equal.
- D. Switches
- Switches at outdoor locations shall be Crouse-Hinds DS 128, Mackworth Rees Style 3845, Joy Flexitite, or equal.
 - Switches at damp locations shall be Mackworth Rees Style 3496, Joy Flexitite, or equal.
 - Switches at dry locations shall be Crouse-Hinds DS 32G, Pyle National SCT 10k, or equal.
- E. Toggle switches shall be suitable for backwiring and shall conform to the following table, or equal:

	<u>Hubbell No.</u>	<u>Bryant No.</u>	<u>Hubbell No.</u>	<u>Bryant No.</u>
Single Pole	1221 (white)	4901 (white)	1221W (white)	4901W (white)
Three Way	1223	4903	1223W	4903W
Momentary	1556	4821	1556W	4821W
Four Way	1224		1224W	

2.9 CABINETS AND ENCLOSURES

- A. General: All electrical cabinets and enclosures housing control relays and terminal blocks shall be manufactured in accordance with NEMA Publications 250, UL Standards 50 and 508.
- Relay or control, and terminal cabinets or outdoor cabinets shall be NEMA 4 enclosures. Sizes shown on the Drawings are minimum. Provide sufficient terminal blocks to terminate 25 percent more conductors than are shown. Interiors of cabinets shall be finished white including internal back mounting plate.
 - Floor standing NEMA 12 construction shall have three-point latching mechanism operated by oiltight key-locking handle, and shall have gasketed overlapping doors. Steel construction shall be 12-gauge; construction for wall-mounted type shall be 14-gauge steel. Exterior finish shall be ANSI 61 light gray, or equal.
- B. Wiring of terminal cabinets, control or relay cabinets shall be accomplished with stranded copper conductor rated for 600-volts and UL listed as Type MTW. Wires for annunciator and indication circuits shall be No. 16 AWG. All others shall be No. 14 AWG. Color coding shall be as specified elsewhere in this Section. Incoming wires to terminal or relay cabinets shall be terminated on a master set of terminal blocks. All wiring from the master terminals to internal components shall be factory-installed and shall be contained in plastic wireways having removable covers. Wiring to door-mounted devices shall be extra flexible and anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

- C. All terminal block requirements shall be as manufactured by Entrelec with cage clamp, Phoenix, or equal.
- D. Engraving shall be as shown or as directed by the Engineer. Characters shall be uniform block style not smaller than 1/8-inch. Nameplates shall be secured using cadmium plated steel or other corrosion resistant screws. Adhesive alone is not acceptable.
- E. Each relay or control and terminal cabinets shall be completed, assembled, wired, and tested at the factory. Test shall be in accordance with the latest UL and NEMA Standards. All cabinets shall bear UL label, as applicable.

2.10 DISCONNECT SWITCHES

- A. Unfused and fused disconnect switches shall be externally operated with quick-make/quick-break mechanisms. The handle shall be interlocked with the switch cover by means of a defeatable interlock device. The switch shall be padlockable in the "off" position. Switches shall have nameplates stating manufacturer, rating, and catalog number. Heavy-duty switches shall have arc suppressors, pin hinges, and shall be horsepower rated at 600-volts. All switches rated at 100 amperes or larger shall have auxiliary contact for remote status indication. Heavy-duty switches shall be provided for all motor circuits above 3 horsepower. In smaller motor circuits switches shall be general duty.
- B. Switch rating shall match the horsepower requirements of the load at the particular voltage if not otherwise shown.
- C. Switch enclosure shall be NEMA 1 and shall be as manufactured by Square D, Cutler-Hammer, or equal.

2.11 ELECTRICAL IDENTIFICATION

- A. Nameplates: Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock, Formica type ES-1, or equal. Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style of adequate size to be read easily at a distance of 6 feet with no characters smaller than 1/8-inch high.
- B. Conductor and Equipment Identification: Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices such as manufactured by Brady, Thomas & Betts, or equal, or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place, or equal.
- C. Identification Tape: Identification tape for protection of buried electrical installation shall be a 6-inch wide red polyethylene tape imprinted "CAUTION - ELECTRIC UTILITIES BELOW."

2.12 LIGHTING AND POWER PANELBOARDS

- A. General: Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1 as well as the provisions of UL 50 and 67. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208-

volt 3-phase operation or 120/240-volt for single phase operation as shown. Power panelboards shall be rated for 600 volts, 3-phase operation.

1. Interiors shall have solderless, anti-turn connectors and shall be constructed so that branch circuit breaker can be replaced without disturbing adjacent units or resorting to field drilling and tapping. Bus bars and connecting drops shall be copper. Neutral bar shall be full-sized and shall have one terminal screw for each branch circuit; main bus bar shall be full-sized for entire length. Spaces shown shall have cross connections for the maximum sized device that can be fitted.
2. Panelboard box shall be galvanized code grade steel with knockouts, and shall have removable end walls. All boxes or panelboard enclosures shall have gray baked enamel finish.
3. All circuit breakers shall be bolt-in type.

B. Lighting Panelboards

1. Cabinets for building panels shall be 20-inch wide minimum, with 4-inch minimum side gutters and 5-inch minimum top and bottom gutters. Panelboard trim shall be the same size as cabinet on surface-mounted panels and 3/4-inch larger all around than cabinet of flush-mounted panels. Panelboard trim shall be door in door construction with piano type hinges. Bus bars shall be copper. Doors in trim shall have typed circuit directory and pocket with protective clear plastic sheet. All trim and cabinets of surface-mounted panels in general purpose areas shall be phosphate treated, primed and finished with baked enamel, panels of flush mounted panels shall be finished to match surrounding wall color.
2. The number of circuit breakers and the ampere ratings shall be in accordance with panel schedules. Main circuit breaker or main lugs only shall be provided as indicated. The panelboard circuit breakers shall be group mounted and shall be molded case with 3- or 2-pole main breakers as required and branch circuit breakers with 18,000 AIC.
3. Provide control enclosures under common panel trim. All panelboard doors shall be keyed alike.

2.13 PROCESS CONTROL DEVICES

- A. Liquid Level Control: Liquid level controls shall be as indicated. Level settings shall be determined by Design Engineer and received from the Engineer.
1. High level flood switches shall be as shown on the drawings.

2.14 CONTROL STATIONS

- A. Control stations shall comply with NEMA Standards ICS2-216. All control stations shall be industrial type, heavy duty, oil-tight, with legend plates.
- B. Control stations shall be as follows:
1. Pushbutton Switch: Pushbutton switches shall be momentary type with round or square button plate. All emergency-stop pushbuttons shall have red button plates. Lock-out stop shall be momentary pushbutton with locking mechanism.
 2. Selector Switches: Selector switches shall be rated 10 amperes at 600 volts and shall be rotary type with number of position and poles as indicated.

3. Indicating Lights: Pilot lights shall be LED type and with plastic color caps: green color for running, yellow for ready, white for power status, and red for failure status.
4. Control station enclosures shall be NEMA 4X in corrosive, below grade, or wet areas.
5. Manufacturers shall be Square D with Class 9001, or equal.

PART 3 - EXECUTION

3.1 GROUNDING

- A. General: Grounding cable shall be sized in accordance with code requirements when sizes are not indicated on the Drawings.
- B. Equipment Ground: Ground continuity throughout the facility shall be maintained by installing a grounding conductor in all raceways.
 1. Metallic raceway shall be installed with double lock nuts or hubs at enclosures. Nonmetallic raceway containing dc conductors operating at more than 50 volts to ground, or any ac conductors, shall contain a copper-grounding conductor insulated green. Such conductor shall be bonded to terminal and intermediate metallic enclosures.
 2. Metal equipment platforms which support any electrical equipment shall be bonded to the nearest ground bus or to the nearest switchgear ground bus. This grounding requirement is in addition to the raceway grounding required in the preceding paragraph herein.
- C. Grounding Electrode System: Install the grounding electrode system with all required components in accordance with National Electrical Code Article 250.
 1. Connection to ground electrodes and ground conductors shall be exothermic welded where concealed and shall be bolted pressure type where exposed. Bolted connectors shall be assembled wrench-tight.
 2. Insulated grounding bushings shall be employed for all grounding connections to steel conduits in switchboards, in motor control centers, in pullboxes, and elsewhere where conduits do not terminate at a hub or a sheet metal enclosure. Where insulated bushings are required, they shall be installed in addition to double lock-nuts.
 3. Copper bonding jumpers shall be used to obtain a continuous metallic ground.
- D. Shield Grounding
 1. Shielded power cable shall have its shield grounded at each termination in a manner recommended by the cable manufacturer.
 2. Shielded instrumentation cable shall be grounded at one end only; this shall be at the RTU or otherwise at the "receiving" end of the signal carried by the cable, unless shop drawings indicate that the shield shall be grounded at both ends.
 3. Termination of each shield drain wire shall be on its own terminal screw. All of these terminal screws in one rack shall be jumpered with No. 16 solid tinned bare copper wire; connection to ground shall be accomplished with a No. 12 green insulated conductor to the main ground bus.

3.2 UNDERGROUND DUCTS AND MANHOLES

- A. The underground duct bank shall be installed in accordance with the criteria below:

1. Duct shall be assembled using high impact nonmetallic spacers and saddles to provide conduits with vertical and horizontal separation. Plastic spacers shall be set every 5 feet.
 2. The duct shall be laid on a grade line of at least 4 inches per 100 feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the duct is a minimum of 24 inches below grade.
 3. Changes in direction of the duct envelope by more than 10 degrees horizontally or vertically shall be accomplished using bends with a minimum radius 24 times the duct diameter.
 4. Couplings shall be staggered at least 6 inches vertically. Bottom of trench shall be of select backfill or sand. The duct array shall be anchored every 4 feet to prevent movement during placement of backfill.
 5. Each bore of the completed duct bank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct through which the mandrel will be drawn. After passing of the mandrel, draw a wire brush and swab through.
 6. A raceway, in the duct envelope, which does not require conductors, shall have a 1/8 inch polypropylene pull cord installed throughout the entire length of the raceway.
- B. Duct entrances shall be grouted smooth; duct for primary and secondary cables shall be terminated with flush end bells. Sections of pre-fabricated manholes and pullboxes shall be assembled with waterproof mastic and shall be set on a 6-inch bed of gravel as recommended by the manufacturer or as required by field conditions.
- C. Duct bank markers shall be installed every 200 feet along run of duct bank, at changes in horizontal direction of duct bank, and at ends of duct bank. Concrete markers, 6 by 6 inches square and one-foot long, shall be set 2 inches above finish grade. The letter "D" and arrow set in the concrete shall be facing in the direction of the duct alignment.
- D. Duct bank penetration through walls of manholes or pullboxes, and on building walls below grade shall be watertight.
- E. Trenches containing duct banks shall be filled with select backfill with no large rocks which could damage the duct.
- F. Concrete encased duct bank shall terminate at building foundations. When duct enters the building on a concrete slab on grade, duct shall not be encased, but shall transition to rigid steel PVC-coated conduits on all stub-ups.

3.3 RACEWAYS

- A. General: Raceways shall be installed as indicated, however, conduit routings shown are diagrammatic. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for the purpose intended. Bends in metallic conduit shall be accomplished by field bending or by the use of factory elbows. All installations shall be in accordance with the latest edition of the National Electrical Code.
- B. Raceways shall be installed in accordance with the following schedule:

1. Low Voltage Raceway (control and power):
 - a. Rigid Schedule 40 PVC shall be used for burial in earth.
 - b. Galvanized rigid steel (GRS) shall be used on exposed installations in general purpose areas.
 - c. Galvanized rigid steel or PVC shall be used for conduits embedded in concrete slab on grade and above grade.
 - d. Schedule 40 PVC shall be used for fiber optic data hi-way system for buried in earth.
 - e. Galvanized rigid steel shall be used in exposed installations in outdoor areas.
 2. Exposed Raceways
 - a. Conduits shall be rigidly supported with clamps, hangers, and Unistrut channels.
 - b. Intervals between supports shall be in accordance with the National Electrical Code.
 3. All underground elbows shall be GRS (coated or wrapped).
- C. Conduit Terminations
1. Empty conduit terminations not in manholes or pullboxes shall be plugged. Exposed raceway shall be installed perpendicular or parallel to buildings except where otherwise indicated. Conduit shall be terminated with flush couplings at exposed concrete surfaces. Conduit stubbed up for floor-standing equipment shall be placed in accordance with approved shop drawings. Metallic raceways installed below-grade or in outdoor locations and in concrete shall be made up with a conductive waterproof compound applied to threaded joints. Compound shall be Zinc Clads Primer Coatings No B69A45, HTL-4 by Crouse-Hinds, Kopr Shield by Thomas & Betts, or equal.
 2. Both rigid and flexible conduit shall be sealed against water at each entrance to enclosures. Unless indicated otherwise, rigid and flexible conduit shall enter panels through the top, shall continue down from the top to the bottom, and shall turn upward at the bottom.
- D. Conduit Installations
1. Conduit may be cast integral with horizontal and vertical concrete slabs, providing one-inch clearance is maintained between conduit surface and concrete surface. If said clearance cannot be maintained, the conduit shall be installed exposed below elevated slabs; provided, that in the case of slabs on grade, conduit shall be installed below the slab and shall be encased with a minimum cover of 3 inches of concrete. Maximum size of conduit that can be cast in slab above grade shall be 3 inches, in slab on grade shall be 1-1/2 inches.
 2. Nonmetallic conduit may be cast integral with horizontal slabs with placement criteria stated above. Non-metallic conduit may be run beneath structures or slabs on grade, without concrete encasement. In these instances conduit shall be placed at least 12 inches below the bottom of the structure or slab. Nonmetallic conduit may be buried 24 inches minimum below grade, with a 3-inch concrete cover, in open areas or where otherwise not protected by concrete slab or structures. Top of concrete cover shall be colored red. Nonmetallic conduit shall be permitted only as required by the Specifications and in concealed locations as described above.
 3. Where a run of concealed PVC conduit becomes exposed, a transition to rigid steel conduit is required. Such transition shall be accomplished by means of a factory

elbow or a minimum 3-foot length of rigid steel conduit, either terminating at the exposed concrete surface with a flush coupling. Piercing of concrete walls by nonmetallic runs shall be accomplished by means of a short steel nipple terminating with flush couplings.

4. Flexible liquid-tight conduit shall be used for the connection of equipment such as motors, transformers, instruments, valves, or pressure switches subject to vibration or movement during normal operation or servicing.
5. Equipment subject to vibration or movement which is normally provided with wiring leads, such as solenoid valves, shall be installed with a cast junction box for the make-up of connections. Flexible conduits shall be as manufactured by American Brass, Cablec, Electroflex, or equal.
6. Conduit penetrations on walls, concrete structures, pull boxes, and equipment cabinets shall be performed in accordance with the following:
 - a. Seal all raceways entering structures at the first box or outlet with conduit sealant to prevent the entrance into the structure of gases, liquids, or rodents.
 - b. Dry pack with nonshrink grout around raceways that penetrate concrete walls, floors, or ceilings aboveground, or use one of the methods indicated for underground penetrations.
 - c. Where an underground conduit enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide an acceptable, malleable iron, watertight, entrance sealing device. When there is no raceway concrete encasement, provide such device having a gland type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement indicated, provide such a device with a gland type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.
 - d. Where an underground raceway without concrete encasement enters a structure through a nonwaterproofed wall or floor, install a sleeve made of Schedule 40 galvanized pipe. Fill the space between the conduit and sleeve with a suitable plastic expandable compound, or an oakum and lead joint, on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device may be used in lieu of the sleeve.
7. All underground GRS conduit shall be PVC coated or taped.

3.4 WIRES AND CABLES

- A. General: Conductors shall not be pulled into raceway until:
 1. Raceway system has been inspected and accepted by the Engineer.
 2. Plastering and concrete have been completed in affected areas.
 3. Raceway system has been freed of moisture and debris.
- B. Wire and Cables
 1. Conductors of No. 1 size and smaller shall be hand pulled. Larger conductors may be installed using power winches. Pulling tensions on the cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

2. Wire in panels, cabinets, and gutters shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.
- C. Splices and Terminations
1. The Contractor shall provide, install, and terminate the conductors required for power and controls to electrical equipment instrumentation terminal cabinets, control and instrumentation equipment except where indicated elsewhere. There shall be no cable splices in underground manhole or pullboxes. If splices are necessary, the cables shall be brought aboveground and terminated in a NEMA 4X, stainless steel terminal or splice cabinet on a concrete pad.
 2. Two- and three-conductor shielded cables installed in conduit runs which exceed 2,000 feet may be spliced in pullboxes. These cable runs shall have only one splice per conductor.
 3. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment. For the purposes of the various Sections of Division 26 of the Specifications, "control conductors" are defined as conductors operating at 120 volts or less in circuits that indicate equipment status or that control the electric energy delivered to a power consuming device.
 4. All 120/208-volt and 480-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the Contractor.
 5. Stranded conductors shall be terminated directly on equipment box lugs making sure that all conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.
 6. Splices in 600-volt wire which are not pre-insulated shall be insulated with three layers of tape each half lapped except that splices in below grade pull boxes or in any box subject to flooding shall be made watertight using an epoxy resin splicing kit.
 7. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape. Provide 3M motor lead termination kits.
 8. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable manufacturer. Submit the proposed termination procedure as described for shop drawings.
 9. Control devices, such as solenoid operated valves, that are normally supplied with conductor pigtails, shall be terminated as described for control conductors.
- D. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements ICEA Publication No. S-68-516 and other relevant ICEA publications. Factory test results shall be submitted in accordance with Section 01 33 20 - Contractor Submittals, prior to shipment of cable. The following tests shall be the minimum requirements:
1. Insulation resistance shall be obtained and shall not be less than the value recommended by ICEA.
 2. All cables rated at 600 volts shall be tested for insulation resistance between phases and from each Phase to a ground using a megohmmeter.
 3. All field testing mentioned above shall be done after cables are installed in the raceways.
 4. Field tests shall be performed by certified test organization acceptable to the Engineer. Test results shall be submitted for review and acceptance.

5. Cables failing in the said tests shall be replaced with a new cable or repaired. Such kind of repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- E. Continuity Test: All control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed prior to placing all cables in service.
- 3.5 PULL AND JUNCTION BOXES
 - A. Pull and junction boxes shall be sized in accordance with the requirements of the National Electrical Code or as shown on drawings.
 - B. Outlet boxes shall be used as junction boxes wherever possible. Where separate pullboxes are required, they shall have screw covers.
 - C. Pullboxes shall be installed when conduit run contains more than three 90-degree bends and runs exceed 200 feet.
- 3.6 CABINETS AND ENCLOSURES
 - A. Cabinets shall be set plumb at an elevation that will cause the maximum circuit breaker height to be less than 5 ft 6 inches. Top edge of trim of adjacent panels shall be at the same height. Panels which are indicated as flush mounted shall be set so cabinet is flushed and serves as a "ground" for plaster application.
 - B. All factory wire connections shall be made at shipping splits, and all field wiring and grounding connections shall be made after the assemblies are anchored.
- 3.7 CONCRETE HOUSEKEEPING
 - A. Concrete housekeeping pads shall be provided for all floor standing electrical equipment. Housekeeping pads for all equipment, including future units, shall be 2 inches above surrounding finished floor or grade and 2 inches larger in both dimensions than the supported equipment, unless otherwise indicated.
 - B. Concrete housekeeping curb shall be provided for all conduit stub-up in indoor and outdoor locations, not concealed by equipment enclosures. Such curb shall be 3 inches above finished floor or grade.
- 3.8 EQUIPMENT ANCHORING
 - A. Freestanding or wall-hung equipment shall be anchored in place by methods that will meet seismic requirement in the area where project is located. Wall-mounted panels that weigh more than 500 pounds or which are within 18 inches of the floor shall be provided with fabricated steel support pedestal(s). Pedestals shall be of welded steel angle sections. If the supported equipment is a panel or cabinet and enclosed with removable side plates, it shall match supported equipment in physical appearance and dimensions. Transformers hung from 4-inch stud walls and weighing more than 300 pounds, shall have auxiliary floor supports.

- B. Leveling channels anchored to the concrete pad shall be provided for all switchgear and pad-mounted transformer installations. Area between the channels shall be grouted perfectly flat.
- C. Anchoring methods and leveling criteria specified in the printed recommendations of the equipment manufacturers are a part of the Work of this Contract. Such recommendations shall be submitted as required for shop drawings in Section 01 33 20 - Contractor Submittals.

3.9 CABLE AND EQUIPMENT IDENTIFICATION

- A. General: The completed electrical installation shall be provided with adequate identification to facilitate proper control of circuits and equipment and to reduce maintenance effort.
- B. Cable: Assign each control and instrumentation wire and cable a unique identification number. Said numbers shall be assigned to all conductors having common terminals and shall be shown on all shop drawings. Identification numbers shall appear within 3 inches of conductor terminals. "Control" shall be defined as any conductor used for alarm, annunciator, or signal purposes:
 - 1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. All individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers indicated on the Drawings.
 - 2. All 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase 1-black, Phase 2-red, Phase 3-blue, and Neutral-white. The 480/277-volt system conductors shall be color coded as follows: Phase A-brown, Phase B-orange, Phase C-yellow, and Neutral-gray. Color-coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase 1-2-3, top to bottom, or left to right, facing the front of the equipment.
 - 3. General purpose ac control cables shall be pink. General purpose dc control cables shall be blue.
 - 4. All spare cables shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
 - 5. Terminal strips shall be identified by imprinted, varnished, marker strips attached under the terminal strip.
- C. Equipment: Equipment and devices shall be identified as follows:
 - 1. Nameplates shall be provided for all panelboards, panels, starters, switches, and pushbutton stations. In addition to the name plates shown, control devices shall be equipped with standard collar-type legend plates.
 - 2. Control devices within enclosures shall be identified similar to the paragraph above.
 - 3. Three-phase receptacles shall be consistent with respect to phase connection of receptacle terminals. Errors in phasing shall be corrected at the bus, not at the receptacle.
 - 4. Toggle switches which control loads out of sight of switch, and all multiswitch locations of more than 2 switches, shall have suitable inscribed finish plates.

5. Empty conduits shall be tagged at both ends to indicate the destination at the far end. Where it is not possible to tag the conduit, destination shall be identified by marking an adjacent surface.
6. Provide typewritten circuit directories for panelboards; circuit directory shall accurately reflect the outlets connected to each circuit.
7. Install identification tape directly above buried unprotected raceway; install tape 8 inches below grade and parallel with raceway to be protected. Identification tape is required for all buried raceway not under buildings or equipment pads except identification tape is not required for protection of street lighting raceway.

END OF SECTION

SECTION 26 05 13
MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

- A. Association of Edison Illuminating Companies, Inc (AEIC).
- B. American Society for Testing Materials (ASTM).
- C. Code of Federal Regulations.
- D. The Institute of Electrical and Electronic Engineers, Inc.
- E. Insulated Cable Engineers Association, Inc.
- F. International Electrical Testing Association, NETA.
- G. NFPA 70, National Electrical Code.
- H. Underwriters Laboratories Inc.

1.3 SUMMARY

- A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.
- B. Related Sections include the following:
 - 1. Division 16 Section "Electrical General Provisions".

1.4 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.
- B. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. National Fire Protection Association.

1.5 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20 and 26 00 00.

- B. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
- C. Qualification Data:
 - 1. Manufacturer Qualifications:
 - 2. Installer Qualifications:
 - a. Submit cable installers training and work history.
- D. Material Certificates: For each cable and accessory type, signed by manufacturers.
- E. Shop Drawings:
 - 1. Pull calculations that show expected pulling tensions.
- F. Field quality-control test reports.
 - 1. Submit discharge plots of corona discharge tests.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Minimum of 10 years experience in manufacturing medium voltage 15 kilovolt class power cables.
- B. Installer Qualifications
 - 1. Contactor shall have a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with latest standards of IEEE C2, and NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Cable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cables:
 - a. General Cable Technologies Corporation.
 - b. Kerite Co. (The).
 - c. Okonite Company (The).
 - d. Pirelli Cables & Systems NA.
 - e. Southwire Company.
 - f. Or equal.
- B. Cable Splicing and Terminating Products and Accessories Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
2. Thomas & Betts Corporation/Elastimold.
3. 3M; Electrical Products Division.

2.2 CABLES

- A. Cable Type: MV105.
- B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.
- C. Conductor: Soft drawn annealed copper, with not less than 97 percent conductivity.
- D. Conductor Stranding: Compact round, concentric lay, Class B.
- E. Conductor Insulation: Ethylene-propylene rubber.
 1. Voltage Rating: 15kV.
 2. Insulation Thickness: 133 percent insulation level
- F. Shielding: Concentric conductor, bare copper applied over semiconducting insulation shield.

2.3 SPLICE KITS

- A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions. Contractor may choose one of the following types of splice kits.
 1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
 2. Premolded, cold-shrink-rubber, in-line splicing kit.

2.4 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations. The termination shall be rated for the application, skirted for outdoor locations. Contractor may choose one of the following types of termination kits.
 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, cold-shrink; shield ground strap; and compression-type connector.
 2. Class 1 Terminations: Heat-shrink type; one piece non-tracking tubing with a co-extruded stress control; shield ground strap; and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

- B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- D. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
 - 1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 - 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
 - 3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 - 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- E. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

2.6 SOURCE QUALITY CONTROL

- A. Manufacturer shall test and inspect cables according to latest standards of ASTM and ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Circuit Conductors:
 - 1. Continuous from origin to termination without splices in intermediate pull boxes.
 - 2. Where splices are necessary, furnish sectionalizer properly installed and labeled. Leave sufficient slack at termination to make proper connections.
 - 3. Splice shall not be pulled into conduit
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
- D. Support cables in such a manner that they shall not be damaged.
- E. Install "buried-cable" warning tape 12 inches above cables.
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- G. Splices:
 1. Splice cables only as required to meet manufacturers pulling tension requirements.
 2. Cable splices shall be made by capable rated high voltage cable men and trained to install the types of splices being used.
 3. Splices shall be weatherproof.
- H. Terminations:
 1. Make terminations in stress cones. Carefully make up stress relief cones in accordance with cable manufacturer's and terminator manufacturer's instructions.
 2. Cable terminations shall be made by capable rated high voltage cable men and trained to install the types of terminations being used.
 3. Terminations outdoors and other wet locations shall be weatherproof.
- I. Install separable insulated-connector components as follows:
 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 2. Portable Feed-Through Accessory: Three.
 3. Standoff Insulator: Three.
- J. Seal around cables passing through fire-rated elements.
- K. Install fault indicators on each phase where indicated.
- L. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- M. Identify cables according to Division 26 Section "Electrical Identification."

3.2 FIELD QUALITY CONTROL

- A. Testing: Perform the following field tests and inspections and prepare test reports:
 1. Visual and mechanical inspections.
 - a. Inspect exposed section for physical damage.
 - b. Verify cable is supplied and connected in accordance with single line diagram.
 - c. Inspect for shield grounding, cable support, and termination.
 - d. Visible cable bends shall be checked against IPCEA or manufacturer's minimum allowable bending radius.

- e. Inspect for proper fireproofing in common cable areas.
- 2. Electrical tests.
 - a. Perform D.C. high potential test. Magnitude of D.C. voltage shall be in accordance with manufacturer's recommendation.
 - 1) Each conductor shall be individually tested with all other conductors grounded. All shields shall be grounded.
 - 2) Terminations shall be properly corona suppressed by guard ring, field reduction sphere, or other suitable methods.
 - 3) The test voltage shall be applied in at least eight (8) equal increments until maximum test voltage is reached. D.C. leakage current shall be recorded at each step after a constant stabilization time consistent with system charging current decay.
 - 4) A graphic plot shall be made of leakage current (X axis) versus voltage (Y axis) at each increment.
 - 5) The test conductor shall be raised to a maximum test voltage and held for a total of ten (10) minutes. Readings of leakage current (Y axis) versus time (X axis) shall be recorded and plotted on thirty (30) second intervals for the first two (2) minutes and every minute thereafter.
 - 6) The applied conductor test potential shall be reduced to zero (0) and grounds applied for a period adequate to drain all insulation stored potential.
 - 7) Maximum test voltages shall be in accordance with cable and termination manufacturer's specifications.
 - 8) During test the cable system must be closely watched and recorded for any signs of approaching failure.
 - 9) All conductors must be left grounded when not on test during testing of other conductors and for at least 30 minutes after the removal of the Direct Current test potential.
 - b. All conductors and shields must be grounded.
 - 1) The bare portions of the cable ends must be prepared so as to prevent the escape of ionized air from around the bare conductor thus forming a captive space charge.
 - c. Completely tape all bare conductor surfaces with standard electrical insulating tape.
 - d. Enclose the bare portions of both end terminations in Saran Wrap®.
 - 1) On any test in which the cable will not withstand the prescribed test voltage for the full 10 minute test period without current increase the cable is considered to have failed the test and is subject to replacement.
 - 2) Polarization index is to be calculated as the ratio of the leakage current after 1 minute to the leakage current after 5 minutes at the maximum voltage level. Anything less than 1.00 is a failure, 1.0 to 1.25 is a marginal pass subject to the Engineer's discretion, above 1.25 is a pass.
 - 3) If the ratio between resistance of any two conductors in a installation is in excess of 5:1 for installations less than 1000 feet or 3:1 for installations greater than 1000 feet the cable system has failed the test and is subject to replacement.

- 4) If in the opinion of the Engineer the test results are unacceptable the Contractor will correct the installation, material or labor at no additional cost, and to the complete satisfaction of the Engineer.
 - e. Perform a shield continuity test by ohm meter method. Ohmic value shall be recorded.
 - 3. Test values.
 - a. D.C. high potential test results:
 - 1) Step voltage slope should be reasonable linear.
- B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

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SECTION 26 05 83
WIRING CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

- A. ASTM International.
- B. Code of Federal Regulations.
- C. International Electrical Testing Association, NETA.
- D. National Electrical Manufacturers Association.
- E. NFPA 70, National Electrical Code.
- F. Underwriters Laboratories Inc.

1.3 SUMMARY

- A. Section Includes:
 - 1. Wiring connecting devices.
 - 2. Terminations.
 - 3. Splices.
- B. Related Sections:
 - 1. Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the CONTRACTOR and its Sub-contractors to review all sections to ensure a complete and coordinated project.

1.4 DEFINITIONS

- A. Definitions of terms are specified in Section 26 00 00.

1.5 SYSTEM DESCRIPTION

- A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.6 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20 and 26 00 00.

- B. Product Data:
 - 1. Catalog cut sheets.
- C. Shop drawings:
 - 1. Drawings showing the installation of junction modules, splices and terminators.
- D. Instruction and Operating Manuals:
 - 1. Include drawings and data for medium voltage cable connectors, splices and junction modules in the operating manuals.

1.7 QUALITY ASSURANCE

- A. As specified in Section 26 00 00.
- B. All materials shall be UL listed.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Control Connections:
 - 1. Use insulated ring type wire terminators for connections to all screw terminals:
 - a. With chamfered/funneled terminal barrel entry.
 - b. Deep internal serrations.
 - c. Long barrel design to reduce electrical resistance and increased insulator- barrel surface area to ensure that the insulator remains in contact with the barrel.
 - d. Electroplated-tin copper conductor.
 - e. Manufactured by the following or equal:
 - 1) Thomas and Betts, Stakon.
 - 2. For process equipment connections work from manufacturer's drawings.
- B. Joints, Splices, Taps, and Connections:
 - 1. For 600-volt conductors use solderless connectors.
 - 2. Use only plated copper alloy connectors or lugs:
 - a. Aluminum connectors or lugs are not acceptable for copper conductors.
 - 3. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
 - 4. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps.
 - a. Manufactured by the following or equal:
 - 1) Buchanan 2006S or 2011S with 2007 or 2014 insulating caps.
 - 5. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
 - a. Manufactured by one of the following or equal:
 - 1) Burndy.
 - 2) Thomas and Betts.
 - 6. Where waterproof splices are required:

- a. Suitable for indoor, outdoor, weather exposed, direct buried or submersed applications.
 - b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
 - c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kV.
 - d. Two-part mold body with tongue and groove seams and built in spacer webbing.
 - e. Manufactured by the following or equal:
 - 1) 3M – Scotchcast 72-N
7. Optical Fiber terminations:
- a. All multimode optical fiber cable installed shall be terminated with a split-ferrule alignment sleeve and a precision ceramic tip. All multimode optical fiber connectors shall meet the following technical specifications:
 - 1) Connector Type: ST
 - 2) Fiber Outside Diameter: 125 microns Nominal
 - 3) Loss Repeat: < 0.2 dB per 100 reconnects
 - 4) Axial Load Minimum: 35 Pounds
 - 5) Temperature Stability: +0.1 dB Maximum from -40 C to 75 C
 - b. All single mode optical fiber cable installed shall be terminated utilizing a split-ferrule alignment sleeve and a precision ceramic tip. All single mode connectors shall meet the following technical specifications:
 - 1) Connector Type: SC
 - 2) Fiber Outside Diameter 125 Microns
 - 3) Loss Repeat: < 0.2 dB per 1000 reconnects
 - 4) Axial Load, min. 30 pounds
 - 5) Temperature Stability: -40 C to 85 C
 - c. Contractor shall provide multimode optical fiber patch cords. The multimode optical fiber patch cords shall be Lucent Technologies ML2SC-SC-XX, and shall meet the following technical specifications:
 - 1) Number of fibers: 2
 - 2) Approximate loss, mean, variance 0.1, 0.1
 - 3) Minimum bandwidth: 160 MHz-km @ 850 nm
 - d. Contractor shall provide single mode optical fiber patch cords. The single mode optical fiber patch cords shall be Lucent Technologies MS2SC-SC-XX, and shall meet the following technical specifications:
 - 1) Number of fibers 2
 - 2) Approximate Loss, mean, variance 0.1dB, 0.7dB

C. Insulating Tape:

- 1. General purpose insulating tape:
 - a. Minimum 7 mil vinyl tape.
 - b. Suitable for application in an ambient of -18 degrees Celsius
 - c. (0 degrees Fahrenheit).
 - d. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
 - e. Flame retardant, hot- and cold- weather resistant, UV resistant.
 - f. For use as a primary insulation for wire cable splices up to 600 VAC.
 - g. Meeting and complying with:
 - 1) ASTM D-3005 Type I
 - 2) UL 510

- 3) CSA C22.2
 - h. Manufactured by the following or equal:
 - 1) 3M – Scotch Number Super 33+.
- 2. General-purpose color-coding tape:
 - a. Minimum 7 mil vinyl tape.
 - b. Suitable for application on PVC and polyethylene jacketed cables.
 - c. For use indoors and outdoors in weather protected enclosures.
 - d. Available with the following colors;
 - 1) Red.
 - 2) Yellow.
 - 3) Blue.
 - 4) Brown.
 - 5) Gray.
 - 6) White.
 - 7) Green.
 - 8) Orange.
 - 9) Violet.
 - e. For use as phase identification, marking, insulating, and harnessing.
 - f. Meeting and complying with:
 - 1) UL 510.
 - 2) CSA C22.2
 - g. Manufactured by the following or equal:
 - 1) 3M – Scotch Number 35.
- 3. Fire and Electric Arc Proofing tape:
 - a. Minimum 30-mil, flexible, elastomer tape that expands in fire to form an insulating firewall between flame and cable.
 - b. Bind in place with glass cloth electrical tape.
 - c. Manufactured by the following or equal:
 - 1) 3M – Scotch Number 77.
- 4. Glass cloth electrical tape:
 - a. 7.4-mil thermosetting silicone adhesive that performs at Class H temperatures 180 Celsius (356 degrees Fahrenheit).
 - b. Use for the following applications:
 - 1) To secure no-PSA insulations such as glass in high-temperature areas.
 - 2) Splice wire rated at 180 degrees Celsius.
 - 3) For binding Fire and Electric Arc Proofing Tape.
 - c. Meeting and complying with:
 - 1) MIL-I-1966C.
 - 2) UL Recognized Component listing for 200 degrees Celsius (Guide OANZ2, File E17385).
 - 3) CSA Accepted Component 180 Degrees Celsius File LR93411.
 - d. Manufactured by the following or equal.
 - 1) 3M – Scotch Number 69.
- 5. Self-fusing Silicone Rubber Tape:
 - a. 12-mil, high-temperature, track resistant, insulating tape.
 - b. Composed of fully cured inorganic silicone rubber.
 - c. Use as a protective overwrap for terminating medium voltage cables.
 - d. Manufactured by the following or equal:
 - 1) 3M – Scotch Number 70.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Load connections:
 - 1. Connect loads to the circuits as indicated. Color-code all branch circuits as per Section 26 00 00 "Electrical General Provisions."
- B. Zero to 600-volt systems:
 - 1. Make all connections with the proper tool and die as specified by the device manufacturer.
 - 2. Use only tooling and dies manufactured by the device manufacturer.
 - 3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
 - 4. Number all power and control wires before termination.
- C. Motor connections (600 Volts and below):
 - 1. Terminate wires with compression type ring lugs at motors.
 - 2. Connection at both the motor leads and the machine wires are to have ring type compression lugs.
 - 3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
 - a. In damp and wet locations use a complete kit containing mastic that shall seal out moisture and contamination.
 - b. Shrink cap with low heat as recommended by manufacturer.
 - 4. Wire markers shall be readable after boot installation.
 - 5. Manufactured by one of the following or equal:
 - a. Raychem MCK.
- D. Medium voltage systems:
 - 1. See Division 26 Section – Medium-Voltage Cables.

END OF SECTION

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SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. General: The Contractor shall provide electric motors, accessories, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section apply to electric motors 250 hp and less.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. American Bearing Manufacturers Association (ABMA):
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. IEEE 43 – Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - 2. IEEE 112 – Standard Test procedure for Polyphase Induction Motors and Generators.
 - 3. IEEE 114 – Standard Test procedure for Single-Phase Induction Motors.
 - 4. IEEE 303 – Recommended Practice for Auxiliary Devices for Motors in Class 1, Groups A, B, C, and D, Division 2 Locations.
 - 5. IEEE 841 – Standard for Petroleum and Chemical Industry – Severe Duty totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – up to and including 500hp.
 - 6. IEEE 1349 – Guide for the Application of Electric Motors in Class I, Division 2 Hazardous (Classified) Locations.
- C. National Electrical Manufacturers' Association (NEMA):
 - 1. MG-1 – Motors and Generators.
 - 2. MG-1 – Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators.
- D. Underwriters Laboratories Inc. (UL):
 - 1. UL 674 – Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.

1.3 CONTRACTOR SUBMITTALS

- A. Complete motor data shall be submitted with the driven machinery shop drawings. Motor data shall include:
 - 1. Machine name and specification number of driven machine.
 - 2. Motor manufacturer.
 - 3. Motor type or model and dimension drawing. Include motor weight.
 - 4. Nominal horsepower.
 - 5. NEMA design.

6. Enclosure.
 7. Frame size.
 8. Winding insulation class and temperature rise class.
 9. Voltage, phase and frequency ratings.
 10. Service factor.
 11. Full load current at rated horsepower for application voltage.
 12. Full load speed.
 13. Guaranteed minimum full load efficiency. Also provide nominal efficiencies at 1/2 and 3/4 load.
 14. Type of thermal protection or overtemperature protection, if included.
 15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable.
 16. Bearing data. Include recommended lubricants for relubricatable type bearings.
 17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery.
 18. Power factor at 1/2, 3/4 and full load.
 19. Recommended size for power factor correction capacitors to improve power factor to 0.95 (lagging) when operated at full load.
- B. If water cooling is required for motor thrust bearings, the shop drawing submittals shall indicate this requirement.
- 1.4 PROJECT CONDITIONS
- A. Environmental Limitations: Rate equipment for continuous operation, capable of providing full motor load, under the following conditions unless otherwise indicated:
1. See specifications for the project conditions.
 2. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 3. Altitude: Not exceeding 6600 feet.
 4. Humidity: Equal to or less than 95 percent (noncondensing).
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Storage and handling of motors shall be in accordance with manufacturer's recommendations. Preferred storage is indoors in clean, dry space with uniform temperature to prevent condensation. Protect motors from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- 1.6 QUALITY ASSURANCE
- A. All motors shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. One of the following or equal:
1. Emerson, US Motors.
 2. General Electric.

3. Reliance.
4. Toshiba.
5. Baldor.

2.2 GENERAL REQUIREMENTS

- A. Electric motors driving identical machines shall be identical.
- B. Maximum motor loading shall in all cases be equal to nameplate horsepower rating or less, exclusive of service factor and as verified with the approved submittal data of the driven machinery.
 1. Minimum Motor Horsepower: All motors shall be sized to carry continuously all loads which may be imposed through their full range of operation. The motor horsepower shall be not less than the estimated minimum specified for each driven machine. If the estimated minimum horsepower specified is not adequate to satisfy the foregoing restrictions or any other requirements of these Specifications, the motor with the required horsepower shall be supplied at no additional cost to the Owner. In addition, any changes caused by increase in motor horsepower shall be made by the Contractor at no additional cost to the Owner; such changes may involve circuit breakers, magnetic starters, motor feeder conductors, conduit sizes, etc.
 2. Exempt Motors: Motors which are for valve operators, submersible pumps, or motors which are an integral part of Standard Manufactured Equipment, i.e., non-NEMA mounting, common shaft with driven element, part of domestic or commercial use apparatus may be excepted from these Specifications to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.3 DESIGN REQUIREMENTS

- A. General: All electric motors shall comply with ANSI/NEMA MG 1 - Motor and Generator.
- B. NEMA Design: Electric motors shall be NEMA Design B, (except as indicated in Equipment Specifications for motors controlled for variable speed operation and other special motors,) constant speed squirrel-cage induction motors having normal starting torque with low starting current. In no case shall starting torque or breakdown torque be less than the value in ANSI/NEMA MG 1. Motors shall be suitable for the starting method indicated on the Electrical Drawings.
- C. Motor Voltage Ratings: Motors shall have voltage ratings in accordance with the following, unless otherwise indicated:
 1. Voltage:
 - a. All motors ½ hp and larger shall be 460V, 3 phase unless otherwise indicated on the Drawings.
 - b. dual voltage motors rated 230/460V, 3 phase are acceptable provided all leads are brought to the conduit box.
 2. Motors driving identical machines shall be identical.
 3. All motors 1 hp and larger shall be "Premium Efficiency" motors as defined in NEMA MG-1.
 4. Horsepower as indicated on the Drawings:

- a. Horsepower ratings shown on the drawings are based on Vendor's estimates. Provide motors sized for the load of the actual equipment furnished.
- 5. Service Factor:
 - a. Provide motors rated at 1.15 Service Factor.
 - b. Provide motors capable of operating continuously at 1.15 Service Factor at project altitude.
 - 1) Without exceeding Class B temperature rise limits where motors are provided with Class F insulation.
 - 2) Without exceeding Class F temperature rise limits where motors are provided with Class H insulation.
- 6. Torque:
 - a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
 - b. When started using reduced voltage starters:
 - 1) Provide motors that develop sufficient torque for acceleration to full speed.
 - c. NEMA Design B except where driven load characteristics require other than normal starting torque.
 - 1) In No case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
- 7. Enclosures:
 - a. As indicated in the individual equipment Specifications or as specified in this section.
 - b. Totally Enclosed Fan Cooled::
 - 1) Cast iron conduit box.
 - 2) Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for frames 324T and larger.
 - c. Explosion-Proof:
 - 1) Tapped drain holes with corrosion resistant plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger.
 - d. Lifting Devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
- 8. Manufactured with cast iron frames in accordance with NEMA MG-1.
- 9. Nameplates:
 - a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
 - 1) NEMA Standard motor data.
 - 2) Bearing description and lubrication instructions.
- 10. Hardware:
 - a. Type 316 stainless steel.
- 11. Conduit Boxes:
 - a. Cast iron or stamped steel.
 - b. Split from top to bottom.
 - c. Provide gaskets at the following interfaces:
 - 1) Frames and conduit boxes.
 - 2) Conduit boxes and box covers.
 - d. Rotatable through 360 degrees in 90 degree increments.

- e. Exceeding the dimensions defined in NEMA MG-1.
 - f. Provide grounding lugs inside conduit boxes for motor frame grounding.
- 12. Motor Bearings:
 - a. Antifriction.
 - b. Regreasable and initially filled with grease.
 - c. Pumps Motor ion excess of 100 HP shall have oil lubricated bearings.
 - d. Bearings and lubrication suitable for ambient temperature and temperature rise.
 - e. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
 - f. Fit bearings with easily accessible grease/oil supply, flush, drain, and relief fittings using extension tubes where necessary.
 - g. Where specified in the equipment specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.
- 13. Insulation Systems:
 - a. Motors Installed in Ambient Temperatures of 40 degrees Celsius or less:
 - 1) Provide Class F insulation.
 - 2) Design temperature rise consistent with Class B insulation.
 - 3) Rated to operate at an ambient temperature of 40 degrees Celsius and at the altitude where the motor will be installed.
 - b. Motors Installed in Ambient Temperatures of 40 degrees Celsius and 65 degrees Celsius:
 - 1) Provide Class H insulation.
 - 2) Design temperature rise consistent with Class F insulation.
 - 3) Rated to operate at an ambient temperature of 65 degrees Celsius and at the altitude where the motor will be installed.
- 14. Motor Leads:
 - a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
- 15. Noise:
 - a. Maximum operating noise level of 85dB measured as per IEEE 85.
- D. Submersible Motors:
 - 1. Enclosures:
 - a. Totally Enclosed Non-Ventilated (TENV) watertight casing.
 - b. Smooth outer surface. Cooling fins may clog with solids and are not acceptable.
 - c. Inner and outer shaft seals separated by an oil chamber.
 - 2. Cooling:
 - a. Suitable continuous operation in totally, partially, or nonsubmerged condition without overheating.
 - b. Convection cooling only.
 - c. Water jackets and oil cooling are not acceptable.
 - 3. Electrical Cables:
 - a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
 - b. Epoxy encapsulated cable entry into terminal box.
 - 4. Insulation:

- a. Sealed moisture resistant windings.
- 5. Motor Protection:
 - a. Provide temperature detection in motor windings.
 - b. Provide moisture detection in motor housing.
 - c. Provide associated electronics and relaying in a separate enclosure to be mounted remotely.
- E. Vertical Motors:
 - 1. Enclosures:
 - a. Weather protected Type II (WP II) where installed outdoors.
 - b. Weather protected Type I (WP I) where installed indoors.
 - 2. Thrust Bearings:
 - a. Selected for combined rotor and driven equipment loads.
 - b. Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.
- F. Variable Frequency Drive Motors
 - 1. Compatible with the variable frequency drives specified.
 - 2. Inverter duty rated and labeled.
 - 3. Meet the requirements of NEMA MG-1 Part 31.
 - 4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
 - 5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
 - 6. Service factor of 1.0 when driven by VFD.
- G. Motors Installed in Corrosive Environments:
 - 1. Nameplate indicating conformance to IEEE 841.
 - 2. Stator double dipped in varnish and baked.
 - 3. Stator and rotor coated with corrosion resistant epoxy.
 - 4. Frame, brackets, fan guard and conduit box coated with minimum of two coats of epoxy paint.
 - 5. Withstand salt spray tests as per ASTM B-117.
 - 6. Suitable for hose down areas.
- H. Single Phase Motors:
 - 1. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or as indicated on the Drawings.
 - 2. Totally enclosed, fan cooled motors manufactured in accordance with NEMA MG-1.
 - 3. Ball Bearings: Sealed.
 - 4. ½ Horsepower or Less Fan Motors:
 - a. Split-phase or shaded pole type when standard for the equipment.
 - b. Open type when suitably protected from moisture, dripping water, and lint accumulation.
 - 5. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the Engineer.
 - 6. Integral overload protection.

2.4 ACCESSORIES

A. Space Heaters:

1. Provide all 3 phase motors with belted or cartridge space heaters mounted within the motor enclosure.
2. Space heater rating shall be 120 volts, single-phase, unless otherwise shown.
3. Power leads for heaters wired into conduit box.
4. Installed within motor enclosure adjacent to core iron.

B. Winding Temperature Detectors:

1. Provide temperature switches with normally closed contacts or resistance temperature detectors, 2 per each phase, as indicated on the Drawings.

C. Bearing Temperature Detectors:

1. Where required by the driven equipment specification or as indicated on the Drawings.
2. RTD type and wiring matches the winding RTDs.

D. Vibration Detectors:

1. Where required by the driven equipment specification.
2. In accordance with the driven equipment specification.

2.5 SOURCE QUALITY CONTROL

A. Factory Testing

1. Perform factory tests in accordance with:
 - a. IEEE 112 for three phase motors.
 - b. IEEE 114 single phase motors.
2. Furnish copies of test reports.
3. Include testing of:
 - a. No load current.
 - b. Locked rotor current.
 - c. Winding resistance.
 - d. High potential.
4. Tests required on motors 250 hp and larger:
 - a. Manufacturer's routine test (use polarization index voltage = 5000V for insulation resistance tests).
 - b. Efficiency and power factor versus load test performed at rated speed and 50 percent, 75 percent, 90 percent, and 100 percent of rated load. The curves from the motor tests shall be submitted for information.
 - c. The maximum allowable residual unbalance in each correction plane (journal) shall be calculated using the following equation:
 - 1) $U = 4 W/N$
 - 2) Where:
 - 3) U = residual correction plane unbalance, in ounces-inches
 - 4) W = static correction plane journal loading, in pounds
 - 5) N = maximum specified operating speed, in revolutions per minute

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors in accordance with manufacturer's instructions.
- B. Electrical work involving connections, controls, switches, disconnects, etc., shall be performed as provided in the applicable sections of Division 16.

3.2 FIELD QUALITY CONTROL

- A. Before start-up perform insulation resistance test on each motor furnished or installed on this project.
 - 1. Windings energized to 1000 volts D.C. for one minute.
 - 2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
 - 3. Inform the Engineer of any unusual or unacceptable test results.

3.3 VISUAL AND MECHANICAL INSPECTION FOR MOTORS AND THEIR ROTATING MACHINERY:

- A. Compare equipment nameplate information with the Drawings and Specifications.
- B. Inspect physical and mechanical condition.
- C. Inspect for proper anchorage, alignment, and grounding.
- D. Inspect air baffles, filter media, cooling fans, slip rings, brushes and brush rigging.
- E. Inspected bolted electrical connections for high resistance by one of the following:
 - 1. Use of low resistance ohmmeter.
 - 2. Calibrated torque wrench.
 - 3. Thermographic survey.
- F. Verify correct application of appropriate lubrication and lubrication systems.
- G. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.
- H. Special tests as suggested by manufacturer, such as gap spacing and pedestal alignment shall be made where applicable.

3.4 ELECTRICAL TESTS:

- A. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
- B. Perform insulation resistance test in accordance with ANSI/IEEE43. Test voltage shall be as specified by the manufacturer:
 - 1. On motors 200 HP and smaller, test duration shall be one minute. Calculate dielectric absorption ratio using resistance measurements at 20 seconds and 60 seconds.

2. On motors larger than 200 HP, test duration shall be 10 minutes. Calculate polarization index using resistance measurements at one minute and 10 minutes.
 - a. Perform stator resistance test phase-to-phase.
 - b. Perform insulation power-factor or dissipation-factor tests.
 - c. Perform surge comparison tests.
 - d. Verify operation of motor space heater.
 - e. Perform a rotation test to ensure correct shaft direction.
 - f. Measure no load and full load running current and compare to nameplate.
 - g. Observe proper operation and sequence of any reduced voltage starters.
 - h. Perform vibration base line test. Amplitude to be plotted vs. frequency.
 - i. Check all protective devices in accordance with other sections of these specifications.
 - j. After start-up of each motor, the current on each phase shall be measured:
 - 1) At no load.
 - 2) At defined load:
 - 3) Record the voltage of each phase to round during this test.
 - 4) Inrush current.
 - C. Measurements shall be recorded and submitted to the Engineer.
- 3.5 TEST VALUES:
- A. Insulation resistance should be not less than 10 megohms.
 - B. Dielectric absorption ratio or polarization index readings less than the manufacturer's recommended values (not less than three for polarization index or 1.4 for dielectric absorption ratio) shall be investigated.
 - C. Motor measured full load current shall not exceed nameplate value.
 - D. Vibration amplitudes shall not exceed values furnished by manufacturer.

END OF SECTION

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MOTOR DATA SHEET

MOTOR NUMBER: _____ MOTOR/EQUIPMENT NAME _____

SPECIFICATION NUMBER OF DRIVEN MACHINE _____

MOTOR NAMEPLATE DATA

MANUFACTURER _____ MODEL/SERIES _____ MODEL NO. _____

FRAME _____	ENCLOSURE _____	NEMA DESIGN _____
HP _____	SERVICE FACTOR _____	RPM _____
INSULATION CLASS _____	VOLTS _____	FULL LOAD AMPS _____
AMBIENT TEMP _____	PHASE _____	NO LOAD AMPS _____
DESIGN TEMP RISE _____	HERTZ _____	LOCK ROTOR AMPS _____
		INRUSH CODE LETTER _____

	100 PERCENT LOAD	75 PERCENT LOAD	50 PERCENT LOAD
GUARANTEED MIN EFFICIENCIES	_____	_____	_____
GUARANTEED MIN POWER FACTOR	_____	_____	_____
MAX SIZE OF POWER FACTOR CORRECTION CAPACITOR	_____	_____	KVAR

ACCESSORIES

MOTOR WINDING HEATER	_____	VOLTS	_____	WATTS
WINDING THERMAL PROTECTION	_____			
WINDING TEMP SWITCHES (YES/NO)	_____			
RTD	TYPE _____	QUALITY PER PHASE _____	# OF WIRES	_____
	NOMINAL RESISTANCE _____	NOMINAL TEMP _____	COEFFICIENT	_____
	RECOMMENDED ALARM _____	DEGREES C _____	RECOMMENDED TRIP _____	DEGREES C _____

SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO)	_____	PART WINDING (YES/NO)	_____	WYE-DELTA (YES/NO)	_____
2 SPEED, 1 WINDING (YES/NO)	_____	2 SPEED, 2 WINDING (YES/NO)	_____		_____
AREA CLASSIFICATIONS					
CLASS	_____	DIVISION	_____	GROUP	_____
				TEMP CODE	_____

* Conforms to NEMA MG-1 Part 31.

SECTION 26 22 00
DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Enclosed dry type transformers.
 - a. Stand alone units.
 - b. Units located in motor control centers.
 - c. Units located in packaged power supplies.
2. Rated 1 to 1,000 KVA.
3. Primary voltage 600V and below.

B. Related Sections:

1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:

1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. American National Standards Institute.
4. National Fire Protection Association.

1.3 SYSTEM DESCRIPTION

- A.** Provide 3-phase, or 1-phase, 60 hertz, dry type transformers with the voltage ratings, KVA capacities, and connections as indicated on the Contract Drawings.
- B.** Overall dimensions not to exceed the limits indicated or the space available.

1.4 SUBMITTALS

- A.** Furnish complete submittals in accordance with Section 01 33 20 and 26 00 00.

B. Product Data

1. Catalog cut sheets.
2. Nameplate data.
3. Weight and overall dimensions.
4. Inrush current.
5. Insulation system and temperature constraints.
6. Number and rating of taps.

1.5 QUALITY ASSURANCE

- A.** Regulatory Requirements

1. Meeting all applicable requirements of NEMA ST-20.
2. Sound levels measured and in accordance with ANSI-C89.
3. UL 1561.
4. CSA C22.2.
5. ANSI/NEMA ST-20-1988.

1.6 PROJECT/SITE CONDITIONS

- A. In conformance with the site conditions as identified in Section 26 00 00.

1.7 WARRANTY

- A. All transformers shall be fully warranted for a period of two years from the date of substantial completion.
- B. In accordance with the requirements of Section 26 00 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers of standard power transformers:
 1. Cutler-Hammer
 2. Square D.

2.2 MATERIALS

- A. Insulation:
 1. Transformers 25KVA and smaller: 185°C class.
 2. Transformers 30KVA and larger: 220°C class.
 3. Non-flammable.
- B. Cores of grain-oriented silicon steel.
- C. Windings
 1. High grade magnet wire.
 2. Clearly marked terminal pads shall be attached to a rugged fiberglass termination strip.
 3. Material:
 - a. Copper only.

2.3 EQUIPMENT

- A. Ratings
 1. BIL of 10 kv for 600-volt class windings.
 2. Sound levels, under ANSI Standard test conditions, not to exceed:
 - a. 1-9 KVA 40 db.
 - b. 10-50 KVA 45 db.
 - c. 51-150 KVA 50 db.
 - d. 151-300 KVA 55 db.

- e. 301-500 KVA 60 db.
 3. Impedance, unless indicated otherwise, within the following ranges:
 - a. 75 through 150 KVA 2.0% to 5.0%.
 4. Efficiencies, for full load at 170°C winding temperature, no less than:
 - a. 30 through 75 KVA 97.0%.
 - b. Submit test data, if requested, to prove compliance with the above.
 5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with the loading guide as published in ANSI C57.96.
 6. Temperature Rise
 - a. Transformers rated below 15 KVA shall have a maximum temperature rise of 115°C over a 40°C ambient at full load.
 - b. Transformers rated 15 KVA and above shall be of a low temperature rise design (temperature rise consistent with the next temperature class below the insulation provided). The temperature rise, over a 40°C ambient at full load, shall not exceed the value shown below for the insulation class provided:

1)	Insulation Class	Temperature Rise
2)	220°C	115°C
3)	185°C	80°C
4)	150°C	55°C
- B. Taps
1. 3 through 25 KVA.
 - a. Two 5 percent taps below normal.
 2. 30 KVA and above.
 - a. Four full capacity 2.5% primary taps: two above rated voltage, and two below rated voltage.
 - b. Operated by a tap changer handle or tap jumpers accessible through a panel.
- C. Terminals, suitable for either copper or aluminum conductors, located at the bottom or where the temperature at full load in a 40°C ambient will not exceed 60°C.
- D. Enclosures for free standing transformers.
1. Heavy gauge steel.
 2. Indoor: drip-tight.
 3. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50°C.
 4. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposit ANSI 61 gray enamel rust inhibiting paint.
 5. Wiring compartment temperature rise less than 35°C.
- E. With built-in vibration dampeners to isolate the core and coils from the enclosure.
1. Neoprene vibration pads and sleeves.
- F. Nameplates
1. Provide metal nameplates with stamped or engraved markings showing:
 - a. Connections, including taps.
 - b. KVA, phases, frequency.
 - c. Primary and secondary voltages.
 - d. Percent R, X, and Z.
 - e. Temperature rise.

- f. Insulation class.
- g. BIL rating.
- h. No load and full load losses.
- i. Sound level rating.

2.4 SOURCE QUALITY CONTROL

A. Tests

- 1. Applied voltage test to each winding and from each winding to the core:
 - a. 600-volt class winding 4 kV.
- 2. Induced voltage test at 2 times normal voltage and 2 times the frequency for 7,200 cycles.
- 3. Voltage ratio and polarity.
- 4. Sound level, performed in a test room with ambient sound level not exceeding 24 db.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor, wall, platform, MCC, packaged power supply, or roof mounted, as indicated.
- B. Locate where not in direct contact with building structure.
- C. Install on Korfund Series F or H double-deflection mounts selected for maximum isolation.
- D. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.
- E. Ground the enclosure:
 - 1. To an equipment ground conductor in the conduit.
 - 2. To the facility ground ring.
- F. Install floor mounted transformers on 3-1/2" house keeping pads.

3.2 FIELD QUALITY CONTROL

- A. Perform acceptance tests in accordance with Section 16960.

3.3 ADJUSTING

- A. In the presence of the Engineer, provide all meters and manpower to set the transformer taps as directed by the Engineer.

END OF SECTION

SECTION 26 28 16
LOW-VOLTAGE CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Requirements for Circuit Breakers.
 - a. Molded case circuit breakers.
 - b. Molded case switches.
 - c. Motor circuit protectors.
 - d. Low voltage metal enclosed (large air iron frame) circuit breakers.

B. Related Sections:

1. Division 26 Section "Electrical General Provisions".
2. Division 26 Section "Electrical Identification".
3. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.3 REFERENCES

A. Molded Case Circuit Breakers

1. U.L.:
 - a. U.L. 489 - Branch Circuit and Service Circuit Breakers.
 - b. U.L. 1087 - Molded Case Switches.
2. NEMA:
 - a. AB-1 - Standards Publication Molded Case Circuit Breakers.
3. Federal Specifications:
 - a. WC -375A - Circuit Breaker, Molded Case, Branch Circuit and Service.

B. ANSI Large Air Iron Frame Circuit Breakers

1. NEMA:
 - a. SG3 - Low Voltage Power Circuit Breakers.
2. ANSI:
 - a. C37.13 - American National Standards for Low Voltage AC Power Circuit Breakers used in Enclosures (IEEE Std 20).
 - b. C37.16 - Preferred Ratings, Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors.
 - c. ANSI C37-50 - Test Procedures for Low-Voltage AC Power Circuit Breakers used in Enclosures

1.4 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. National Fire Protection Association.

1.5 SYSTEM DESCRIPTION

- A. Furnish molded case, insulated case, power type, or motor circuit protector circuit breakers as indicated on the drawings and connect to form a completed system.
- B. Circuit breakers must be of the current and voltage ratings indicated and be capable of interrupting the available fault current.
- C. Where circuit breakers are used as disconnects for miscellaneous over-current protection, provide automatic type enclosed units with the indicated ratings and complying with applicable requirements (including manufacturer) for circuit breakers as specified.

1.6 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20 and 26 00 00.
- B. Product Data:
 - 1. Catalog Cut Sheets
 - 2. Complete data sheets indicating:
 - a. Manufacturer.
 - b. Type of enclosure.
 - c. Voltage rating.
 - d. Current rating.
 - e. Amperage rating.
 - f. Complete dimensional and weight information.
- C. Operating Manuals
 - 1. Furnish complete operating and maintenance instructions presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this section.
 - a. Complete electrical ratings.
 - b. Complete renewal parts list.

1.7 WARRANTY

- A. All circuit breakers shall be 100% warranted for a period of not less than two years from the date of final acceptance by the ENGINEER.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Cutler-Hammer.
2. Square D

2.2 EQUIPMENT

A. Breakers General

1. All breakers shall have temperature insensitive trips.
2. Breakers installed in the existing panelboards shall be the same brand as the panelboard.

B. Molded Case Circuit Breakers

1. Molded case circuit breakers for distribution panelboards and motor control centers.
 - a. Basic circuit breaker must be trip free with a quick-make, quick-break mechanism.
 - b. Trip indicating handle position.
 - c. Frame sizes:
 - 1) 150 Amp.
 - 2) 400 Amp.
 - 3) 600 Amp.
 - 4) 800 Amp.
 - 5) 1,200 Amp.
 - d. Trip mechanism as indicated on drawings:
 - 1) Thermal magnetic.
 - 2) Thermal high magnetic.
 - 3) Solid State.
 - a) Adjustable long time pickup-, ampere setting to determine the value of current that the breaker will carry indefinitely.
 - b) Adjustable long time delay- varies the time it will take the breakers to trip under sustained overload.
 - c) Adjustable short time pickup- controls the level of high current the breaker will carry for short periods of time.
 - d) Adjustable short time delay- controls the length of time the breaker will carry a high current without tripping.
 - e) Adjustable instantaneous pickup- controls level at which immediate tripping of breaker occurs.
 - i. Instantaneous trip function may be eliminated on main breakers, refer to drawings.
 - f) Adjustable ground fault pickup- controls the level at which the breaker will trip under a ground fault condition (where shown on the drawings).
 - g) Adjustable ground fault delay- controls the time that a ground fault can exist without tripping the breaker (where ground fault feature is shown on the drawings).

- h) Long time pickup indicator- provides a visual indication that the breaker is experiencing an overload condition.
 - i) Fault indicators shall be either mechanical or powered from a separate battery and charger that shall be an integral component of the switchboard.
 - i. Indicator for overload fault trip.
 - ii. Indicator for short circuit fault trip.
 - iii. Indicator for ground fault trip.
 - 2. Provide non-automatic trip breakers (molded case switches) only where specifically indicated on the contract drawings or in the specifications.
- C. ANSI Metal Enclosed (Large Air Iron Frame) Circuit Breakers
- 1. Shall be used exclusively in:
 - a. 600 V switchgear.
 - 2. The individually mounted low-voltage power circuit breakers shall consist of an electrically and mechanically trip-free circuit breaker element.
 - 3. The circuit breaker shall be of the draw out type capable of being racked to the disconnect position with the door closed.
 - a. Interlocks shall be provided to prevent connecting or disconnecting the circuit breaker unless the breaker is in the open position.
 - b. The breaker shall be prevented from being closed during any racking operation.
 - c. A test position shall be provided to permit operating the breaker while it is disconnected from the power circuit.
 - 4. Circuit breakers shall be manually or electrically operated as indicated on the drawings.
 - a. Control voltage for electrically operated circuit breakers shall be as indicated on the drawings.
 - 5. Overcurrent trip device shall be solid-state type with the following functions:
 - a. Adjustable long time pickup-, ampere setting to determine the value of current that the breaker will carry indefinitely.
 - b. Adjustable long time delay- varies the time it will take the breakers to trip under sustained overload.
 - c. Adjustable short time pickup- controls the level of high current the breaker will carry for short periods of time.
 - d. Adjustable short time delay- controls the length of time the breaker will carry a high current without tripping.
 - e. Adjustable instantaneous pickup- controls level at which immediate tripping of breaker occurs.
 - 1) Instantaneous trip function may be eliminated on main breakers, refer to drawings.
 - f. Adjustable ground fault pickup- controls the level at which the breaker will trip under a ground fault condition (where shown on the drawings).
 - g. Adjustable ground fault delay- controls the time that a ground fault can exist without tripping the breaker (where ground fault feature is shown on the drawings).
 - h. Long time pickup indicator- provides a visual indication that the breaker is experiencing an overload condition.

- i. Fault indicators shall be either mechanical or powered from a separate battery and charger that shall be an integral component of the switchboard.
 - 1) Indicator for overload fault trip.
 - 2) Indicator for short circuit fault trip.
 - 3) Indicator for ground fault trip.
- 6. Each circuit breaker shall be equipped with the following accessories as required for proper operation of the control system.
 - a. Shunt trip.
 - b. Overload bell alarm.
 - c. Lockout Device.
 - d. Auxiliary Switch:
 - 1) Number of contacts as required plus a minimum of one spare.
 - 2) Type "a" normally open.
 - 3) Type "b" normally closed.
- 7. Minimum insulation, dielectric withstand ratings:
 - a. Breaker - 2.2 KV.
 - b. Control wiring - 1.5 KV.
 - c. Closing motor - 0.9 KV.
- 8. Available in the following frame sizes:
 - a. 800 Amps.
 - b. 1,600 Amps.
 - c. 2,000 Amps.
 - d. 3,200 Amps.
 - e. 4,000 Amps.
 - f. 5,000 Amps.
- 9. Operating Times:
 - a. Electrically closing time from energizing closing circuit until contacts touch, 5 cycles max.
 - b. Maximum clearing time with instantaneous overcurrent trip 3 cycles.
 - c. Maximum clearing time with shunt trip 3.5 cycles.

2.3 COMPONENTS

A. Enclosures

- 1. Furnish enclosures consistent with the area classification and NEMA designation as indicated on the plans and specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive safety switches for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Arrange all breakers to correspond exactly with the schedules.

- B. In damp or wet areas, mount the enclosures on Unistrut type mounting channels that run vertically so that water and moisture may flow freely behind enclosure.

3.3 FIELD QUALITY CONTROL

A. Low Voltage Molded Case and Insulated Case Circuit Breakers:

- 1. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage and alignment.
 - d. Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
 - e. Operate circuit breaker to ensure smooth operation.
 - f. Check tightness of connection with torque wrench in accordance with manufacturer's recommendations.
 - g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
- 2. Electrical tests for breakers in excess of 200 Amp trip ratings:
 - a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
 - b. Time-current characteristic tests shall be performed by passing 300 percent rated current through each pole separately. Trip time shall be determined:
 - 1) Determine long-time pickup.
 - 2) Determine short-time pickup.
 - c. Instantaneous pickup current shall be determined by run-or pulse method:
 - 1) Clearing times should be within 4 cycles or less.
 - d. Insulation resistance shall be determined pole to pole, across pole and pole to ground.
 - 1) Circuit breaker shall be closed.
 - 2) Test voltage shall be 1000 volts dc applied for one minute.
 - e. Perform adjustments for final setting in accordance with the Short Circuit and
 - f. Coordination Study.
- 3. Test values:
 - a. Contact resistance shall be compared to adjacent poles and similar breakers:
 - 1) Deviations of more than 50 percent shall be investigated.
 - b. Insulation resistance shall not be less than 100 megohms.
 - c. All trip times shall fall within manufacturer's published time current curves:
 - 1) Circuit breakers exceeding maximum time shall be replaced.
 - d. Instantaneous pickup current levels should be within 20 percent of manufacturer's published values.

B. Low Voltage Air Circuit Breaker ANSI Class Breakers:

- 1. Visual and mechanical inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage and alignment and grounding.
 - d. Verify that all maintenance devices are available for servicing and operating the breaker.
 - e. Verify the unit is clean.
 - f. Verify the arc chutes are intact.

- g. Perform all mechanical operator and contact alignment tests in accordance with manufacturer's instruction manual.
 - h. Check cell fit and element alignment.
 - i. Check tightness of connections using a calibrated torque wrench.
 - j. Verify racking mechanism operation.
 - k. Lubrications requirements.
 - 1) Verify appropriate lubrication on moving current-carrying parts.
 - 2) Verify appropriate lubrication on moving and sliding surfaces.
2. Electrical tests:
- a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
 - b. An insulation resistance test shall be performed on each pole, phase-to-phase and phase to ground with the circuit breaker closed, and across each open pole:
 - 1) Test voltage shall be 1000 volts dc applied for one minute.
 - c. Perform a contact/pole-resistance test.
 - d. Make adjustments to the trip settings in accordance with the Short Circuit and coordination study.
 - e. Minimum pickup current shall be determined by primary current injection.
 - f. Long time delay shall be determined by primary injection at 300 percent pickup current.
 - g. Short time pickup and time delay shall be determined by primary injection of current.
 - h. Instantaneous pickup current shall be determined by primary injection.
 - i. Trip unit reset characteristics shall be verified.
 - j. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, trip unit battery condition, and reset all trip logs and indicators.
 - k. Verify operation of charging mechanism.
3. Test Values:
- a. Contact resistance shall be determined in micro-ohms:
 - 1) Any values exceeding 200 micro-ohms or any values which deviate from adjacent poles or similar breakers by more than 50 percent should be investigated.
 - b. Insulation resistance shall not be less than 50 megohms.
 - c. Pickup currents and trip times should fall within manufacturer's published time-current characteristic tolerance band.

END OF SECTION

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SECTION 26 29 13 MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following motor starters rated 600 V and less:
 - 1. Full-voltage magnetic.
 - 2. Contactors.
- B. For installation in motor control centers, control panels and as standalone devices.
- C. Related Section:
 - 1. Division 26 Section "Variable Frequency Drives" for general-purpose, ac, adjustable-frequency, pulse-width-modulated drives.
 - 2. Division 26 Section "Low Voltage Motor Control Centers".
 - 3. Division 26 Section "Electrical General Provisions".
 - 4. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. SCR: Silicon-controlled rectifier.
- G. Definitions of terms and other electrical considerations as set forth in the:
 - 1. Institute of Electrical and Electronic Engineers.
 - 2. National Fire Protection Association.
 - a. NFPA 70; National Electrical Code.

1.4 SYSTEM DESCRIPTION

- A. General Requirements

1. Starters shall be incorporated into motor control centers, individual starters, combination starters, and control panels as reflected on the drawings and noted in the specifications.
2. Ratings, components, and features shall be as shown on the single-line diagrams, control diagrams, details and schedules on the drawings.
3. All components shall be newly manufactured and of the latest construction series of the manufacturer.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20 and 26 00 00.

B. Product Data

1. Manufacturer.
2. Technical information.
3. Complete nameplate schedule.
4. Dimensions:
 - a. Overall length.
 - b. Overall width.
 - c. Overall height.
5. Complete Bill of Material.
6. List of recommended spare parts.
7. Painting and finish procedures and materials list.
8. Manufacturer and Amperage rating for the following:
 - a. Overload relays.
 - b. Motor circuit protectors.
 - c. Circuit breakers.
 - d. Fuses.
 - e. Protective relays.
9. Confirmation that the overload relay class meets the requirements of the equipment and motor suppliers for each starter.
10. Confirmation that any reduced voltage solid-state starters are matched to the respective driven loads at the installed conditions and will reliably accelerate the driven load.

C. Shop Drawings

1. Layout drawings.
2. Provide fully dimensioned and to scale layout drawings which include:
 - a. All equipment furnished.
 - b. Interfaces with other equipment.
 - c. Allowable top and bottom conduit windows.
 - d. Nameplate legends.
 - e. Short-circuit current rating of integrated unit.
3. Elementary schematic diagrams.
4. One diagram for each and every starter and/or contactor.
5. Wiring diagrams showing wire numbers for all internal control wires.
6. Show lug sizes, type, and manufacturer based on the cable size as specified or indicated on the project drawings.

D. Operation and Maintenance Data

1. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this section. Manuals shall include the following:
2. Electrical ratings
 - a. Phase.
 - b. Wire.
 - c. Voltage.
 - d. Ampacity.
3. Complete Bill of Material.
4. Manufacturer's operating and maintenance instructions for the starters and/or contactors and all component parts, including;
 - a. Overload relays and heater elements.
 - b. Protective devices (fuses, breakers, protective relays, etc.).
 - c. Pilot devices.
5. Complete renewal parts list.
6. 11" x 17" prints of final as-built record drawings.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements

1. Comply with NFPA 70, National Electric Code.
2. All portions and components of the starters and/or contactors shall bear UL or other nationally recognized independent testing laboratory labels.
3. Certifications:
 - a. The manufacturer shall certify that the reduced voltage solid state starter will reliably control the acceleration and of the driven load at the installed conditions.
 - b. Failure of the manufacturer to provide said certification shall be interpreted as to mean that the manufacturer has agreed that the reduced voltage solid state starter is matched to the driven load at the installed conditions and will function without fault. If the reduced voltage solid state starter fails to perform as desired the manufacturer shall replace or modify the reduced voltage solid state starter in order to achieve the desired operational conditions, as directed by the Engineer, at no additional costs to the Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store motor starters indoors in clean, dry space with uniform temperature to prevent condensation. Protect motor starters from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: The equipment shall withstand the seismic forces defined for this project as outlined by the Uniform Building Code. The seismic forces defined for this project and the other project conditions are:
1. See section 26 00 00 "Electrical General Provisions" for the project conditions.
 2. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg.

3. Altitude: Not exceeding 6600 feet.
 4. Humidity: Equal to or less than 95 percent (noncondensing).
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Engineer and Owner no fewer than three days in advance of proposed interruption of electrical systems.
 2. Indicate method of providing temporary utilities.
 3. Do not proceed with interruption of electrical systems without Engineer and Owner written permission.
 4. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of motor starters with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are referenced in Division 16 Section "Electrical General Provisions".

1.10 WARRANTY

- A. Provide a full two year warranty that shall cover all parts and labor needed to replace any components associated with the starters and/or contactors for a period of two years from the complete and final acceptance of the total project.
1. Warranty requirements that require the return of parts and Owner installation of said parts will not be accepted.

1.11 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents and corresponding equipment number.
1. Control Power Fuses: Two spare fuses of each size and type.
 2. Indicating Lights: Two of each type and color installed.
 3. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.
 5. One of each type of circuit board used in the solid state starters:
 - a. Control board.
 - b. Power board.
 - c. Bridge rectifier.
 - d. Inverter module.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE STARTERS AND CONTACTORS

- A. General Requirements for Full-Voltage Starters: Comply with NEMA ICS 2, general purpose, Class A.
- B. Magnetic Starters: Full voltage, across the line, electrically held.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Square D; a brand of Schneider Electric.
 - 2. Rating: The minimum size shall be a NEMA size 1. Verify motor ratings and coordinate starter and overload trip rating with actual horsepower and nameplate current ratings of motor installed.
 - a. If motors provided are different in horsepower rating than those specified or indicated on the drawings, provide starters of sufficient size to accommodate the specific motors furnished.
 - 3. Configuration: Nonreversing or Reversing as required for the application and as shown on the drawings.
 - 4. Contactor Coils: Pressure-encapsulated type, and with coil transient suppressors as required for voltage or size of the coil.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 5. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 6. Magnetic contactors shall be factory adjusted and chatter free.
 - 7. Control Circuits: Normally the control voltage will be 120V ac, however 24V dc, may be used as required for manufacturer's special applications, and as shown on the drawings. If other control voltages are used they shall be as shown on the drawings.
 - a. 120V ac shall be obtained from integral CPT, with primary and secondary fuses, CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - b. 24V dc shall be obtained from power supply, with primary and secondary fuses, control power source shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 8. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. The overload relay shall be set to protect the motor in the application shown on the drawings and for the size of the motor shown.
 - e. Mount extended overload reset buttons to be accessible for operation without opening door of enclosure.
 - f. Isolated overload alarm contact for indication and connection to the SCADA system as shown on drawings.

9. Starter shall be capable of communicating Ethernet TCP/IP Networks. As shown on the drawings.
 - a. Shall provide the following information and/or control on a communications network.
 - 1) Average current.
 - 2) Percent phase imbalance.
 - 3) Percent thermal capacity used.
 - 4) Trip cause.
 - 5) Full load current setting.
 - 6) Start.
 - 7) Stop.
 - 8) Reset.
- C. Combination Magnetic Starter: Factory-assembled combination of magnetic starter, overcurrent protective device, and disconnecting means. The type of overcurrent protective device used shall be as shown on drawings.
 1. The overcurrent protective device shall be rated for the short circuit as shown on the drawings. The overcurrent protective device and the starter shall be rated together to provide Type 2 coordination for starter protection from very high short circuit currents.
 2. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle are required as shown on drawings.
 3. MCCB Disconnecting Means: If a molded-case circuit breaker is shown on the drawings it shall be provided in accordance with the following:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle are required as shown on drawings.
- D. NEMA Contactors
 1. Furnished in combination with thermal magnetic circuit breakers.
 2. Electrically held, minimum NEMA size 1.
 3. Open type, coil voltage, and number of poles as specified or indicated on the drawings.
 4. Same as magnetic starters but without overload relays.
 5. Installation same as that for starters unless otherwise noted.

2.2 ENCLOSURES

- A. Motor starters: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Enclosures for combination starters shall be the type as specified on the drawings or in Section 26 00 00 "Electrical General Provisions".

2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 - 1. All pilot devices shall be supplied as specified in Section 26 00 00 "Electrical General Provisions".
- B. Auxiliary Contacts
 - 1. Contact ratings as per NEMA A600 rating.
 - 2. Auxiliary contacts rated 10 Amps at 600 volts.
 - 3. Provide all contacts shown on the drawings, and any additional contacts required for proper operation.
 - 4. Provide at least 1 normally open and 1 normally closed spare auxiliary contact with each starter.
- C. Control Relays: Auxiliary relays and adjustable time-delay relays.
 - 1. Control relays shall be supplied as shown in the drawings.
- D. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings. Space heaters shall be installed when specified on the drawings.
- E. Power factor correction capacitors shall be sized and provided by the starter manufacturer when they are shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive motor starters, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine motor starters before installation. Reject motor starters with electronic circuitry that is moisture damaged or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Combination Starters shall be installed in accordance with manufacturer recommendations and as specified in this section.

- B. Combination Wall-Mounted Starters: Install motor starters on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For starters not at walls, provide freestanding racks as shown on the drawings.
- C. Combination Floor-Mounted Starters: Install motor starters on 3-1/2 inch raised concrete housekeeping pad, unless otherwise indicated, as shown on the Contract Drawings. Comply with requirements for concrete referenced in Division 16 Section "Electrical General Provisions".
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify motor starters, components, and control wiring. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between motor starters remote devices and control system. Comply with requirements in Division 16 Section "600 Volt or Less Wires and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable as shown on drawings.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.

- d. Verify the unit is clean.
 - e. Verify contactors:
 - 1) Verify mechanical operation.
 - 2) Inspect contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect starters, wiring, components, connections, and equipment installation.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Manufacturer's Field Service: Engage a factory-authorized service representative for startup and inspection of Reduced-Voltage Solid-State Starters.
 - 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Motor starters will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies motor starters and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times

for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer and Owner before increasing settings.

- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state starters.

3.7 TRAINING

- A. Provide the services of the manufacturer's technical representative to provide training in start-up, adjustment, and troubleshooting of the following equipment:
 - 1. Reduced Voltage Solid-State Starters: minimum of 8 hours at the Owner's facility.

END OF SECTION

SECTION 26 42 14
CORROSION MONITORING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the Work necessary to furnish and install a corrosion monitoring system, which includes test stations, electrical isolation, dc blocking devices, and pipe joint bonds for electrical continuity, complete.
- B. Contractor to have a third party Corrosion Expert perform Contractor required quality control testing as defined in this Section.

1.2 DEFINITIONS

- A. Electrically Continuous Pipeline: A pipeline which has a linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable joint bond resistance for each bonded pipe joint as specified in this section.
- B. Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, reinforcement, casings) and the environment as defined in NACE SP0169 Recommended Practice.

1.3 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:
 - ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- B. American Wood Protection Association (AWPA) standards, most recent editions:
 - AWPA U1 Use Category System: User Specification for Treated Wood
- C. American Water Works Association (AWWA) standards, most recent editions:
 - AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4 In. (100 mm) and Larger—Shop Applied
- D. NACE International (NACE) standards, most recent editions:
 - NACE SP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems

1.4 SUBMITTALS

- C. Submit in accordance with Section 01 33 20 – Submittal Procedures.

- A. Product Data
 - 1. Submit catalog cuts and other information for products proposed for use.
 - B. Quality Assurance Submittals
 - 1. Field test reports.
 - 2. Qualifications of NACE accredited testing personnel.
- 1.5 QUALITY CONTROL
- A. All Contractor specified quality control testing shall be performed by a third party Corrosion Expert who holds a current NACE accreditation as a Cathodic Protection Specialist (CP-4) or Cathodic Protection Technologist (CP-3), and/or a registered professional engineer with verifiable expertise in corrosion control and cathodic protection.
 - B. Contractor performed quality control testing shall include the following tests, which shall be performed as defined this section.
 - 1. Joint Bond Resistance test.
 - 2. Insulating Joint Testing.
 - 3. Concrete Reinforcement Isolation Testing.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Like items of materials provided hereunder shall be the end product of one manufacturer to achieve standardization of appearance, maintenance, and replacement.
- B. Materials and workmanship as specified in this Section shall be installed concurrently with pipe installation. Coordinate all work specified herein with related Sections.

2.2 SUPPLIERS

- A. Subject to compliance with the Contract Documents and approval of Engineer, the following Suppliers are acceptable. Address given is that of the general office. Contact these offices for information regarding the location of their representative nearest the Project Site.

1. Corrpro, Inc., Chicago, IL	www.corrpro.com
2. Farwest Corrosion Control, Gardena, CA	www.farwestcorrosion.com
3. Hoff Company, Inc. , Denver, CO	www.pipelinesupplies.com
4. MESA Products, Tulsa, OK	www.mesaproducts.com
5. Northtown Products, Huntington Beach, CA	www.northtownproducts.com

2.3 JOINT BONDS

- A. General:
 - 1. All joint bonds provided either by pipe manufacturer or Contractor shall meet the following minimum requirements:
 - a. All connections on a joint bond shall be welded or soldered.
 - b. Mechanical or compression type connections shall not be permitted.

- c. Bonds and welds shall exhibit sufficient strength and flexibility to allow thermal movement of the pipe after pipe backfill without cracking or breakage.
- d. Bond connections to pipe shall be with an Engineer approved welding method.
- 2. All copper bonds shall be insulated or coated with any exposed copper field coated to prevent galvanic corrosion of the pipe.

B. Ductile or Cast Iron Pipe, External Bonds:

- 1. Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with formed copper sleeve on each end of the wire.
- 2. Quantity of joint bonds per pipe joint by pipe diameter shall be as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
#2 AWG Wire	16" or less	42" or less	Over 42"

- 3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
- 4. Bond installation on DIP shall be similar to the wire bond for Flanged Joints as shown on the Drawings.
- 5. Bonds shall be as manufactured by Erico Products, Continental Industries, or approved equal. Third party manufactured bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.

C. Flange joints:

- 1. Flanged joint bonds shall be one of the following types at the Contractor's option:
 - a. Steel rod, 5/8-inch diameter, length as required, arc welded to flange. Steel rod bonds will not be allowed where welding to the flange is not approved by the Engineer.
 - b. Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with a formed copper sleeve on each end of the wire.
- 2. Quantity of joint bonds per pipe joint shall be as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Steel Rod	36" or less	72" or less	Over 72"
#2 AWG Wire	NA	30" or less	Under 60"

- 3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
- 4. Coat steel rod bonds with fast curing epoxy in buried condition after welding to joint as specified, this Section, except when pipe is specified to be coated in accordance with Section 09 90 00 Coatings and Painting.

D. Sleeve Coupling, Flanged Coupling Adapter, and Other Non-standard Joints:

- 1. Ductile Iron Pipe:

- a. Bond: No. 2 AWG wires, 24 inches long, HMWPE insulation, with two 12-inch long THHN insulated No. 12 AWG wire pigtails,
 - b. Manufacturer: Erico Products Inc. (Cadweld), Cleveland, OH, Hoff Company, Denver, Colorado, or equal.
2. Steel Pipe:
- a. Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWG wire, with five punched holes for thermite welding to the coupling follower rings, middle, ring, and pipe. Strap bond shall be fabricated for the length of the coupling with sufficient additional length for 1 inch of joint movement. Strap holes shall be sized for the thermite weld mold and shall provide for physical centering of the mold over the hole.
 - b. Strap bond shall be as manufactured by Erico Products, Continental Industries, Hoff Company, or approved equal. Third party manufactured copper strap bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.
3. Bond Quantity per Joint: Provide the quantity of bonds per pipe diameter as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Copper Strap	NA	54" or less	Over 54"
No. 2 Wire Bond	30" or less	54" or less	Over 54"

4. Connection of wire or copper strap joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for the bond type used.

2.4 CATHODIC PROTECTION TEST STATIONS

A. Post Style, Wood Post:

1. Test Box: Cast aluminum suitable for threaded mounting to a 1-inch or larger rigid galvanized steel conduit.
2. Terminal Block: Plastic or glass-reinforced laminate, 1/4-inch thick with seven terminals. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal. Terminal studs, washers, and nuts shall stainless steel.
3. Mounting Post: 4-inch by 6-inch by 5-foot long wood post, preservative-treated per AWP A U1, Use Category 4A, with inorganic boron (SBX).
4. Mounting Hardware: One hole, malleable iron strap and clamp back, O. Z. Gedney 14-100G and 143G or equal. Two hole straps will not be permitted. Mount using 2.5" long, 1/4" stainless steel lag bolt or wedge anchor.
5. Manufacturer and Product: Gerome Manufacturing, Testox 800 series (round) or equal.

2.5 WIRE

A. Pipe and Test Lead Wires:

1. Pipe Test Wires: No. 10 AWG wire, single-conductor, stranded copper with 600volt, TW, THWN, or HMWPE insulation. Color coded insulation as specified.

2. Insulation Color: Color shall indicate the function of each test wire and shall be as follows:
 - a. Pipe: White
- B. Joint Bond Wires:
1. No. 2 AWG, single conductor, stranded copper with 600 volts, HMWPE insulating.
- 2.6 CONDUIT, LOCKNUTS, AND STRAPS:
- A. Outdoors, Exposed Conduit
1. Rigid conduit shall be rigid galvanized steel.
 2. Fittings, junction boxes, pull boxes, and outlet bodies shall be hot-dipped galvanized iron.
 3. Locknuts, conduit clamps, and other miscellaneous hardware shall be hot dipped galvanized steel. Galvanized items shall be hot-dipped galvanized in accordance with ASTM A153.
 4. Conduit clamps shall be two piece, malleable iron, one hole, strap and clamp back spacer, O. Z. Gedney 14-100G and 143G or similar, for mounting to surfaces with either lag bolts or concrete wedge anchors, as shown on the Drawings.
- 2.7 THERMITE WELD MATERIALS
- A. General
1. Thermite weld materials consist of wire sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and material.
 2. Welding materials and equipment shall be the product of a single manufacturer. Interchanging materials of different manufacturers is not acceptable.
- B. Molds: Graphite, as recommended by manufacturer for pipe and wire size.
- C. Adapter Sleeves:
1. For No. 12 AWG and No. 2 AWG wires.
 2. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable. Attach field-formed joint bonds sleeves with the appropriate size and type of hammer die furnished by the thermite weld manufacturer.
 3. Extend wire conductor 1/8 inch beyond the end of the adapter sleeve.
- D. Cartridges
1. Steel: 32 grams, maximum.
 2. Cast and Ductile Iron: 45 grams maximum, XF-19 Alloy
- E. Welders and Cartridges: For attaching copper wire to pipe material:

Pipe Material	Weld type	Cartridge Size, Max.
No. 6 AWG Wire & Smaller		
Steel	HA, VS, HC	15 gm
Ductile or Cast Iron	HB, VH, HE	25 gm

Pipe Material	Weld type	Cartridge Size, Max.
No. 2 Wire Joint Bonds		
Steel	FS	32 gm
Ductile or Cast Iron	FC	45 gm
Concrete Cylinder Pipe	HA, GR	32 gm

F. Welding Materials Manufacturers

1. Erico Products Inc. (Cadweld), Cleveland, OH.
2. Continental Industries, Inc. (Thermo-Weld), Tulsa, OK.

2.8 COATING REPAIR MATERIAL FOR PIPE AND FITTINGS

A. General

1. Complete coating repairs in accordance with recommendations of the pipe or fitting manufacturer.

B. Coating Requirements

1. Steel Pipes:
 - a. Coal tar based coatings: Koppers Bitumastic 50 or Denso or Tapecoat wax tape coatings; or equal, 20 mils dry film thickness, minimum.
 - b. Polyurethane or Epoxy Coatings: Fast cure epoxy, 20 mils dry film thickness, minimum
 - c. Tape Wrap Coating: Thermite Weld Cap, Canusa CRP Patch, or Raychem PERP patch, or equal
 - d. Cement Mortar Coating: Same as pipeline coating or in accordance with AWWA C205.
2. Ductile iron Pipe:
 - a. Fast cure epoxy
 - b. Thermite weld cap

C. Coating Materials:

1. Thermite Weld Caps:
 - a. Royston Laboratories Handi-Cap IP, prefabricated primerless thermite weld cap and coating system.
 - b. Provide primer unless specifically stated in product data sheet that no primer is required.
2. Fast Cure Epoxy Coating:
 - a. 100 percent solids, fast curing epoxy suitable for submerged or buried conditions.
 - b. Acceptable products or equal:
 - 1) Denso Protal 7125 (low temperature) or Protal 7300
 - 2) Tapecoat TC 7010
 - 3) 3M ScotchKote 323

2.9 INSULATING JOINTS

- A. General: Insulating joints shall be dielectric unions, flanges, or couplings. The complete assembly shall have an ANSI rating equal to or higher than that of the joint and pipeline. All

materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.

B. Insulating Flanges:

1. Flange:
 - a. As specified in applicable pipe sections or in conformance with AWWA C207, whichever is more stringent.
 - b. Bolt holes may be oversized not more 1/4 inch over nominal bolt diameter where required for insulating flange assembly.
2. Gaskets:
 - a. Full-face or ring gasket, fiberglass (G10) with O-ring seal. Buried insulating flanges shall be full face gaskets only.
 - b. Complete assembly shall have an ANSI rating equal to the flanged joint.
 - c. Gasket materials shall be resistant to intended chemical exposure, operating temperatures, and pressures in the pipeline.
3. Insulating Sleeves: Full-length Mylar or fiberglass reinforced epoxy (NEMA G-10 grade).
4. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
5. Steel Washers: Plated, hot-rolled steel, 1/8-inch thick.
6. Manufacturers:
 - a. GPT Industries, Houston, Texas
 - b. Advanced Products and Systems, Scott, LA
 - c. Central Plastics Co., Shawnee, OK.

C. Insulating Unions: O-ring sealed with molded and bonded insulating bushing to union body, as manufactured by Central Plastics Company, Shawnee, OK; or equal.

2.10 DC BLOCKING DEVICES

- A. DC isolation devices shall be solid-state electronic devices capable of passing ac current while blocking dc current.
- B. Device shall have electrical rating of 3KA fault current at 30 cycles and 40 amperes steady state ac current, minimum.
- C. Device shall have symmetrical dc blocking capabilities of -2 volts to +2 volts.
- D. DC isolation devices shall be as manufactured by Dairyland Electrical Industries, Inc., Stoughton, Wisconsin.

2.11 OTHER MISCELLANEOUS MATERIALS

- A. Test Station Wire Terminations: One-piece, tin-plated crimp-on ring tongue connector as manufactured by Burndy Co. or Thomas and Betts.

PART 3 - EXECUTION

3.1 GENERAL:

- A. The installation of the facilities herein specified and described shall conform to the latest applicable NEC rules.
- B. The workmanship shall be of the highest grade and shall be in strict accordance with material manufacturer's instructions. Equipment or materials damaged in shipment or in the course of installation shall be replaced.
- C. Contractor shall examine all Drawings and coordinate his work so as to avoid conflicts, errors, delays, and unnecessary interference with the construction of the facilities and to avoid duplication of the work such as excavation, filling, etc. In the event of any conflicts in the Specifications, the ENGINEER shall be consulted.

3.2 PIPE JOINT BONDING

- A. To form an electrically continuous pipeline and associated appurtenances, all metallic pipe joints shall be electrically bonded; including buried, vault, and manhole pipe, fittings, and restrained joints; except threaded, welded, or insulated joints.
- B. Install the quantity of joint bonds at each joint required to be bonded as specified this section or shown on the Drawings. Should the specifications and drawings conflict, the larger quantity shall apply.
- C. Electrical connection of bonds to pipe and fittings shall be by thermite or arc welding process. Bolted, compression, or mechanical connections will not be permitted.
- D. Contractor shall test each bonded joint for electrical resistance as specified under Contractor Quality Control Testing, this Section.

3.3 TEST STATION INSTALLATION

A. General:

- 1. Test station location, type, and style shall be as shown on the Drawings.
- 2. Contractor may relocate test station up to ± 25 feet for site conditions without Engineer approval. Relocation greater than ± 25 feet must be approved by the Engineer.
- 3. Contractor shall maintain records showing actual pipeline stationing of test station wire connections to the pipe.
- 4. Records of actual pipeline stationing shall be provided to Engineer prior to preliminary electrical continuity testing by Engineer.
- 5. Locate post-mounted test stations directly over the pipe and, where possible, at protected locations such as structures, fences, manholes, power poles, or edges of cultivated land.

B. Style:

- 1. Test station style shall be as shown on the Drawings and as follows:
- 2. Post mount style test stations shall be wood or steel style as shown on the Drawings.

- C. Installation:
 - 1. Post mounted test station:
 - a. Height shall be between 36 to 42 inches above finish grade.
- D. Test Wires:
 - 1. Wires shall be attached to the pipe as specified under WIRE CONNECTIONS, this section.
 - 2. Wire connections shall be an individual connection for each wire with not less than 6-inches separation from other connections. Common connections will not be allowed. Where a steel tab is welded to the pipe for test wire connections, a separate tab must be provided for each wire connection.
 - 3. Wires shall be buried a minimum of 24 inches below finished grade, except in undeveloped or cultivated areas where test wires shall be a minimum of 30-inches below finished grade.
 - 4. Wires shall be direct buried.
 - 5. Provide 12-inch diameter loop in wires at the pipeline connection, at each end of rigid conduit when required, and below post mounted test stations to prevent wires from being stressed or broken.
 - 6. Make wire connections to test station terminals with crimp-on ring tongue terminals, except where solid wire is specified.

3.4 THERMITE WELD WIRE CONNECTIONS

- A. Use thermite weld method for electrical connection of copper wire to steel, ductile iron, and cast iron surfaces. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation as recommended by the material manufacturer. Assure that pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the pipe or fitting wall's integrity or damage the lining in any way.
- B. Before the connection is made, the surface shall be cleaned to bare metal by making a 2-inch by 2-inch window in the coating, and then filing or grinding the surface with a vitrified wheel to produce a bright metal finish. Wire sleeves shall be installed on the ends of the wire before welding to the metal surface.
- C. After the weld connection is cooled, remove slag, visually inspect, and physically test wire connection by hitting with a hammer. Remove and replace any defective connections.
- D. Coat each completed wire connection as specified, this section. If lining is damaged by welding, repaired in accordance with the lining applicator's recommendations.

3.5 TRENCHING AND BACKFILL

- A. General
 - 1. Complete excavations and trenching regardless of the type, nature, or condition of materials encountered, and as required to accomplish specified construction to lines and grades shown.
 - 2. Contractor shall complete all utility notifications prior to performing trenching and excavations work.

3. Take care to avoid damage to existing structures and utilities during excavating and trenching process. Contractor may modify location, where approved by the Engineer, to minimize possible damage to existing structures. Trench shall be of uniform depth and width, level, smooth, and free of sharp objects.
- B. Trench Depths:
1. Trench depths vary for conditions and requirements. Trench depths provided are minimum requirements. Contractor to meet minimum requirements or that required by local utilities, ordinances, or regulations, whichever is more stringent.
 2. Minimum depths for corrosion monitoring work shall be as defined herein or shown on the Drawings. If in conflict, the more stringent shall
 - a. Pipeline Test wires, undeveloped 24-inches (direct bury)
 - b. Pipeline Test wires, roadways or within plants 30-inches (conduit)
 - c. All other 30-inches
- C. Safety
1. Slope, shore, or brace excavations and trenches in accordance with OSHA regulations as necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public.
 2. Contractor shall have sole responsibility for ensuring safety of trenches and conformance to OSHA trench safety requirements.
- D. Backfill and Compaction
1. Backfill trench with excavated backfill materials, unless otherwise specified.
 2. Compaction requirements shall be as specified for the pipeline or 90 percent compaction, whichever is more stringent. Backfill within 5 feet of roadways, paved areas, or other traffic areas shall be compacted to 95 percent.
 3. Do not use backfill material of frozen or consolidated debris. Leave the trench with the excess backfill material neatly mounded, but not more than 4 inches above the existing ground level, for the entire width of the trench in undeveloped areas.
 4. Replace topsoil in developed, landscaped, or cultivated areas.

3.6 CONDUITS

- A. Secure conduits entering cabinets, junction boxes, or terminal boxes with double locknuts, one on the outside and one on the inside.
- B. Install conduit parallel to walls, floors, or posts, and either plumb or horizontal. All changes in direction shall be at 90 degrees using either radius bends or outlet boxes. Conduit crossings shall be perpendicular to the other conduit or pipe.
- C. Install insulated bushings and insulated throat connectors on the ends of rigid metallic conduit.
- D. Use watertight couplings and connections. Install and equip boxes and fittings to prevent water from entering the conduit or box. Seal unused openings.

3.7 WIRE INSULATION REPAIR

- A. Underground splicing of wire will not be permitted, except where specifically shown on the drawings and approved by the ENGINEER.
- B. Where splicing is approved by the ENGINEER, splices shall mechanically secure and soldered with rosin cored 50/50 solder. Compression connectors will not be permitted.
- C. Splices or insulation damage to test station wires shall be spirally wrapped with two coats of high-voltage self-vulcanizing rubber splice tape and two layers of vinyl electrical tape.

3.8 INSULATED JOINTS

- A. Install insulated joints to electrically isolate the pipeline from other pipes or structures where shown on the Drawings.
- B. Install insulated joints as shown on the Drawings.
- C. Align and install insulating joints according to the manufacturer's recommendations to avoid damaging insulating materials.
- D. Install a Type I test station at each buried insulated joint.
- E. Provide a DC blocking device on all insulating joints, except buried joints, as specified herein and shown on the Drawings.
- F. The Contractor shall test each insulated joint for electrical insulation as specified this section. Defective insulating joints shall be repaired by the Contractor at his sole expense. All damaged or defective insulation parts shall be replaced.

3.9 DC BLOCKING DEVICES

- A. Install dc blocking devices in ground wire at all motor operated valves and where indicated on the Drawings.
- B. DC blocking devices be installed at each electrical power connection to the pipeline and shall be placed as close to the pipe as reasonable possible and shall have no conduit supports between the pipe and the dc blocking device.
- C. Support of dc blocking device shall be on either a 2-inch diameter hot-dipped galvanized steel pipe support, 4-inch hot dipped galvanized channel support, or shall be mounted to a concrete wall at the Contractor's option. Engineer shall review and approve the applicable equipment support based on the conditions present.
- D. All electrical conduits connecting or attaching to the pipeline shall be electrically isolated from pipeline. Conduit connections to the pipe or equipment mounted on the pipe or associated appurtenances shall be electrically isolated with an insulating union located within 6-inches of the connection and shall have no conduit supports between the insulating union and the pipeline.

- E. Contractor is responsible for proper installation of dc blocking devices and electrical conduit isolation where necessary to achieve complete electrical isolation of all electrical grounding from the pipeline. The Contractor shall be responsible for requesting installation guidance from the Engineer under complex field conditions, where grounding isolation cannot be achieved, or clarification of the electrical isolation requirements are needed.
- F. Upon completion of electrical system ground isolation from the pipeline, the Engineer shall review the completed installation for proper installation. Improperly installed conduit isolation or dc blocking devices shall be corrected at the Contractor's sole expense.

3.10 QUALITY CONTROL TESTING

A. General:

- 1. Contractor shall correct all construction defects identified during testing.
- 2. Provide engineer with 7 days advance notice of completion for Engineer acceptance testing.
- 3. Contractor required testing as defined herein shall be performed by a Corrosion Expert, with qualifications as specified this section, whom is an employee or subcontractor to the Contractor.

B. Joint Bond Resistance Test:

- 1. General
 - a. Contractor shall test completed joint bonds for electrical continuity using a digital low resistance ohmmeter.
 - b. Joint bond quality control test shall be performed on all bonded joints after the bonds are installed but before backfilling of the pipe.
 - c. Furnish all equipment and materials as required for test.
- 2. Digital Low Resistance Ohmmeter Test Method:
 - a. Required Equipment And Materials:
 - 1) One AVO Model DLRO10, digital low resistance ohmmeter or equivalent instrument.
 - 2) One set of duplex, helical spring point leads with current and potential points, AVO Model No. 242011-7, or equivalent wire lead set.
 - b. Test Procedure:
 - 1) Measure the resistance of joint bonds with the low resistance ohmmeter in accordance with the manufacturer's written instructions.
 - 2) Use the helical handspikes to contact the pipe on each side of the joint, without touching the thermite weld or the bond. The contact area shall be cleaned to bright metal by filing or grinding and without any surface rusting or oxidation.
 - 3) Record the measured joint bond resistance on the test form described herein.
 - 4) Repair any damaged pipe coating in accordance with Wire Connections, this Section.
- 3. Joint Bond Acceptance:
 - a. Joint bond resistance shall be less than or equal to the maximum allowable bond resistance values shown below.

Joint Type	Max. Allowable Resistance (micro-ohms)		
	Two Bonds/Joint	Three Bonds/Joint	Four Bonds/Joint
No. 2 AWG wire (Steel)	155	101	76
No. 2 AWG wire (DIP)	164	109	82
Copper Strap (12-inch)	64	43	32
Copper Strap (9-inch)	48	32	24
Coupling, 24" No. 2 AWG	205	137	102
Coupling, 24" Copper Strap	128	85	64
MLC Steel Pipe Clips	NA	55	42
Z-bars	142	95	71

- b. For bond quantities greater than shown above obtain maximum allowable bond resistance from the Engineer.
 - c. The Contractor shall remove and replace all joint bonds on a joint that exceeds the maximum allowable resistance. Replacement joint bonds shall be retested for compliance with the specified bond resistance.
 - d. Any defective joint bond discovered during SYSTEM TESTS AND INSPECTION shall be located, excavated, repaired, and backfilled by the Contractor.
 4. Test Records: Records shall be made of each bonded pipeline during the test and submitted to the Engineer. These records shall include:
 - a. Description and location of the pipeline tested.
 - b. Starting location and direction of test.
 - c. Date of test.
 - d. Joint type.
 - e. Measured joint bond resistance
 5. Report: Contractor shall submit a QC report upon completion of joint bond resistance testing which includes the information listed above.
- C. Insulated Joint Isolation Test:
1. Contractor shall provide a Corrosion Expert to test each insulating joint after assembly with a GAS Electronics Model 601 insulator tester or equivalent instrument in accordance with the manufacturer's written instructions.
 2. The Corrosion Expert shall conduct additional insulating joint testing as required to insure that insulating flanges are not electrically shorted by other equipment or incidental contact with concrete reinforcement.
 3. Conduct test before burial and coating of buried insulating flanges.
 4. Contractor to replace damaged or defective insulation parts identified during testing.
 5. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
 6. Contractor shall submit a report prepared by the Corrosion Expert certifying insulating joint testing isolation, test method(s), test data, and any corrective action required.
- D. Concrete Reinforcement Isolation Test:

1. Pipe penetrations as listed below shall be tested for electrical isolation from electrical grounding and concrete reinforcement by a Corrosion Expert.
2. Contractor to perform concrete reinforcement isolation tests where concrete reinforcement isolation is required on the Drawings and the following specific locations:
 - a. All metallic pipe penetrations into finish water reservoir and vaults.
3. Electrical isolation test method and evaluation criterion to be utilized by Corrosion Expert is to be submitted in writing for approval by Engineer prior to beginning field testing.
4. Testing shall be conducted prior to concrete placement and shall be monitored during concrete placement to ensure no electrical shorts between the pipe and tank occur.
5. Corrosion Expert shall prepare a report certifying the concrete reinforcement is properly isolated and describe test method used to verify electrical isolation upon completion of the isolation test.
6. Electrical shorted detected and identified during Engineer performed SYSTEM TESTS AND INSPECTIONS, shall be located and repaired by the Contractor at Contractor's sole expense.
7. Contractor shall submit a written report prepared by the Corrosion Expert certifying concrete reinforcement isolation, testing method(s), test data, and any corrective action required.

END OF SECTION

SECTION 26 50 00
LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. The general requirements for luminaries and light poles.

B. Related Sections

1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:

1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. National Fire Protection Association.
4. Illuminating Engineering Society.

1.3 SYSTEM DESCRIPTION

A. The Contractor shall furnish and install luminaries, and accessories for all lighting systems, complete and operable, all in accordance with the requirements of the Contract Documents.

B. Individual luminaire types etc. are identified in the plans and on the luminaire schedule.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data

1. Catalog literature for each luminaire specified cross referenced to the luminaire type found on the Luminaire Schedule in the plans.
 - a. Each such submittal shall clearly describe:
 - 1) Materials.
 - 2) Type of diffuser.
 - 3) Hardware.
 - 4) Gasketing.
 - 5) Reflector.
 - 6) Chassis.
 - 7) Finish.
 - 8) Ballast.
2. Complete literature for each luminaire substitutions.
 - a. Submittals for luminaries shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire.

- 1) Photometric data shall include coefficients of utilization, average brightness, candle power distribution curves, and lumen output chart.
 - b. Substitutions for specified luminaires shall be based upon quality of construction, light distribution, appearance, and maintenance.
 3. Support method shall be submitted for interior fixtures weighing more than 50 pounds.
 4. Ballast catalog data indicating lamp wattage, input watts, sound rating, power factor, and type of ballast.
 - a. Data for outdoor ballast shall be include low temperature starting characteristics.
 5. Photocell data submittal shall indicate switching capacity, the means of adjusting the lighting pickup level, and enclosure.
 6. Pole-mounted luminaries, including complete data on the pole material, finish, handholes, anchoring, and fixture attachment.
 7. Pole height, dimensions, bolt hole circle layout, light supporting rating, and wind withstand rating based on effective area of luminaries, and hardware.
- C. Calculations
1. Provide mounting details for indoor lights with calculations showing that the installation meets the seismic requirements of the site and detailed in Appendix J.
 2. Calculations and design must be made by and stamped by a registered professional engineer registered in the state where the project is being constructed. In light of the fact that this design is being provided by a professional engineer the submittal will be reviewed for form and content but not reviewed for technical completeness, methods, or calculations.
- D. Record Drawings
1. The luminaire schedule in the plans must be updated to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

1.5 QUALITY ASSURANCE

- A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.
1. National Electric Code.
 2. Underwriters Laboratories.
 3. ANSI C82.1 Specifications for Fluorescent Lamp Ballasts.
 4. ANSI C84.4 Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type).
 5. Standards of the Certified Ballast Manufacturer's Association.
 6. Illuminating Engineering Society (IES).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Luminaries shall be stored in their original cartons from the manufacturers until the time of installation.

- B. Luminaire poles shall be stored on blocks above grade until the time of installation.

1.7 PROJECT/SITE CONDITIONS

- A. Seismic and wind withstand ratings in accordance with Section 26 00 00.

1.8 SEQUENCING AND SCHEDULING

- A. Exterior lighting system operation shall be demonstrated during the hours of darkness.
- B. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

1.9 WARRANTY

- A. The Contractor shall warrant all luminaries, ballasts, and lamps for a minimum period of one (1) year from Substantial Completion unless otherwise specified by the General Conditions.
 - 1. Furnish, and replace any defective equipment during that period at no charge to the Owner.
 - 2. Said warranty shall be independent of any manufacturer infant mortality or normal failure statistics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pre-approved manufacturers are indicated on the Luminaire Schedule, and in notes on the drawings.
 - 1. This selection of manufacturer's is not intended to be overly restrictive and the Contractor may make substitutions from the manufacturers listed in the Luminaire Schedule in order to offer a more advantageous luminaire package.
 - 2. The lighting design and luminaire selection has been based upon the photometrics of the identified luminaries. It is the Contractor's responsibility to insure and prove to the Engineer at time of submittal that any substitutions meet the quality and photometric requirements of the original design.
 - 3. The Engineer shall make final determination if proposed substitutes are acceptable.
 - a. The Contractor shall furnish the identified luminaries at no additional cost to the Owner for any luminaire substitutions that in the sole opinion of the Engineer, are not acceptable.

2.2 EQUIPMENT

- A. Luminaries – General
 - 1. All luminaries shall be pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
 - 2. In general the luminaries furnished shall be as per the Luminaire Schedule. The specifications apply to those luminaries not described or as an addition or supplement to the luminaire schedule.
- B. Exterior Luminaries

1. Exterior luminaries in combination with their mounting pole and bracket shall be capable of withstanding winds of levels consistent with the levels identified in Section 26 00 00 without damage.
 2. Exterior luminaries shall have corrosion-resistant hardware and hinged doors or lens retainer.
 3. Luminaries specified to be furnished with integral photo-electrical control shall be of the luminaire manufacturer's standard design.
- C. Interior Luminaries
1. Interior fluorescent luminaries without diffusers shall be furnished with end plates.
 2. Where diffusers are required, they shall be of high molecular strength acrylic.
 - a. Minimum thickness of the acrylic shall be 0.125 inches for all diffusers, except that those on 4-foot square fixtures shall be 0.187 inches thick.
- D. Lamps
1. Lamps shall be first-line:
 - a. General Electric.
 - b. Westinghouse.
 - c. Sylvania.
 - d. Phillips.
 2. LED lamps shall be:
 - a. As indicated on the luminaire schedule.
 3. Incandescent lamps shall be frosted unless a specified lighting control system requires clear globe lamps.
 4. High-pressure sodium lamps shall be of the dual filament design, suitable for use in standby duty.
 - a. General Electric - LU400/SBY.
 5. Unless otherwise indicated in the Contract Documents, lamps shall be suitable for operation in any burning position.
- E. Photo-Electric Cells
1. Photoelectric cells for control of multiple fixtures shall be self-contained, weatherproof type and shall be provided with time-delay features.

2.3 COMPONENTS

- A. Poles in general:
1. As indicated in the Luminaire Schedule
 2. Anchor bolts:
 - a. Hot dip galvanized, and formed from hot rolled carbon steel bar stock, with an "L" bend on one end.
 - b. Complete with leveling shims.
 3. Anchor base:
 - a. Fabricated from structural quality hot rolled carbon steel plate, with a minimum yield strength of 36,000 psi.
 - b. Base plate to telescope the pole shaft.
 - c. Welded top and bottom along the entire perimeter.
 - d. With slotted bolt holes on the bolt circles as submitted.
 4. Handhole:

- a. Reinforced handhole located approximately eighteen (18) inches above the base.
 - b. Complete with steel cover and attachment screws.
 - c. With an integral ground connection nut, ½" x 13 UNC welded to the pole for connection to the grounding system.
- 5. Pole mounted convenience outlet:
 - a. Furnish a 120 volt, GFCI protected receptacle integrally mounted in the pole shaft at twenty four (24) inches above the base. Complete with corrosion resistant and weather proof cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Special Techniques

- 1. Luminaries shall be installed plumb and square with building and wall intersections.
 - a. Pendant-mounted luminaries which are mounted from sloping ceilings shall be suspended by ball hangers, unless otherwise indicated on the Drawings.
 - b. Luminaries installed in machinery rooms shall be located after machines have been installed.
- 2. In all cases, luminaire locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures.
- 3. Luminaries shall be installed in accordance with the architectural reflected ceiling drawings.
- 4. Unless otherwise indicated, luminaries shall be centered on ceiling tiles.
- 5. Luminaries weighing more than 25 pounds shall be supported independently of the outlet box.
- 6. Recessed luminaries shall be installed light-tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure.
 - a. Said safety supports shall consist of #12 AWG soft drawn galvanized wire.
- 7. Luminaries installed in suspended grid ceilings shall be supported independently of the grid.
- 8. All luminaries installed in suspended grid ceilings shall be held in place with seismic restraint clips.

B. Lighting Poles

- 1. Poles shall be set on anchor bolts and secured with double nuts on each bolt.
- 2. After luminaire has been leveled and plumbed, the pole base shall be dry-packed.
- 3. Poles that are specified as hinged shall have one pole lowering winch furnished for all of the poles.

3.2 ADJUSTING

- A. All outdoor luminaries shall be aimed after installation during dark evening hours as directed by the Engineer.

3.3 CLEANING

- A. Lenses, diffusers, and reflectors shall be cleaned just prior to the time specified for the system demonstrations.
- B. Luminaire trim, poles and support brackets, where finish has been damaged, shall be refinished.
- C. All luminaries used during construction for construction lighting shall be cleaned, the lamps shall be replaced, and the used lamps returned to the Owner.

3.4 DEMONSTRATION

- A. Exterior lighting system operation shall be observed to indicate that fixtures are properly focused, photo-cell operation is correct, and that switching functions as intended in accordance with paragraph 1.09 of this Section.
- B. Similar requirements shall apply to interior lighting.
- C. Through demonstration, the Contractor shall also verify that panel schedules properly indicate the lighting outlets connected to each circuit.
- D. Lighting demonstration shall occur in accordance with paragraph 1.09 of this Section.

3.5 SCHEDULES

- A. Refer to the Luminaire Schedules as found in the plans.

END OF SECTION

DIVISION 31
EARTHWORK

**SECTION 31 10 00
SITE PREPARATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Work of this Section includes all those measures required during the Contractor's initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process: clearing, grubbing and stripping; and regrading of areas to receive embankment fill.
- B. The Contractor is required to protect and preserve all things designated to remain. Where Contractor's operation causes damage or injury to trees and plants designated to remain, an arborist or other qualified professional shall be employed by the Contractor, at no additional cost to the Owner, to repair the damage or provide adequate replacement to the Owner's satisfaction where damage is beyond repair.

1.2 SITE INSPECTION

- A. Prior to moving onto the Project site, the Contractor shall inspect the site conditions and review maps of the existing plant site and off-site pipeline routes and facilities delineating the Owner's property and right-of-way lines.
- B. Contractor shall submit photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site preparation.
- C. The Contractor shall identify and accurately locate utilities and other subsurface structural, electrical, and mechanical conditions. Existing conditions shall be incorporated into the record drawings for the project.

1.3 DEFINITIONS

- A. The following definitions apply to the Work of this Section:
 - 1. Clearing is defined as cutting trees, removing fences and posts, removing curbs and other improvements to prepare the site for grubbing and stripping.
 - 2. Grubbing is defined as the below grade part of clearing to remove roots, small piping, irrigation systems, etc., to prepare the site for stripping.
 - 3. Stripping is defined as removing a surface layer of soil and organic material, sod, topsoil, and other unsuitable material as defined in Section 31 23 00 – Earthwork, to a depth that earthwork can proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

- A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
- B. Do not excavate within drip line of trees, unless otherwise indicated.
- C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
 - 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 - 4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
 - 1. Employ a qualified arborist, licensed in jurisdiction where project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 2. Arrange to shut off indicated utilities with utility companies.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Engineer's written permission.
 3. Continuous utility service to the site is required during the construction period to allow the Owner to operate existing WTP, reservoir, pump station, gates, supply pipelines, valves, and instrumentation.
 4. Where existing electrical and instrumentation lines must be removed for construction, provide temporary lines to allow for Owner's continued operation of existing facilities.
- C. Excavate for and remove underground utilities indicated to be removed.

3.4 PRIMARY PLANT SITE ACCESS

- A. Develop any necessary access to the site, including barrier facilities to be installed at the beginning of construction in order to prohibit entry of unauthorized persons.
- B. Utility Interference: Where existing utilities interfere with the Work of this Section, notify the Engineer and work around the interferences until a directive is issued.

3.5 CLEARING, GRUBBING, AND STRIPPING

- A. All construction areas shall be cleared of grass and weeds to at least a depth of six inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Loose boulders within 10 feet of the top of cut lines shall be incorporated in landscaping or removed from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.
- B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Debris or waste shall be totally removed if they are found on the site. All objectionable material from the clearing and grubbing process shall be removed from the site and wasted in approved safe locations in compliance with state and federal regulations.
- C. The area to be affected by construction that have not been pre-excavated to the subgrade elevation shall be removed and placed in the designated stockpile areas, and/or incorporated into landscaped areas or other nonstructural embankments.
- D. For all areas that have not been previously disturbed, including staging areas and temporary construction easements, topsoil-salvaging operation shall immediately follow clearing operations. The area shall be stripped of topsoil to a depth of 8 inches. Unsuitable materials, specified in Section 31 23 00, shall not be considered topsoil. The Contractor shall strip to

the depth indicated regardless of the material encountered using a D8 Caterpillar, or equal, fitted with a standard dozer blade and dual shank rippers. All stripped topsoil shall be stockpiled within stripped areas in stockpiles not to exceed 15 feet in height. Vegetation shall be ground or chipped to a mulching consistency and mixed with the stripped soil. Stockpiles shall be placed away from high construction traffic areas and shall be fenced and signed to prevent accidental use as fill prior to topsoil replacement.

- E. Upon completion of Work within the construction areas stripped of topsoil, the stored topsoil shall be respread over the disturbed areas. Topsoil shall be spread in about a 6-inch layer using paddlewheel scrapers and front-end wheel loaders. Respread topsoil shall match the existing terrain as much as possible. Interfaces between restored disturbed areas and undisturbed areas shall be chain dragged to eliminate obvious edges. All tracks and equipment marks shall be chain dragged or hand raked away. Replaced topsoil shall be thoroughly watered for dust control upon completion of the resspreading operations. Once topsoil replacement has been completed, no vehicles or other motorized equipment shall be allowed to travel on the finished surface.
- F. Unless otherwise indicated, native trees larger than three inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if not necessary for the Contractor's choice of means and methods, shall be arranged with the property owner and be removed and replaced at no increased cost to the Owner.
- G. Except in areas to be excavated, holes and other holes resulting from Work of this section shall be backfilled with suitable material in accordance with Section 31 23 00 – Earthwork.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincides with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.7 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

**SECTION 31 23 00
EARTHWORK**

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform all earthwork indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

29 CFR 1926	OSHA Safety and Health Regulations for Construction
ASTM C150	Portland Cement
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2,700 kN-m/m ³)
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2901	Test Method for Cement Content of Freshly Mixed Soil Cement
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods
ASTM D 4253	Test Methods for Maximum Index Density of Soils using a Vibratory Table
ASTM D4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4832	Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D 5971	Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM)
ASTM D 6023	Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
ASTM D 6024	Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
ASTM D 6103	Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor's attention is directed to the provisions of Subpart P, 29 CFR 1926 of the OSHA Safety and Health Standards for Construction, which relate to protection of employees in excavations. The Contractor shall submit, for information to the Engineer, the project excavation plan and the name of the Contractor's competent person, prior to commencing any excavation.
- B. Submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01 33 20 – Submittal Procedures. Sample sizes shall be as determined by the testing laboratory.
- C. Submit dewatering and water removal plan prior to performing any dewatering or water removal.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

- A. General: Fill, backfill, and embankment materials shall be suitable material.
- B. Suitable Materials: Suitable material is defined as selected or processed clean, well graded earth material, sands and gravels free of excessive fines, less than 20 percent rock and boulders larger than 4 inches, grass, roots, brush, vegetation, or other deleterious materials.
- C. Fill and backfill materials within 6 inches of any structure or pipe shall be smaller than 1 inch in any dimension.
- D. Suitable materials may be obtained from onsite excavations, may be processed onsite materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the Project, provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. Onsite materials shall be stockpiled and segregated prior to use.

E. It is expected that the Project will require a significant volume of exported materials. Contractor is responsible for identifying suitable export and disposal locations offsite. Contractor is responsible for all costs associated with furnishing materials qualification testing for suitability, for processing, hauling, storing and placing suitable fill materials, and for export and disposal of excess materials.

F. The following types of suitable materials are defined:

1. Type A (Granular Backfill): Crushed rock or gravel, and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
1-inch	100
No. 40	30 - 50
No. 200	0 - 12

2. Type B (Crushed Rock): Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 5

3. Type C (Sand Backfill): Sand non-plastic, meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/4-inch	100
No. 4	80 - 100
No. 10	30-50
No. 40	10-30
No. 200	7 - 15

Squeegee is not acceptable as sand backfill.

4. Type D (Select Backfill): Suitable material that can be readily compacted and meets the requirements of AASHTO M 145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2 inches.

<u>Sieve Size</u>	<u>Percentage Passing</u>
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	0 - 15

5. Type E (Pea Gravel Backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a No. 4 sieve.

6. Type F: (Coarse Drainrock): Crushed rock or gravel conforming to one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

Sieve Size	Percentage Passing		
	3 inch Max.	2 inch Max.	3/4 inch Max.
3 inch	100		
2 inch	90-100	100	
1 1/2 inch	70-100	95-100	
3/4 inch	0-50	50-100	100
1/2 inch			95-100
3/8 inch	0-10	0-55	70-100
No. 4		0-25	0-70
No. 8	0-5	0-15	
No. 200	0-3	0-3	0-3

7. Type G (Type II Aggregate Base): Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, or crushed gravel, free of organic matter and contamination from chemical or petroleum products meeting State specification requirements and conforming to the following Table and gradations:

Aggregate Properties			
	Aggregate Class		
	A	B	
Dry Rodded Unit Weight	Not less than 75 lb/ft ³		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI ≤ 6	AASHTO T 89 AASHTO 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table below		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

Sieve Size	Percentage Passing
3/4-inch	100
3/8-inch	75 - 95
No. 4	55 - 70
No. 16	30 - 40
No. 200	2 - 10

8. Type H (Graded Drainrock): Graded drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting and drying. The material shall be uniformly graded and shall meet the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
1 inch	100
3/4 inch	90-100
3/8-inch	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

9. Type I: Not used
10. Type J (Cement-Treated Backfill): Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.
11. Type K (Topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth as defined in Section 31 10 00 - Site Preparation. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris. Stockpiled topsoil and imported topsoil must meet the requirements of Section 32 90 00 - Planting.
12. Type M (Aggregate Subbase): Crushed rock aggregate subbase material non-plastic that can be compacted readily by watering and rolling to form a stable base. The sand equivalent value shall not be less than 18 and shall meet one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

<u>Sieve Size</u>	<u>Percentage Passing</u>	
	<u>3-inch Max.</u>	<u>2-inch Max.</u>
3-inch	100	-
2-inch	90-100	100
1-1/2 inch	-	95 - 100
1-inch	70 - 90	-
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	2 - 12	2 - 12

13. Type N (trench plug): Low permeable fill material, a nondispersable clay material having a minimum plasticity index of 10.
14. Type O (Controlled Low Strength Material (CLSM)): CLSM material shall be in accordance with Section 31 23 26 - Flowable Fill.
15. Type P (Suitable Trench Backfill): Suitable material that can be readily compacted, with less than 35 percent passing the No. 200 sieve and a plasticity index of 10 or less. Maximum particle size shall be restricted to two inches.

16. Type Q (Embankment Fill): Embankment fills may be obtained from processed on-site materials, subject to approval by the Engineer, provided processed materials meet one of the specifications for Type A through H, maximum particle size is restricted to 3 inches, and compaction density of the materials can be demonstrated and verified

2.2 UNSUITABLE MATERIAL

- A. Unsuitable materials include but are not limited to the materials listed below.
 1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.
 2. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use.
 3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, slag, and any material which may be classified as hazardous or toxic according to applicable regulations.
 4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing onsite soils.
 5. Topsoil, except as allowed below.
- B. All unsuitable excavated material shall be disposed off site.

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

- A. Use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.
- B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, notify the Engineer immediately. In case of conflict between types of pipe embedment backfills, use the agency-specified backfill material if that material provides a greater degree of support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, use the agency-specified backfill material if that material provides the greater in-place density after compaction.
- C. Fill and backfill types shall be used in accordance with the following provisions:
 1. Embankment fills shall be constructed of Type P or Q material, as defined herein, or any mixture of Type P or Q and Type A through Type H materials.
 2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.
 - a. Mortar coated pipe, concrete pipe, and uncoated ductile iron pipe shall be provided with Type C material in the pipe zone. Large diameter pipe (36-inch diameter and greater) shall be backfilled to the springline with CLSM, and the remainder of the pipe zone backfilled with Type C material.
 - b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other nonmortar coated pipe shall be backfilled with Type C material in the pipe zone.
 - c. Plastic pipe and vitrified clay pipe shall be backfilled with Type C material in the pipe zone.

- d. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve, trench plugs of Type J or N material shall be provided at maximum intervals of 200 feet unless indicated otherwise.
- e. Type O material shall be used in the pipe zone where shown on plans, specified, or required by the Engineer for special crossings or other locations, or where otherwise approved.
- f. Type E material will not be allowed for backfill within the pipe zone.
- 3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type D, Type P, or any of Types A through H, backfill material.
- 4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill.
- 5. Trench backfill and final backfill for pipelines under structures shall be Type A or B, except where concrete encasement is required by the Contract Documents.
- 6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.
- 7. Backfill around structures shall be Type P material, or Types A through Type H materials, or any mixture thereof, except as shown.
- 8. Backfill materials beneath structures shall be as follows:
 - a. Graded drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.
 - b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types G or H materials shall be used.
 - c. Under structures where groundwater must be removed to allow placement of concrete, Type H material shall be used. Before the Type H material is placed, filter type geotextile fabric shall be placed over the exposed foundation.
 - d. Under all other structures, Type G or H material shall be used.
- 9. Backfill used to replace pipeline trench overexcavation shall be a layer of Type H material with a 6-inch top filter layer of Type E material or filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.
- 10. Backfill used to replace overexcavation beneath structures shall be Type G or H.

2.4 PIPELINE MARKING TAPE

- A. **Metallic Tape:** Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be a minimum of 6 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, as indicated. Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D"), Allen (Detectatape), or equal.
- B. **Plastic Tape:** Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalis, acids, and chemicals and solvents which are likely in the soil. Tape shall be a minimum of 6 inches wide and lettering shall be 1-inch tall permanent black on a colored background. Tape shall be manufactured by Reef Industries (Terra Tape), Allen (Markline), or equal.
- C. **Warning Tape:** Warning tape manufactured for marking and identifying underground utilities continuously inscribed with a description of utility, colored as follows:

1. Red; Electric.
2. Yellow; Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water Systems.
5. Green: Sewer Systems.

2.5 MATERIALS TESTING

- A. All soils testing of samples submitted by the Contractor will be done by a testing laboratory of the Owner's choice and at the Owner's expense. At its discretion, the Engineer may request that the Contractor supply samples for testing of any material used in the work.
- B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.
- C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.
- E. The testing for chloride, sulfate, resistivity, and pH will be done by a testing laboratory of the Owner's choice and at the Owner's expense.

PART 3 - EXECUTION

3.1 EXCAVATION – GENERAL

- A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including rock and all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. Furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with safety requirements of the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
- B. Maximum Length of Open Trench: The maximum length of open trench in urban and rural areas shall not exceed 500-feet at each pipe installation heading beyond the end of the installed pipeline, or the requirements of the agency with jurisdiction, whichever is lesser.
- C. Construction Delays: In the case of any construction delay in excess of five calendar days, whether Contractor or Owner caused, the Contractor shall backfill the excavation, install temporary paving including temporary traffic markings, and restore traffic to pre-

construction condition to minimize disruption to traffic and the community at no additional cost to the Owner.

- D. **Removal and Exclusion of Water:** Remove and exclude water, including storm water, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, well points, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

- A. **Overexcavation:** Except as noted otherwise, excavation beneath all structures (including new reservoir, vaults, retaining walls, and manholes) shall be carried to a depth of 12 inches to allow for placement of a leveling course below the bottom of footing or slab (for the tank, excavation shall be carried to a depth of 12 inches below the underdrain liner). Overexcavated areas shall be backfilled and compacted using Type G material to the grade of the bottom of the slab. Beneath new tank, backfill and compact to 95 percent of maximum density using Type G material to bottom of underdrain system elevation. Install underdrain system, including Type H material. All backfill of overexcavation beneath structures shall be compacted to obtain 95 percent of maximum relative density
- B. **Excavation Beneath Structures and Embankments:** Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be overexcavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched. When such overexcavation is indicated, both overexcavation and subsequent backfill to the required grade shall be performed. When such overexcavation is not indicated but is ordered by the Engineer, such overexcavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or overexcavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.
- C. **Excavation Beneath Concrete Reservoirs:** Excavation under reservoirs shall extend 12 inches below the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the sand, liner, and drainrock. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density with moisture content within plus and minus 2 percent of the optimum moisture content.
- D. **Excavation Beneath Paved Areas:** Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the bottom of the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and

rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

- E. Notification of Engineer: Notify the Engineer at least 3 days in advance of completion of any structure excavation and allow the Engineer a review period of at least 1 day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

- A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.
- B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe zone. Excavations for pipe bells and welding shall be made as required.
- C. Open Trench: The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be protected in accordance with Section 01 71 50 – Protection and Restoration of Existing Facilities. The Contractor shall provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.
- D. Trench Overexcavation: Where trenches are indicated to be overexcavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.
- E. Overexcavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be overexcavated beyond the depth and/or width shown. Such overexcavation shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Overexcavation less than 6 inches below the limits on the Drawings shall be done at no increase in cost to the Owner. When the overexcavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made. Said additional payment will be made under separate unit price bid items for overexcavation if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.
- F. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

- G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVEREXCAVATION NOT ORDERED OR INDICATED

- A. Any overexcavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed at no additional cost to the Owner.

3.5 EXCAVATION IN LAWN AREAS

- A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner so as to restore the lawn as near as possible to its original condition. Provide new sod if stockpiled sod has not been replaced within 72 hours.

3.6 EXCAVATION IN VICINITY OF TREES

- A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed by the Engineer.

3.7 BACKFILL – GENERAL

- A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed. Structures shall not be constructed on CLSM backfill until the CLSM has obtained a 7-day minimum cure.
- B. Except for drainrock materials being placed in overexcavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.
- C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.
- D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. All materials disturbed from their intact condition that are 4 inches or larger in

least dimension or aggregates of soil material thicker than 4 inches shall be removed from the excavation walls and base prior to placing pipe or any backfill material. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.8 PLACING AND SPREADING OF BACKFILL MATERIALS

- A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness.
- B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.
- C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
- D. Where the backfill material moisture content is too high to permit the indicated degree of compaction the material shall be dried or mixed with drier material until the moisture content is satisfactory.
- E. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs.

3.9 COMPACTION OF EARTH FILL, BACKFILL, AND EMBANKMENT MATERIALS

- A. Each layer of Types A, B, C, D, G, H, I, K, M, P and Q backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.
- B. Each layer of Type E and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.
- C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.
- D. Pipe zone backfill materials that are granular, shall be compacted by using vibratory compactors.
- E. Equipment weighing more than 10,000 pounds shall not be used closer to structure walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power

compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

- F. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.
- G. Compaction Requirements: The following compaction test requirements shall be in accordance with ASTM D 1557, method C. Compaction shall be obtained with the moisture content within plus or minus 2 percent of the optimum moisture content. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe embedment backfill for flexible pipe	90
Pipe bedding and overexcavated zones under bedding for flexible pipe, including trench plugs	90
Pipe embedment backfill for steel yard piping	---
Pipe embedment backfill for rigid pipe	90
Pipe zone backfill portion above embedment for rigid pipe	90
Pipe bedding and overexcavated zones under bedding for rigid pipe	90
Final backfill, beneath paved areas or structures	95
Final backfill, not beneath paved areas or structures	85
Trench zone backfill, beneath paved areas and structures, including trench plugs	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs	90
Embankments and fills	90
Embankments and fills beneath paved areas or structures	95
Backfill beneath structures and hydraulic structures	95
Backfill and fill around structures on reservoir or structure roof	90
Topsoil (Type K material)	80
Aggregate base or subbase (Type G or M material)	95

3.10 PLACEMENT OF CLSM

- A. Following placement and anchoring of the pipe, remove all loose soil from trench walls and floor. Remove any unstable soil at the top of the trench, which might fall into the trench during placement of the CLSM.
- B. Prior to placement of CLSM, the pipeline steel temperature shall be controlled as specified in Section 33 11 11 - Steel Pipe.
- C. Deliver the CLSM to the trench in ready mix trucks and utilize pump or chutes to place the CLSM in the trench. Direct CLSM to one side of the pipe, taking care not to displace the pipe at any time. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1.5 feet above the pipe bottom. Use at least two hand-held vibrators to continuously liquefy and move CLSM into all voids. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Continue placing CLSM on both sides of the pipe continuously using two vibrators for every 30 feet of pipe run.
- D. Maintain stability of pipe throughout CLSM placement. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to the Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

3.11 PIPE AND UTILITY TRENCH BACKFILL

- A. Pipe Zone
 - 1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe. The bedding is defined as that portion of pipe zone backfill material between the bottom of the trench and the bottom of the pipe. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 6 inches above the top surface of the pipe.
 - 2. After compacting the bedding, perform a final trim using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.
 - 3. The pipe zone shall be backfilled with the indicated backfill material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
 - 4. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. Do not displace the pipe or backfill while the shield is being moved.
- B. Trench Zone: After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point

18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

- C. Marking Tape Installation
 - 1. Continuously install metallic marking tape along the pipe at a depth of 3 feet below finish grade.
 - 2. Continuously install plastic marking tape along the pipe at the elevation indicated on the Drawings.
- D. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.12 FILL AND EMBANKMENT CONSTRUCTION

- A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be scarified to a depth of 6 inches, moisture conditioned, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.
- B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 5H:1V, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 12 inches normal to the slope of the hillside or fill shall be removed and recompacted as the embankment or fill is brought up in layers. Material thus cut shall be recompacted along with the new material at no additional cost to the Owner. Hillside or fill slopes 5H:1V or flatter shall be prepared in accordance with Paragraph A, above.
- C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe.

3.13 FIELD TESTING

- A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.
- B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Field density in-place tests will be performed in accordance with ASTM D 1556 or by such other means acceptable to the Engineer.
- C. In case the test of the fill or backfill show noncompliance with the required density, perform remedies as may be required to ensure compliance. Subsequent testing to show compliance

shall be by a testing laboratory selected by the Owner, paid by the Contractor, at no additional cost to the Owner.

- D. Provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner's field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.
- E. Frequency of Testing
 - 1. Backfill around structures and in embankments shall be tested every 300 square ft of each lift of placement.
 - 2. CLSM shall be tested each batch being placed or every 100 cubic yards that is placed.
 - 3. Pipe backfill shall have one test every 80 feet (2 joints) of backfill placed.

END OF SECTION

**SECTION 31 23 19
DEWATERING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes construction dewatering.

1.3 PERFORMANCE REQUIREMENTS

- A. The Contractor shall provide all labor, materials, and equipment necessary to dewater site excavations, in accordance with the requirement of the Contract Documents.
- B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.
- C. To complete this Work, the Contractor shall secure a Utah Pollution Elimination Discharge System (UPDES) General Permit for Construction Dewatering and Hydrostatic Testing prior to commencing any dewatering work.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 2. The geotechnical report is included elsewhere in the Project Manual.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 1. Maintain free water level below bottom of excavation during construction.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
 1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

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SECTION 31 23 26
CONTROLLED LOW STRENGTH MATERIAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install flowable fill, complete and in place, in accordance with the Contract Documents.
- B. Flowable fill refers to a cementitious slurry consisting of a mixture of fine aggregate or filler, water, and cementitious material(s), which is used as a fill or backfill in lieu of compacted earth. Flowable fill is sometimes referred to as controlled density fill (CDF), controlled low strength material (CLSM), lean concrete slurry, and unshrinkable fill.
- C. Place flowable fill where indicated on the Drawings. With approval of the Engineer, normal flowable fill with high slump, non-segregating consistency that readily flows and fills voids and difficult-to-reach places may also be used for the following purposes:
 - 1. Pipe zone fill.
 - 2. Trench zone fill.
 - 3. Pipe abandonment.
 - 4. Structure backfill.
 - 5. Structure cavity fill.

1.2 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM C33	Standard Specifications for Concrete Aggregates
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C150	Standard Specifications for Portland Cement
ASTM C260	Specification for Air-Entraining Admixtures for Concrete Compounds for Curing Concrete
ASTM C403	Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

1.3 DEFINITIONS

- A. Flowable fill: A mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C94.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Product data.
1. Flowable fill mix designs which show the proportions and gradations of materials proposed for each type of flowable fill indicated. Provide independent laboratory test results for each mix design verifying indicated properties.
- C. Test and Evaluation Reports
1. If Contractor proposes to provide lower strength flowable fill with aggregates that do not conform to ASTM C33, provide written testing program that will be used to control the variability of the aggregates. Testing program must be acceptable to Engineer.
- D. Correlation Test Reports

1.5 QUALITY ASSURANCE

- A. Testing will be performed by a testing laboratory selected by the Owner at the Owner's expense, except when otherwise specified herein or on the Drawings. Preconstruction qualification testing to verify compliance of materials with specifications shall be done by the Contractor and supplier at their expense.
- B. If tests of the flowable fill indicate non-compliance with these Specifications, make changes as may be required to achieve compliance. Perform and pay for subsequent testing to show compliance.

PART 2 - PRODUCTS

2.1 PERFORMANCE / DESIGN CRITERIA

- A. Prepare flowable fill mixes within the following limits and as necessary to produce the indicated compressive strengths:
1. Density: Between 120 pcf minimum and 145 pcf maximum.
 2. Slump: As required by for placement methods, which do not promote segregation; maximum of 10 inches.
 3. Compressive Strength: 28-day compressive strength to be between 100 psi minimum and 300 psi maximum per ASTM D4832.
 4. Entrained Air: Between 20 percent minimum and 30 percent maximum.
 5. Water reducing agent: Provide at Contractor's option as necessary.

2.2 MATERIALS

- A. Cement: Provide per ASTM C150, Type I or Type II.
- B. Pozzolan: Provide fly ash conforming to ASTM C618, Type C or Type F. Pozzolan content, by weight, is limited to the weight of cement in the mixture.
- C. Aggregate:
 - 1. Provide aggregates free from organic matter and containing no more alkali, sulfates, or salts than the native materials at the Site.
 - 2. Provide aggregate consisting of a well-graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8 inch and conforming to the following sieve limits:

Sieve Size	Percent Passing
1/2-inch	100
3/8-inch	>70
No. 200	<12 ¹

¹ If more than 5 percent of the aggregate passes the No. 200 sieve, the plasticity index must be less than 0.73 (liquid limit – 20), when tested in accordance with ASTM D4318.

- D. Admixtures
 - 1. Air entraining admixture: ASTM C260.
 - 2. Water reducing admixture: ASTM C494
- E. Water: Provide potable, clean, and free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Batch, mix, and deliver flowable fill per ASTM C94. Produce at a batch plant acceptable to the Engineer and delivered in transit mix trucks.

3.2 PLACEMENT

- A. Place flowable fill by tailgate discharge, conveyor belts, pumps, or other appropriate means. Direct flowable fill in place by vibrator, shovel, or rod to fill crevices and pockets. Avoid over-consolidation that causes segregation of aggregates.
- B. Temperature Limits:
 - 1. Flowable fill temperature at placement: 50 degrees F to 90 degrees F.
 - 2. Air temperature at placement: Above 40 degrees F and rising.

3. Do not place flowable fill against frozen subgrade or other materials having a temperature less than 32 degrees F.
- C. Place flowable fill continuously against fresh material unless otherwise approved by the Engineer. When new material is approved to be placed against existing flowable fill, conform to the following:
 1. Clear the area of all loose and foreign material.
 2. Soak the surface of the existing material a minimum of 1 hour before placement of fresh material but do not create standing water.
- D. Flowable fill Placement for Piping:
 1. Place pipe on soil pads.
 2. Place bedding under the pipe from one side and vibrate as necessary, so that the flowable fill flows to the opposite side.
 3. Add flowable fill to both sides of the pipe and vibrate until it fills the space between the pipe and the excavated trench bottom.
 4. Deposit flowable fill in such a manner as to avoid uplift. Deposit in final position to avoid disturbing the pipe trench or causing foreign material to mix with the cement slurry.
 5. Do not place pipe zone backfill until the flowable fill has reached initial set.
 6. Pipes placed on steep slopes may require a stiffer mix to prevent flowable fill from flowing down the trench.
 7. Vibrate as necessary to ensure that the flowable fill fills all voids.

3.3 FINISHING

- A. Finish flowable fill smooth and to the grade indicated on the Drawings or as directed by the Engineer. Finish free from fins, bulges, ridges, offsets, and honeycombing.
 1. Finishing by wood float, steel trowel, or similar methods is not required.

3.4 CURING

- A. Maintain flowable fill damp for a minimum of 7 days or until final backfill is placed.

3.5 PROTECTION

- A. Protect flowable fill from temperatures below 40 degrees F for a minimum of 72 hours after placement.
- B. Protect flowable fill from running water, rain, or other damage until the material has been accepted and final fill completed.

3.6 FIELD QUALITY CONTROL

- A. Correlation Testing:
 1. Perform a field correlation test for each mix of flowable fill used in pipe zones, trench zones, or backfill used in amounts greater than 100 cu yd, or when flowable fill is required to support traffic or other live loads on the fill less than 7 days after placing the flowable fill.

2. Perform field correlation tests in a test pit similar in cross section to the Work and at least 10 feet long at a location near the Work, acceptable to the Engineer. Test under the following standards:
 - a. Compression Testing: ASTM D4832.
 - b. Setting Test: ASTM C403.
 - c. Density Test: ASTM C138
3. Perform all laboratory and field tests on samples taken from the same flowable fill batch mix at Contractor's expense and in accordance with the following schedule:
 - a. Perform tests once each 2 hours during the first 8 hours.
 - b. Perform tests once each 8 hours during the first week (after the first 8 hours).
 - c. Perform tests once each 24 hours (after the first week) until the flowable fill reaches its design strength.

END OF SECTION

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SECTION 31 32 19
GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install geotextiles, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus.
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles.
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).

1.3 DEFINITIONS.

- A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.
- B. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.
- C. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.

- D. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.
- E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.
- F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.
- G. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.
- H. Nonwoven geotextile: A geotextile fabric composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Product Data.
 - 1. Manufacturer's material specifications and product literature.
 - 2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
 - 3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
- C. Samples.
 - 1. Geotextile: One-piece, minimum 18-inches long, taken across full width of roll of each type and weight of geotextile. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.
 - 2. Field Sewn Seam: 5-foot length of seam, 12-inches wide with seam along center, for each type and weight of geotextile.
 - 3. Securing Pin and Washer: 1 each.
- D. Certificates.
 - 1. Certification from geotextile manufacturer that products satisfy the indicated requirements.
 - 2. Field seam efficiency test results.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.
- C. Handle products in manner that maintains undamaged condition.

- D. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

PART 2 - PRODUCTS

2.1 NONWOVEN GEOTEXTILE

- A. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.
- B. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.
- C. Geotextile Edges: Selvaged or finished to prevent outer material from separating from sheet.
- D. Unseamed Sheet Width: Minimum 6 feet.
- E. Nominal Weight Per Square Yard: 8 ounces.
- F. Physical Properties: Conform to physical property requirements below:

<u>Property</u>	<u>Requirement</u>	<u>Test Method</u>
Apparent Opening Size (AOS)	Max No. 80 U.S. Standard Sieve Size	ASTM D4751
Water Permittivity	1.2 sec. ⁻¹ , MinARV	ASTM D4491 (Falling Head)
Vertical Water Flow Rate	90 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	300 MinARV	ASTM D4595
Wide Width Strip Elongation	50 percent, MaxARV	ASTM D4595
Trapezoidal Tear Strength	120 lb, MinARV	ASTM D4533
Puncture Strength	130 lb, MinARV	ASTM D4833
Ultraviolet Radiation Resistance	70 percent strength retention, MinARV after 500 hours	ASTM D4355

2.2 SEWING THREAD

- A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

2.3 SECURING PINS

- A. Securing pins shall be steel rods or bars conforming to the following:
 - 1. 3/16-inch diameter.
 - 2. Pointed at one end; head on other end, sufficiently large to retain washer.
 - 3. Minimum Length: 12-inches.
- B. Steel Washers for Securing Pins:
 - 1. Outside Diameter: Not less than 1-1/2 inches.
 - 2. Inside Diameter: 1/4-inch.
 - 3. Thickness: 1/8-inch.
- C. Steel Wire Staples:
 - 1. U-shaped.
 - 2. 10-gauge.
 - 3. Minimum 6-inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Laying Geotextile
 - 1. Notify the Engineer whenever geotextiles are to be placed. Do not place geotextile prior to obtaining Engineer's approval of underlying materials.
 - 2. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.
- B. Orientation on Slopes
 - 1. Orient geotextile with long dimension of each sheet parallel to direction of slope.
 - 2. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18-inches beyond toe of slope.
- C. Joints.
 - 1. Unseamed Joints.
 - a. Overlap unseamed joints to the following dimensions unless otherwise indicated:
 - b. Foundation/Subgrade Stabilization: Minimum 18-inches.
 - c. Riprap: Minimum 18-inches.
 - d. Drain Trenches: Minimum 18-inches, except overlap shall equal trench width if trench width is less than 18-inches.
 - e. Other Applications: Minimum 12-inches.
 - 2. Sewn Seams.
 - a. Use sewn seams wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.
 - b. Seam efficiency shall be minimum 70 percent.
 - c. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.
 - d. Stitch Count: Minimum 3 to maximum 7 stitches per inch.
 - e. Stitch Type: Double-thread chain stitch, Type 401, Federal Standard No. 751a.

- f. Stitch Location: 2-inches from geotextile sheet edges, or more if necessary to develop required seam strength.
- g. Sewing Machines: Capable of penetrating 4 layers of geotextile.

D. Securing Geotextile.

- 1. Secure geotextile during installation as necessary with sand bags or other means approved by Engineer.
- 2. Securing Pins
 - a. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6-inches from free edges.
 - b. Spacing:

Slope	Maximum Pin Spacing (Feet)
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

- c. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
 - d. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
- 3. For underdrain applications (geotextile cushion over PVC or rubber waterproof membrane liner) do not use pins, staples or other securing methods that would damage waterproof membrane liner.

E. Placing Products over Geotextile.

- 1. Notify Engineer before placing material over geotextile. Do not cover installed geotextile prior to receiving authorization from the Engineer to proceed.
- 2. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

F. Installing Geotextile in Trenches.

- 1. Place geotextile in a way that will completely envelope granular drain material to be placed in trench and with indicated overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.
- 2. After granular drain material is placed to grade, fold geotextile over top of granular drain material, unless otherwise indicated. Maintain overlap until overlying fill or backfill is placed.

G. Riprap Applications.

- 1. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet. Sew joints where wave run-up may occur.

H. Geotextile-Reinforced Earth Wall Applications.

- 1. Sew exposed joints; extend sewn seams minimum 3-feet behind face of wall.

2. Protect exposed geotextile from damage and deterioration until permanent facing is applied.
- I. Silt Fence Applications.
 1. Install geotextile in one piece or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.
 2. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.
 3. Securely fasten geotextile to a wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.
 4. Promptly repair or replace silt fence that becomes damaged.
- 3.2 REPAIRING GEOTEXTILE
 - A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18-inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by Engineer.
- 3.3 REPLACING CONTAMINATED GEOTEXTILE
 - A. Protect geotextile from contamination that would interfere, in Engineer's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.
- 3.4 FIELD QUALITY CONTROL
 - A. Testing: Test seam efficiency by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided for the Work. Test according to ASTM D4884 and submit written results to Engineer.

END OF SECTION

SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide excavations with ground supports conforming with 29CFR1926, Subpart P-Excavations, OSHA requirements, and the General Conditions.
- B. The Contractor shall prepare and follow in his work the following plans for worker and property protection:
 - 1. Plan for trench and structure excavations
 - 2. Plan for supporting trenches and structure excavations
 - 3. Plan for movement monitoring.
- C. These plans shall be prepared, signed and properly sealed by a Professional Engineer registered in the State of Utah with suitable license and experience to prepare said plans. Submit such plans to Engineer. No excavation or blasting shall take place until these plans have been prepared, signed, sealed and reviewed by all pertinent members of Contractor's staff.
- D. These plans shall address temporary excavations for tank structure, vault structures, pipeline trenches, temporary stockpile slopes, and other temporary excavations and stockpiles.
- E. Excavation and support plans shall address the following topics:
 - 1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
 - 2. Design assumptions and calculations.
 - 3. Methods and sequencing of installing excavation support.
 - 4. Proposed locations of stockpiled excavated material.
 - 5. Minimum lateral distance from the crest of slopes for construction vehicles, stockpiled excavated materials, and other construction loadings
 - 6. Anticipated difficulties and proposed resolutions.
- F. Movement monitoring plan shall address the following topics:
 - 1. Survey control

2. Location of monitoring points
3. Plots of data trends
4. Interval between surveys

1.2 SUBMITTALS

- A. Submit excavation plans for worker protection in pipe trenches and other excavations. Submittal of excavation plans shall be for records only. Submittals will not be reviewed as they are the sole responsibility of the Contractor and the registered engineer who signs and seals said plans.

1.3 QUALITY ASSURANCE

- A. Provide surveys and competent persons to monitor movements of critical facilities and areas of anticipated difficulties.

PART 2 - MATERIALS (NOT USED)

PART 3 - EXECUTION

3.1 EXCAVATION SUPPORT

- A. Provide, and maintain shoring, sheeting, and sloping as necessary to support the sides of excavations, to protect workers and other people on the site, and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.
- B. Take necessary measures to protect excavations and adjacent improvements from running, caving, boiling, settling, or sliding soil resulting from high groundwater table, surcharge, or other problems associated with the soil excavated.
- C. Install shoring, sheeting, and sloping for trench and structure excavation progressively with the removal of excavated material. Erect sheeting or lagging to exclude groundwater and prevent fines from migrating into the excavation. In soft, wet ground, drive sheeting to a lower elevation level as excavation progresses so that sheeting is embedded in undisturbed earth. Bracing or sheet piling may be permitted to penetrate structural concrete only as approved in advance by the Engineer.
- D. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting, and bracing shall be carefully removed so no voids shall be created and no caving, lateral movement, or flowing of the subsoils shall occur.
- E. Withdraw the shoring and sheeting members as the backfill is raised, maintaining sufficient support to protect the work and workers. Remove bracing completely. Where unstable conditions may occur in the underlying strata, and withdrawal of the excavation support system may endanger the work, portions of the sheeting and bracing, including pressure

treated lagging, may be left in place with approval of the Engineer. Remove all wood within a zone extending 5 feet below finished grade.

- F. Any damage resulting from improper installation or inadequate maintenance shall be the responsibility of the Contractor.
- G. Nothing contained in this specification shall be construed as relieving the Contractor of the full responsibility for providing shoring, bracing, sloping, or other provisions which are adequate for the protection of people and property.

3.2 MOVEMENT MONITORING

- A. This sub-section does not limit the Contractor's choice of construction methods based on the site conditions. It establishes minimum requirements for the Contractor to monitor the effects of construction on existing site features and to demonstrate a reasonable preparedness to meet potential contingencies and protect existing site features.
- B. Where trenching or excavating are required within 50 feet of existing structures and aqueducts, the Contractor shall implement and maintain monitoring and contingency plans during the open excavation until completion of excavation operations.
- C. Prepare a movement monitoring and contingency program for any permanent structure and any buried utilities larger than 12 inches in diameter, all natural gas pipelines, and any additional structures indicated which are within a horizontal distance of 50 feet from any excavation.
- D. Perform a photographic survey of all structures that may be affected in the presence of the Engineer. Provide written monitoring and contingency program and site photos to Engineer prior to commencing excavation.
- E. Where excavations are required within 50 feet of existing structures, aqueducts, and other pipelines, the Contractor shall implement and maintain monitoring and contingency plans until completion of excavation operations.
- F. Establish a horizontal and vertical movement monitoring program and perform all survey and inspections necessary for monitoring existing site features. All surveys shall be performed under the direction of a licensed land surveyor. Set control for movement monitoring in a location that will not be subject to ground movement or construction disturbance.
- G. Set at least two survey monuments on each existing structure, a minimum of one survey monument within 10 feet of the excavation in the immediate vicinity of existing buried utilities, and a minimum of one survey target on existing structures, utilities or gas lines. The survey monuments and targets shall be spaced at least 50 feet apart on structures and 100 feet apart for all other conditions, when excavations parallel structures, utilities, or gas pipes.
- H. The survey monuments shall consist of permanently installed metal plates scribed with an identification number, elevation and coordinate location. The method of installing survey monuments shall be as approved by the Engineer. The survey monuments shall consist of

permanently scribed elevation and coordinate location securely fastened to the structure. The Engineer shall be notified a minimum of one day prior to setting a survey monument and be given free access to confirm any survey information immediately after the Contractor has set the elevation and location.

- I. Perform surveys of each monument at least once during every five vertical feet of excavation or prior to and after each blasting event. Surveys shall be performed more often during excavation if deemed necessary by the Engineer for any reason. Upon completion of the excavation, surveys shall be performed at least once a week, or more often if deemed necessary by the Engineer, until the Engineer determines that there is no risk of significant additional ground movement. If pumping or dewatering of excavations is interrupted or cannot be adequately maintained, the survey monuments shall be checked a minimum of once every 6 hours for as long as the conditions exist or as necessary for the protection of the site and worker's safety.
- J. Immediately notify the Engineer of any cumulative change in elevation or location of any monument in excess of 1/4 inch.
- K. Maintain the survey data taken on a daily basis for each monument or target in a log. A copy of the log shall be sent to the Engineer on a daily basis.
- L. Perform, at a minimum, daily visual inspections of the perimeter of the excavation to identify any signs of excessive settlement or movement. The results from visual inspections shall be recorded with the daily survey log. Any area which appears to be excessively deformed or damaged shall immediately be brought to the attention of the Engineer and be corrected.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

SECTION 32 12 16
A.C. PAVEMENT AND BASE

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform all work associated with asphalt concrete (A.C.) Pavement and Base, as shown and specified herein including all labor, materials, equipment supplies and facilities associated with providing of finished product satisfying all the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (45-mm) Drop ⁷
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Saturated Surface-Dry Specimens.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

1.3 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 20 – Submittal Procedures. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the Engineer.
- B. Prior to Delivery to Site:
 - 1. Mix Design: Submit current mix design dated within one year of submittal listing:
 - a. Date of mix design
 - b. Asphalt cement source, type and chemical composition.
 - c. Aggregate gradation target.
 - d. Asphalt cement target percentage, dust to asphalt ratio, moisture sensitivity (tensile strength ratio), stability, flow and voids in the bituminous mix.
 - 2. Before changing mix design, submit new design to Engineer 10-days prior to placing pavement for review and evaluation of changes.
 - 3. Type and number of compaction and finish rollers.
- C. At Delivery: Supply a batch ticket identifying:
 - 1. Serial Number of ticket.
 - 2. Date and truck number.
 - 3. Job name, location and mix identification.
 - 4. Type, grade and weight of asphalt.
 - 5. Type, grade and weight of aggregate.
 - 6. Mix design method.
- D. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than two laboratory trial batch tests will be paid by the Owner but the Contractor shall furnish the materials at no cost to the Owner. Any additional trial batch testing required shall be performed at the expense of the Contractor.

1.4 QUALITY ASSURANCE

- A. Use a laboratory that follows and complies with ASTM D 3666.
- B. Do not change aggregate source, asphalt source or mix design without Engineer's prior written approval.
- C. Reject product and work that does not meet the requirements of this Section.
- D. Remove product that is found to be defective after installation and install acceptable product at no additional cost to the Owner.
- E. Foreman of paving crew shall have completed at least five projects of similar size and nature.

1.5 WEATHER

- A. Do not pave until air temperature is 50 degrees F and rising.
- B. Cease paving if air temperature falls below 50 degrees F.
- C. Do not pave if surface is wet or if rain, snow or other precipitation is expected.
- D. Do not pave if wind or ground cools the mix material before compaction.

1.6 ACCEPTANCE

- A. General: Acceptance is by lot.

- B. Materials:

- 1. Lot is one day's production.
- 2. At the source:
 - a. Aggregate: Verify gradation. Collect sample from the conveyor belt or stockpile if belt is not accessible.
 - b. Paving Asphalt: Asphalt shall meet the requirements of this section and shall satisfy the limits identified in the Utah Department of Transportation's "Manual of Instructions – Part 8 Materials"
 - c. Mix Temperature shall not exceed 325 degrees F in the transport vehicle.
- 3. At the Site:
 - a. A sub-lot is 500 tons.
 - b. Obtain one random sample per sub-lot behind the paver before compaction or at locations exhibiting non-uniform appearance.
- 4. At the Laboratory:
 - a. Air voids shall be evaluated on the basis of laboratory compacted samples.
 - b. Dust to asphalt ratio.
 - c. Asphalt content and aggregate gradation.
- 5. If material does not meet any requirement of the specification, the Engineer may direct that the sub-lot be removed and replace with a material meeting the specification requirements at no additional cost to the Owner.

- C. Installation:

- 1. Observation of Contractor's field quality control testing does not constitute acceptance.
- 2. Opening a paved surface to traffic does not constitute acceptance:
- 3. Reject any mixes exceeding 325 degree F in transport vehicle.
 - a. Dispose of cold mix in paver hopper as thin spread underlay.
- 4. Grade, Cross Slope: Verify that tolerance is not exceeded.
- 5. Compaction:
 - a. For compaction a lot is 1,000 square yards or any part thereof.
 - b. Core Density: A lot is acceptable if the average core density does relative to ASTM D 2041 is 93 percent, with no individual test less than 89 percent.
 - c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.
 - d. Cores shall be tested per ASTM D 2725 for core density and ASTM D 2041 (Rice) for maximum theoretical density.

- e. Other non-destructive testing methods may be used during placement to aid in establishing a rolling pattern and determining the required compaction effort. However, density acceptance will be by core densities.
- 6. Thickness:
 - a. For thickness a lot is 1,000 square yards or any part thereof.
 - b. Core Thickness: A lot is acceptable if the average core thickness is not less than 0.25 inches less than the specified thickness.
 - c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.
 - d. Cores shall be tested per ASTM D 3549 for thickness.
- 7. Lots that are not acceptable may be rejected and the Engineer may direct that the lot be removed and replaced at no additional cost to the Owner.

PART 2 - PART 2 - PRODUCTS

2.1 UNTREATED BASE COURSE

- A. The untreated base course shall consist of select material, either natural or crushed and shall be graded as follows:

Sieve Size	Gradation Ideal Gradation
3/4 inch	100
3/8-inch	75-95
No. 4 sieve	55-70
No. 16 sieve	30-40
No. 200 sieve	2-10

2.2 TACK COAT

- A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.3 ASPHALT CEMENT (AC)

- A. Petroleum Asphalt that complies with table 2 of ASTM D 3381 except as follows:
 - 1. Replace ductility at 77 deg F. with ductility at 39.2 deg. F. Use the following values:
 - a. AC - 10: greater than 15
 - b. AC - 20: greater than 5
 - 2. Delete the loss on heating requirement on the residue from the "Thin-Film Oven Test".
- B. Substitute Performance Graded Asphalt Binder (PGAB)
 - 1. PGAB asphalt meeting the requirements of ASTM D 6373 may be substituted for AC asphalt cement as follows:
 - a. AC - 10 – PGAB 58-22 or PGAB 58-28
 - b. AC - 20 – PGAB 64-22

2.4 AGGREGATE

- A. Aggregate shall be clean, hard, durable, angular and sound consisting of crushed stone, crushed slag, crushed gravel, sand, or a combination of two or more of these materials.
- B. Source Suitability: Use the following requirements to determine the suitability of the aggregate source and not for project control.
 - 1. Coarse Aggregates:
 - a. Angularity (fractured faces), ASTM D 5281: 50 percent maximum by weight of particles with at least 2 fractured faces.
 - b. Hardness (toughness), ASTM C 131: 40 percent minimum wear of aggregate retained above the No. 4 sieve unless specific aggregates having higher values are known to be satisfactory.
 - c. Flat or elongated particles, ASTM D 4791: 20 percent maximum retained above the 3/8 inch sieve has a 3:1 length to width ratio.
 - 2. Fine Aggregates:
 - a. Friable Particles, ASTM C 142: 2 percent maximum passing the No. 4 sieve.
 - b. Plasticity, ASTM D 4318: Aggregate passing the no. 40 sieve shall be non-plastic even when filler material is added to the aggregate.
 - 1) Liquid Limit: Less than 25
 - 2) Plastic Limit: Less than 6
- C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.5 ADMIXTURES

- A. Mineral filler shall comply with ASTM D 242.
- B. Antistrip shall be heat stable cement slurry or lime slurry.

2.6 MIX DESIGN

- A. Material Designation:
 - 1. Asphalt Cement shall be AC-20.
 - 2. Aggregate gradation shall be DM-3/4.
 - 3. Traffic Classification shall be medium.

- B. Design Aggregate Gradation: The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following gradation limits as percent passing by weight, ASTM C 136:

Aggregate Gradations				
Sieve Size	DM-1	DM-3/4N	DM-3/4	DM-1/2
1 inch	100			
3/4 inch		100	100	
1/2 inch	75-91	74-99		100
3/8 inch		69-91	75-91	
No. 4	47-61	49-65	46-62	60-80
No. 8		33-47		
No. 16	23-33	21-35	22-34	28-42
No. 50	12-22	6-18	11-23	11-23
No. 200	3-7	2-6	3-7	3-7

1. Dry-rodded Unit weight per ASTM C 29 shall be a minimum of 75 pounds per cubic foot.
2. Weight Loss or soundness per ASTM C 88 shall be a maximum of 16 percent using sodium sulfate.
3. Clay Content or cleanliness per ASTM D 2419 shall be determined by the sand equivalent value after passing through the dryer or prior to the drum mixer at the following levels:
 - a. 45 percent minimum for Medium Traffic Classification
 - b. 60 percent minimum for Heavy Traffic Classification.

- C. Design Mixture Test Criteria: Use the Marshall volumetric mix design, AI MS-2: price and payment procedures

Mix Design Criteria			
Criteria	Traffic Classification		
	Light	Medium	Heavy
Number of Compaction Blows	35	50	75
Stability, lbs. (minimum), ASTM D 5581	750	1200	1800
Flow, in 0.01 inch units, ASTM D 5581	10-18		
Voids in Mineral Aggregate (VMA), percent min., ASTM D 3203			
Nominal Maximum Particle Size			
1"	13		
3/4"	14		
1/2"	15		
3/8"	16.5		
Voids in Bituminous Mix (percent)	3-5		
Dust to Asphalt Ratio	0.8 – 1.6		
Moisture Sensitivity, ASTM D 4867	>0.8 with freeze thaw conditioning and test specimen compacted at 6-8 percent air voids		

Notes and Traffic Classifications:

Light – Parking lots, driveways, light traffic residential streets, light traffic farm roads.
(ESAL <10⁴ per year)

Medium – Residential streets, rural farm and residential roads (Class II); Urban minor collector streets, rural minor collector roads (Class III). (10⁴<ESAL<10⁶ per year)

Heavy – Urban Minor arterial and light industrial streets, rural major collector and minor arterial highways (Class IV); Urban major arterial and heavy industrial streets, freeways, expressways, arterial highways, rural interstate, and other principal arterial highways (Class V). (ESAL > 10⁶ per year)

2.7 SOURCE QUALITY CONTROL

- A. General: Supplier shall randomly collect samples per ASTM D 3665. The same sample point shall be used for all samples of a particular material.
 - 1. Aggregate sampling shall be per ASTM D 75.
 - 2. Asphalt Cement sampling shall be per ASTM D 140.
- B. Asphalt-aggregate mix shall be sampled per ASTM D 979 and test for:
 - 1. Air Voids per ASTM D 3203.
 - 2. Paving Asphalt Content per ASTM D 6307.
 - 3. Aggregate Gradation per ASTM D 5444
 - 4. Tensile strength of bitumen-aggregate mixtures per ASTM D 4867.
- C. Mixing plant shall meet the requirements of ASTM D 3515.

2.8 PAVEMENT MARKING PAINT

- A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability. The paint striping materials shall conform with the State of Utah Standard Specifications for Road and Bridge Construction and its addenda.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

- A. The subgrade shall be prepared in accordance with Section 31 23 00 – Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the specified grade and cross section.

3.2 UNTREATED BASE COURSE

- A. Untreated base course shall be provided where shown and to the thickness indicated. Imported untreated base course shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness

is more than 6 inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 96 percent of maximum density when measured in accordance with ASTM D 1557 with no test below 92 percent of maximum density. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the specified grade or cross-section.

3.3 TACK COAT

- A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.4 CONSTRUCTION EQUIPMENT

- A. Lay Down Machine shall have tracks when operating on fabrics, geogrids or pavement mats hotter than 180 degrees F.
- B. Compactors shall be static or vibratory, steel wheel rollers. Pneumatic tire rollers may be used for intermediate rolling only.

3.5 ASPHALT CONCRETE

- A. At the time of delivery to the work site, the temperature of mixture shall not be higher than 320 degrees F, and shall not be less than indicated below:

Minimum Asphalt Concrete Temperature, degrees F						
Air Temperature	Compacted Mat Thickness					
	3/4 inch	1 inch	1-1/2 inch	2 inch	3 inch	4 inch +
45-50	-	-	-	-	280	265
50-59	-	-	-	280	270	255
60-69	-	-	285	275	265	250
70-79	285	285	280	270	265	250
80-89	280	275	270	265	260	250
90+	275	270	265	260	250	250

- B. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.
- C. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed especially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location

that use of a self-propelled machine is impractical, the Engineer may waive the self-propelled requirement.

- D. Spreading, once commenced, shall be continued without interruption.
- E. The mix shall be compacted immediately after placing. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.
- F. Compaction shall be completed before temperature drop to 180 degrees F.
- G. Do not leave unsafe butt joints if paving operations stop.
- H. Barricade or eliminate fall off edges.
- I. Joints
 1. Construct joints to have the same texture, density and smoothness as other section of the new pavement course.
 2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new pavement or between successive day's work.
 3. Offset longitudinally joints a minimum of 12 inches in succeeding courses and offset transverse joints a minimum of 6 feet to avoid a vertical joint through more than one course. In the tops course restrict longitudinal joints to either side of the lane lines.
 4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges prior to making another pass with the paver if the mix has cooled to 90 degrees F.

3.6 TOLERANCES

- A. Lift thickness shall not be less than 2 times the maximum aggregate size nor more than 3 inches (compacted thickness) or the limits established by the pneumatic or vibratory compactor equipment manufacturer, whichever is less.
- B. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

3.7 BITUMINOUS SURFACE PATCHING

- A. Where pits are excavated through bituminous surfaced roads, driveways, parking areas, etc., the surface shall be restored and maintained as follows:
 1. A temporary gravel surface shall be placed and maintained after the required backfill and compaction of the trench has been accomplished.
 2. The gravel shall be placed to such depth as to provide six inches below the pavement and shall be brought flush with the paved surface.
 3. The area over trenches to be resurfaced shall be graded and rolled with a roller weighing not less than twelve tons, or with the rear wheels of a five-yard truck loaded

to capacity, until the subgrade is firm and unyielding. Mud or other soft or spongy material shall be removed and the void filled with gravel and rolled and tamped thoroughly in layers not exceeding six inches in thickness. The edges of trenches which are broken down during the making of subgrade shall be removed and trimmed neatly before resurfacing.

4. Before any permanent resurfacing is placed, the Contractor shall trim the existing paving to clean, straight lines as nearly parallel to the centerline of the trench as practicable.
5. Existing bituminous paving shall be cut back a minimum of six inches beyond the limits of any excavation of cave-in along the trench so that the edges of the new paving will rest on at least six inches of undisturbed soil.
6. As soon as is practical, weather permitting, the bituminous surface shall be restored by standard paving practices to the thickness specified herein.
7. Pavement restoration shall include tacking of pavement of edges and subbase with MC 70-250 bituminous material and placing rolling plant hot mix bituminous material to the level of the adjacent pavement surfaces.

3.8 PROTECTION AND REPAIR

- A. General: All work is at no additional expense to the Owner.
- B. Protection:
 1. Protect all structures, including curb, gutter, sidewalks, street fixtures, delineators, signs, guard rails and guide posts.
 2. Remove all spatter, over-coat or mar.
 3. Do not discharge bituminous materials into borrow pits, roadside ditches, gutters or other areas.
 4. Protect hot pavement from traffic until mixture has cooled enough not to become marked.
 5. Protect neighborhood, storm drains and downstream wetland and fish habitats.
- C. Repair
 1. When thickness is deficient, place additional material over deficient areas. Do not skin patch. If necessary, mill for inlay.
 2. Repair defective seams, edges and joints.
 3. Remove and replace unacceptable paving.

3.9 PAVEMENT MARKING

- A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. Pavement marking shall commence no sooner than 21 days after completion of pavement installation. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions shown. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the Engineer.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide chain link fencing, three strand barb wire, manual swing gates, and vertical pivot automated gates and appurtenant Work, complete and operable, in accordance with the Contract Documents.
- B. Single Manufacturer: Chain link fencing, swing gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-in-Place Concrete apply to this section.

1.3 REFERENCE STANDARDS

ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	Zinc-Coated Steel Chain Link Fence Fabric, Class I
ASTM F 668	Poly (Vinyl Chloride)(PVC) - Coated Steel Chain Link Fence Fabric, Class 2b

1.4 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.
- B. The Contractor, at a minimum, shall submit the following information for Engineer approval prior to installing any chain link fencing:
 - 1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.
 - 2. Scale layout of fencing, pedestrian gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, and other accessories which may be necessary.
- C. Samples: Samples of proposed fence components, at least 12 inches long, to illustrate the selected color and finish.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.
- B. Fence fabric height shall be 6 feet unless otherwise indicated.
- C. All fencing materials shall be hot-dip galvanized after fabrication, and coated with either PVC coating, or powder coating as specified below. The coatings shall be black.
 - 1. All PVC coatings shall be made from virgin PVC resin with plasticizer, stabilizers, and ultraviolet inhibitor. Coatings shall have a tensile strength of 2500 psi; maximum elongation of 200 percent, coating thickness shall be at least 7 mils thick and a shore durometer hardness of 40 to 46 unless specified otherwise.
 - 2. Powder coatings shall be made of 'degassing' grade polyester powder only. Pretreatment shall be used to ensure surface is perfectly clean and pre-heat work prior to powder application. Check for correct curing by solvent testing. Adjust pre-heat and line speed to ensure full cure. Coating thickness shall be at least 3 mils thick.

2.2 STEEL FABRIC

- A. Fence fabric shall be No. 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.
- B. Fabric Finish: Fabric shall be galvanized according to ASTM A 392 - Zinc-Coated Steel Chain Link Fence Fabric, zinc per square foot of coated surface, followed by a thermally fusion bonded poly vinyl chloride coating at least 7 mils thick.
 - 1. PVC coating shall comply with ASTM F 668 - Poly Vinyl Chloride (PVC) - Coated Steel Chain Link Fence Fabric, Class 2b, except that the wire core shall measure 9 gauge prior to application of coating.

2.3 FRAMING AND ACCESSORIES

- A. Steel Framework, General: Unless otherwise indicated, framework components shall be fabricated of galvanized steel conforming to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, with not less than 1.8 ounces zinc per square feet of coated surface.
 - 1. Fittings and accessories shall be galvanized in accordance with ASTM A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware, with zinc weights per Table I of that standard, except that no coating shall be less than 1.8 ounce zinc per square foot of coated surface.
 - a. After galvanizing, posts, braces, top rails, framework, fittings, and accessories shall be finished with: manufacturer's standard thermally fusion bonded PVC finish, not less than 10 mils thick. PVC coating shall comply with ASTM F 668 - Poly (Vinyl Chloride)(PVC) - Coated Steel Chain Link Fence Fabric, Class 2b.
 - 2. Concrete shall completely encase the bottom of the post.
 - a. At the Contractor's option, gate frameworks, fittings and accessories may have a powder coat finish. Powder coatings shall be made of 'degassing' grade polyester powder only. Pretreatment shall be used to ensure surface is

perfectly clean and pre-heat work prior to powder application. Check for correct curing by solvent testing. Adjust pre-heat and line speed to ensure full cure. Coating thickness shall be at least 3 mils thick.

- B. End, Corner and Pull Posts: Posts shall be one-piece without circumferential welds, 3 inch schedule 40 pipe, 5.79 pounds per linear foot.
- C. Line Posts: Line posts shall be spaced no more than 10 feet on center and shall be 2-1/4 inch "H" column section, 4.1 pounds per linear foot, or schedule 40, 2-1/2 inch pipe, 3.65 pounds per linear foot.
- D. Gate Posts: Gate posts shall be 4 inch schedule 40 pipe, 9.1 pounds per linear foot for leaf widths up to 13 feet. For leaf widths between 13 and 18 feet, gate posts shall be 6-5/8 inch schedule 40 pipe, 28.55 pounds per linear foot.
- E. Top Rail: Top railing shall be provided in manufacturer's longest lengths, with expansion type couplings, approximately 6 inches long, for each joint. Fence design shall provide positive, secure attachment of top rail to each gate post, corner post, pull post and end post. Top rail and braces shall be 1-5/8 inch schedule 40 pipe, 2.27 pounds per linear foot, or 1-1/2 inch "H" column section, 2.00 pounds per linear foot.
- F. Tension Wire: Tension wire shall be located at the bottom of the fabric and shall consist of No. 7 gauge coated coil spring wire of metal and finish to match fabric. Tension wire shall be interlaced with the fabric or attached to the fabric along the extreme bottom of the fence. Tension wire attachment shall be with fabric tie wires at a spacing of no more than 24 inches apart.
- G. Fabric Tie Wires: Fabric tie wires shall be No. 9 gauge galvanized steel wire of the same finish as the fabric. Aluminum ties shall not be used. Ties shall be spaced 14 inches apart on posts and 24 inches apart on rails.
- H. Post Brace Assembly: Post brace assembly shall be manufacturer's standard adjustable brace assembly provided at each end post, gate post and at both sides of each corner post and intermediate brace post. Material used for brace shall be same as top rail. Truss bracing between line posts shall be achieved with 0.375-inch diameter rod and adjustable tensioner.
- I. Post Tops: Post tops shall be weather-tight closure caps, designed for containment of top rail and positive permanent attachment to post. One cap shall be provided for each post.
- J. Stretcher Bars: Stretcher bars shall be one-piece lengths equal to the full height of the fabric, with minimum cross-section of 3/16 inch by 3-1/2 inch. One stretcher bar shall be provided for each gate and end post, and two for each corner and intermediate brace post.
- K. Stretcher Bar Bands: Stretcher bar bands shall be one-piece fabrications designed to secure stretcher bars to end, corner, intermediate brace, and gate posts. Bands shall have a minimum cross-section of 1/8 inch by 3/4 inch. Stretcher bar bands shall be spaced no more than 15 inches on center.
- L. Barbed Wire Supporting Arms: Supporting arms shall be manufacturer's standard fabrication, of metal and finish to match fence framework, with provision for anchorage to

each post and attachment of three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap. Supporting arm shall be single 45-degree arm type and shall be capable of withstanding 250 pounds of downward pull at outermost end.

- M. Barbed Wire: Barbed wire shall be two-strand, No. 12-1/2 gauge zinc-coated steel or iron wire with four-point, 14 gauge barbs spaced no more than 5 inches apart.

2.4 GATES

- A. Fabrication: Perimeter frames of gates shall be fabricated from same metal and shall be finished as specified in paragraph 2.1 - GENERAL. Gate frames shall be assembled by welding. Welds shall be ground smooth. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of fabric.
 - 1. Fabric shall be installed with stretcher bars at all perimeter edges. Stretcher bars shall be attached to gate frame with stretcher bar bands spaced no more than 15 inches on center.
 - 2. Each gate shall be diagonally cross-braced with a 3/8-inch diameter adjustable length truss rod to ensure frame rigidity without sag or twist.
- B. Swing Gates: Perimeter frames of swing gates shall be constructed of the same pipe or "H" column members as the top rails and shall be fabricated by welding. Welds shall be ground smooth prior to hot-dip galvanizing.
 - 1. Hardware and accessories shall be provided for each gate, galvanized in conformance with ASTM A 153, and in accordance with the following:
 - a. Hinges: Hinges shall be of size and material to suit gate size, non-lift-off type, offset to permit 180-degree gate opening. Three hinges shall be provided for each leaf 6 feet or more in height.
 - b. Latch: Latch shall be forked type or plunger-bar type, permitting operation from either side of the gate, with padlock eye as an integral part of the latch.
 - c. Keeper: Keeper shall be provided which automatically engages the gate leaf and holds it in the open position until it is manually released.
- C. Automated Vertical Pivot Lift Gates: Vertical pivot lift gates shall be manufactured by AG Autogate Gate Entry Systems, Series #300 Chainlink gates, to match existing automated vertical pivot lift gate at south end of the existing plant. Specifications for automated gate are attached at the end of this section.
 - 1. Provide one double gate (vertical pivot lift gate with operator on each side) at the north end of the project, as shown in the Civil Drawings.
 - 2. Road Width: 24 feet
 - 3. Rough Opening (Post to Post): 28 feet
 - 4. Fence Height: 6 feet
 - 5. Color: Black
 - 6. Controls: Keypad and Intercom outside gate, loop sensor inside gate.
 - 7. Concrete Footings: As shown in attached details.

2.5 RELATED ITEMS

- A. Concrete: Concrete shall be provided according to Section 03 30 00 – Cast-In-Place Concrete.

- B. Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication. Upon completion of installation, bolts, nuts and exposed threads shall be painted to match with an exterior paint in accordance with Section – 09 90 00 Painting and Coating. .

2.6 MANUFACTURERS

- A. Manufacturer's Qualifications: Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.
- B. Installer's Qualifications: Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.
- C. Manufacturers, or equal
 1. American Fence Company Inc.
 2. Mountain States Fence.
 3. United Fence Company

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to commencing installation, require Installer to inspect all areas and conditions within which Work of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

3.2 INSTALLATION

- A. General: Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected. The soils report is appended to the Contract Documents and contains information regarding soil properties in the vicinity of the site.
- B. Excavation: Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations which are not designed by an engineer shall comply with the following:
 1. Holes shall be excavated to a diameter not less than 12 inches or not less than five times the largest dimension of the item being anchored, whichever is larger.
 2. Depth for holes shall be not less than 42 inches; excavated approximately 6 inches lower than the post bottom, with bottom of posts set not less than 36 inches below finish grade surface, or as indicated in the Drawings.
 3. Concrete shall completely encase the bottom of the post.
- C. Setting Posts: Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb and shall

be centered in holes, 4 inches above the bottom of the excavation, with posts extending not less than 36 inches below finish grade surface.

1. Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, measured horizontally.
2. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.

D. Concrete

1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.
2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.
3. Concrete footings shall have a neat appearance and shall be extended 2 inches above grade and troweled to a crown to shed water.
4. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.

E. Bracing: Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.

1. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

F. Intermediate Brace Posts: Where straight runs of fencing exceed 500 feet, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500 feet. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

G. Top Rails: Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

H. Tension Wire: Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts. Tension wire shall be installed on a straight grade between posts, with approximately 2 inches of space between finish grade and bottom selvage, unless otherwise indicated. Tension wire shall be tied to each post with not less than 6-gauge galvanized wire.

I. Fabric:

1. Chain-link fabric shall be fastened on the secured side of the posts.
2. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively.

3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.
- J. Tie Wires: Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasp pipe and fabric firmly with ends twisted at least two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.
 1. Fabric shall be tied to line posts with tie wires spaced at 12 inches on center.
 2. Fabric shall be tied to rails and braces with tie wires spaced at 24 inches on center.
 3. Fabric shall be tied to tension wires, with hog rings spaced 24 inches on center.
- K. Stretcher Bars: Fabric shall be fastened to end, corner, intermediate brace, and gate posts with stretcher bars. Bars shall be threaded through or clamped to fabric at 4-inches on center and secured to posts with stretcher bar bands spaced no more than 14 inches on center.
- L. Fasteners: Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.
- M. Galvanized coating damaged during construction of the fencing shall be repaired by application of Galvo-Weld; Galvinox; or equal.
- N. Damage to PVC coating shall be repaired with material equivalent in color and thickness to the original coating.

3.3 GROUNDING

- A. Fences crossed by power lines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 50 feet on each side of the crossing.
- B. All fences, gates, and appurtenances enclosing electrical equipment areas, gas yards, or other hazardous areas shall be electrically continuous and grounded.
- C. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be $\frac{3}{4}$ -inch by 10-foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade.
 1. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. Top of electrode shall be not less than 2 feet or more than 8 feet from the fence

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

- A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout

entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

- B. Lubricate hardware, and other moving parts.

END OF SECTION

VERTICAL PIVOT LIFT GATE STYLES



#100 - Cornhusker



#200 - Barracuda



#300 - Chainlink



#400 - Catawba



#500 - Buckeye



#600 - Congress



#700 - Saratoga



#800 - Prestigious



#900 - Ohioan



#1000 - Islander



Custom Curb Notch



Anti-Terrorism

VERTICAL PIVOT LIFT GATE SPECIFICATIONS

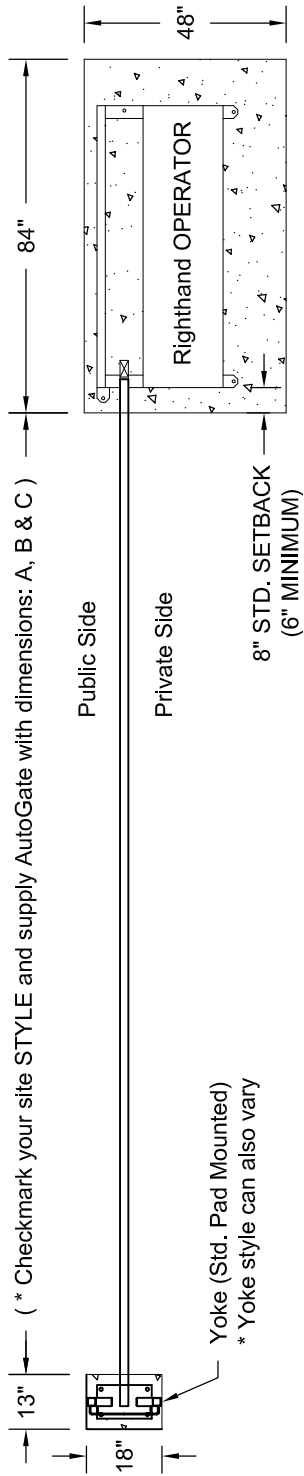
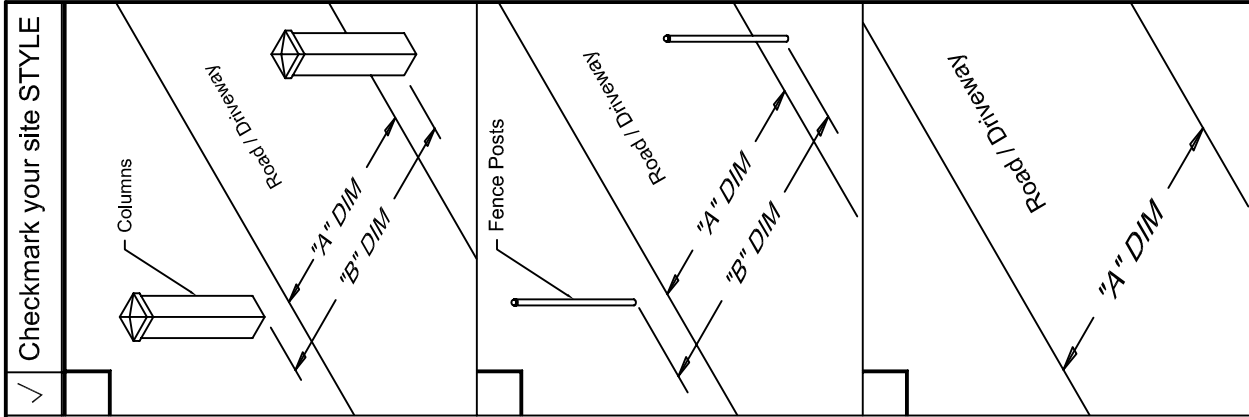


OPERATOR:	Meets UL 325 Specifications. (Certified early 2001)				CSA Certified: CAN/CSA-22.2 No.247			
OPERATOR	Frame:	2" Sq., 11 Ga. (.120) Steel Tubing						
CONSTRUCTION:	Skins:	18 Ga. Galvaneal Sheet			Mounting Pads: 304 SS			
OPERATOR SIZE:	Type:	VPL-24	Length:	68"	Height:	51"	Width:	30"
PAINT:	Sherwin Williams Polane®. Std Colors: Black, White, Brown, Green & Gray (Custom colors available)							
DUTY CYCLE:	Continuous.							
POWER SUPPLY:	120VAC (15 amp) supply, 24v DC powered. (2) 12v Batteries required, NOT included.							
POWER MAINTENANCE:	24v Built-In Battery Maintainer "Over-Charge" protection built-in.							
CONTROL CIRCUITRY:	Solid state coated Control Board in NEMA 4x weatherproof electrical enclosure. Sealed Proximity Switches ensure weather & moisture-proof integrity (Boards tested to –40° F).							
CONTROL WIRING:	16 & 18 Ga. single conductor. Copper w/electrolytic copper compression terminals tin-plated for maximum corrosion prevention.							
GEAR MOTOR:	Horse Power:	1/3	Gear Type:	Hardened Steel				
OPEN / CLOSING CYCLES:	Bearing Type:	Ball	Gear Lube:	Dextron II E ATF (Rated to -70° F)				
	10 – 12 seconds.							
DELAYED CLOSING:	Adjustable from 0 – 60 seconds.							
OBSTRUCTION SENSOR:	Adjustable IRD senses obstructions opening or closing.							
SEC. BREACH PROTECTION:	24v built-in System Brake when 120v or battery power is present.							
REVERSING EQUIPMENT:	Optional Reversing/Safety Loop, Leading Reversing Edge, Infrared Reversing Beams, Siren or Optical Operated Sensors.							
COMPATIBLE CONTROLS:	Keypad, Card Reader, Intercom, Telephone, Wireless & Siren or Optical Operated Sensors.							
GATE CONSTRUCTION:	2" Sq., 16 Ga. (.063) Steel Tubing 10'-16'			2" Sq., 11 Ga. (.120) Steel Tubing over 16' to 20'				
	2 1/2" Sq., 7Ga. (.187) Aluminum Tubing 21'-24'							
CHAIN LINK CONSTRUCTION:	2-3/8", Sch. 40 & Sch. 20 Steel Tubing			9 Ga. Galv. Fabric from 12' up to 22'				
	2-3/8", Sch. 40 & Sch. 20 Aluminum Tubing			9 Ga. Alum. Fabric over 22' up to 24'				
GATE LENGTHS:	10' – 24' (Consult factory for gates over 24').							
GATE HEIGHTS:	4' – 8' from pad grade. Consult factory for gates over 8' high. (Gates over 8' will require special crating & freight arrangements).							
GATE HARDWARE:	Mounting hardware is 304 Stainless Steel							
ALUMINUM PICKET CONSTRUCTION:	3/4" Sq. Aluminum Tubing							
STEEL PICKET CONSTRUCTION:	¾" Sq. 16 Ga. Galvanized Steel							
WINDBRACING:	75 mph design, ¼" aircraft coated cable 16'-20'. Rigid masted alum over 20'.							
DOUBLE GATES:	Control Panel can be set to accommodate 2 nd Operator or Sallie Port with another Operator (Optional Add).							
SHIPPING WEIGHT:	Typical VPL-24 Operator with 6' high x 16' long Buckeye style gate = 1,200 lbs. crated weight.							
WARRANTY:	Res. = Five (5) Years / Comm. = Three (3) years from date of shipment on manufactured components and workmanship. Purchased components and accessories are covered under their respective warranties (See full Warranty for details).							

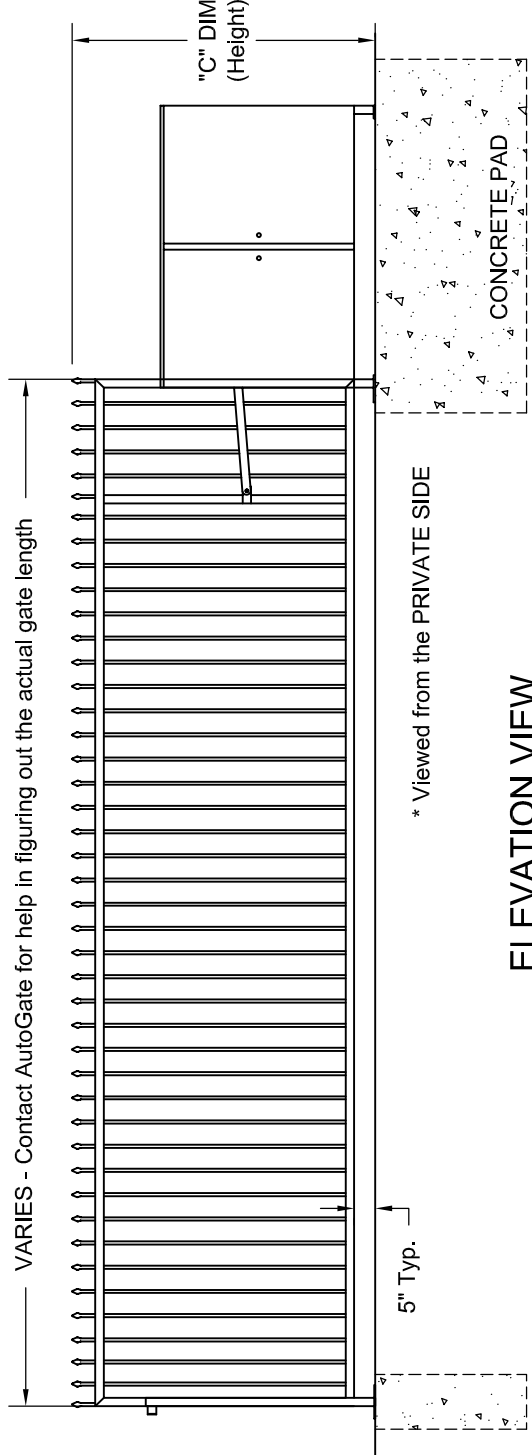
**7306 Driver Road
Berlin Heights, OH 44814
PH: 800.944.4283**

WWW.AUTOGATE.COM

SALES@AUTOGATE.COM



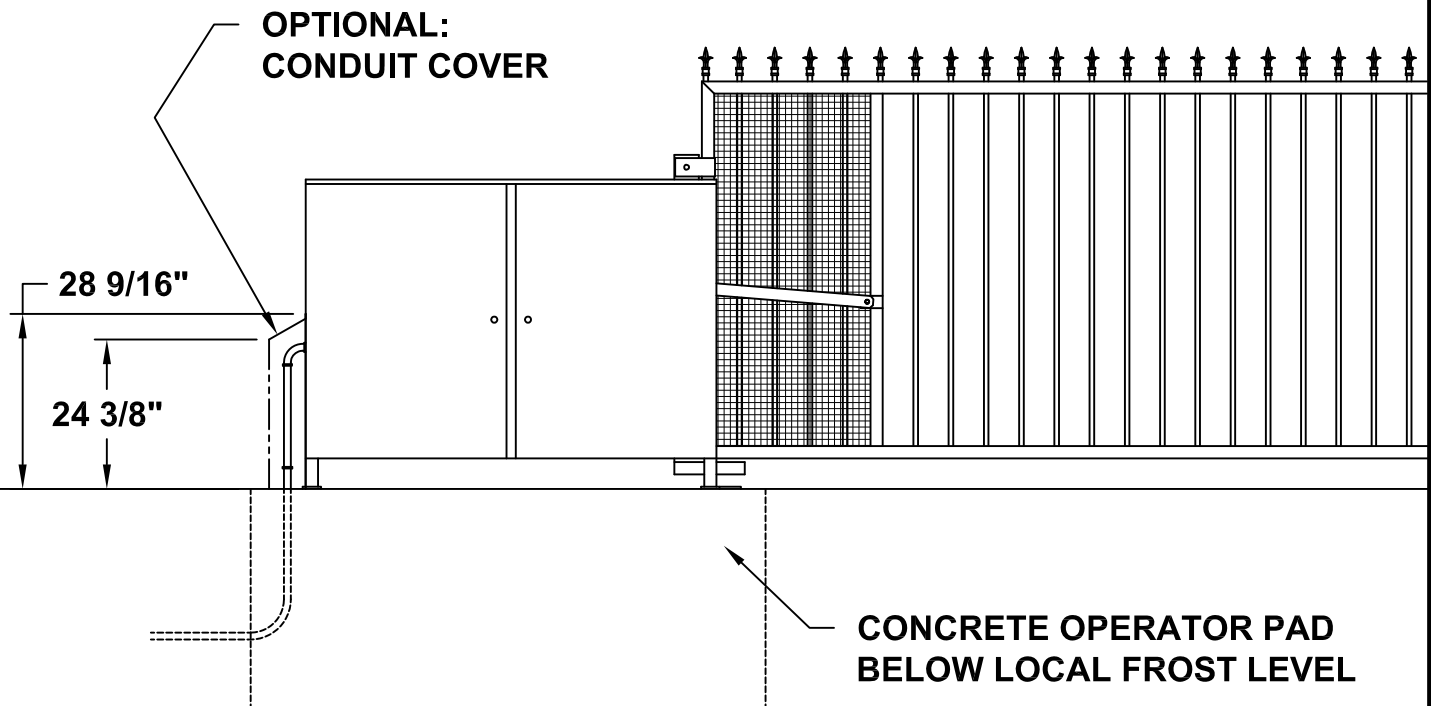
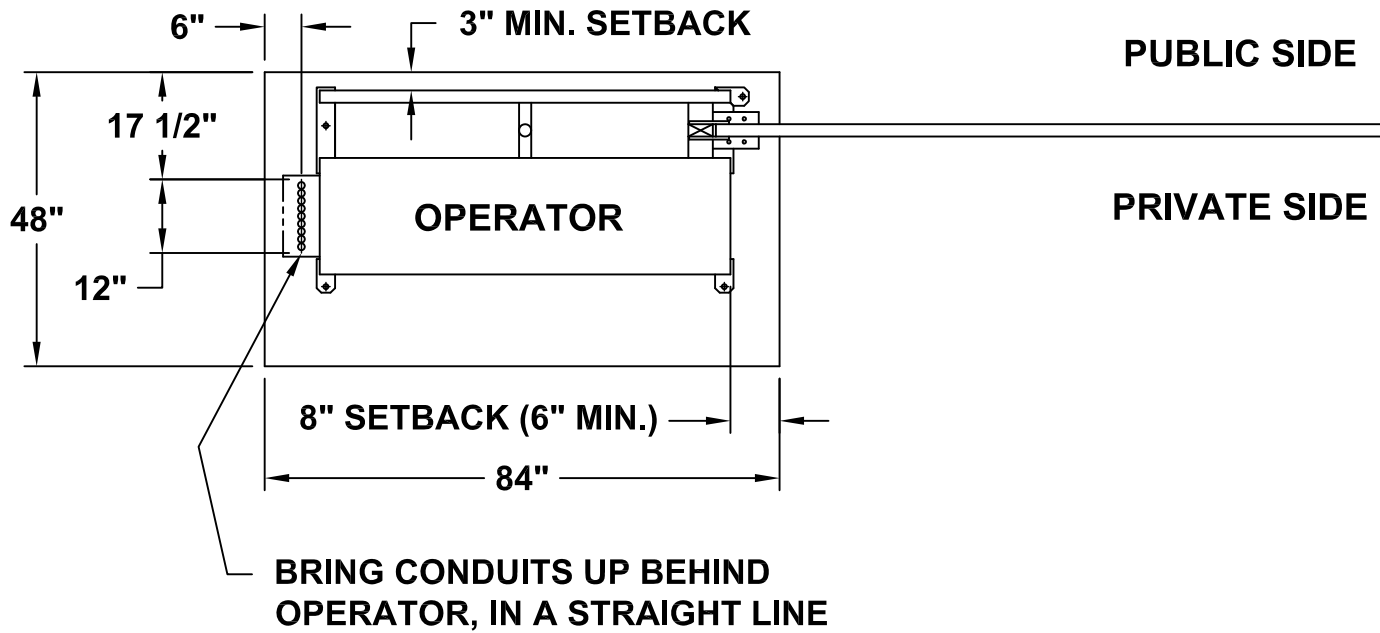
PLAN VIEW



ELEVATION VIEW

* Note: The customer is responsible for indicating (to AutoGate) any variance in the road or driveway grading. If the road has curbs, or any slope in the grade, print out and fill in dimensions on: Dwg. # 120, 121 or 122.

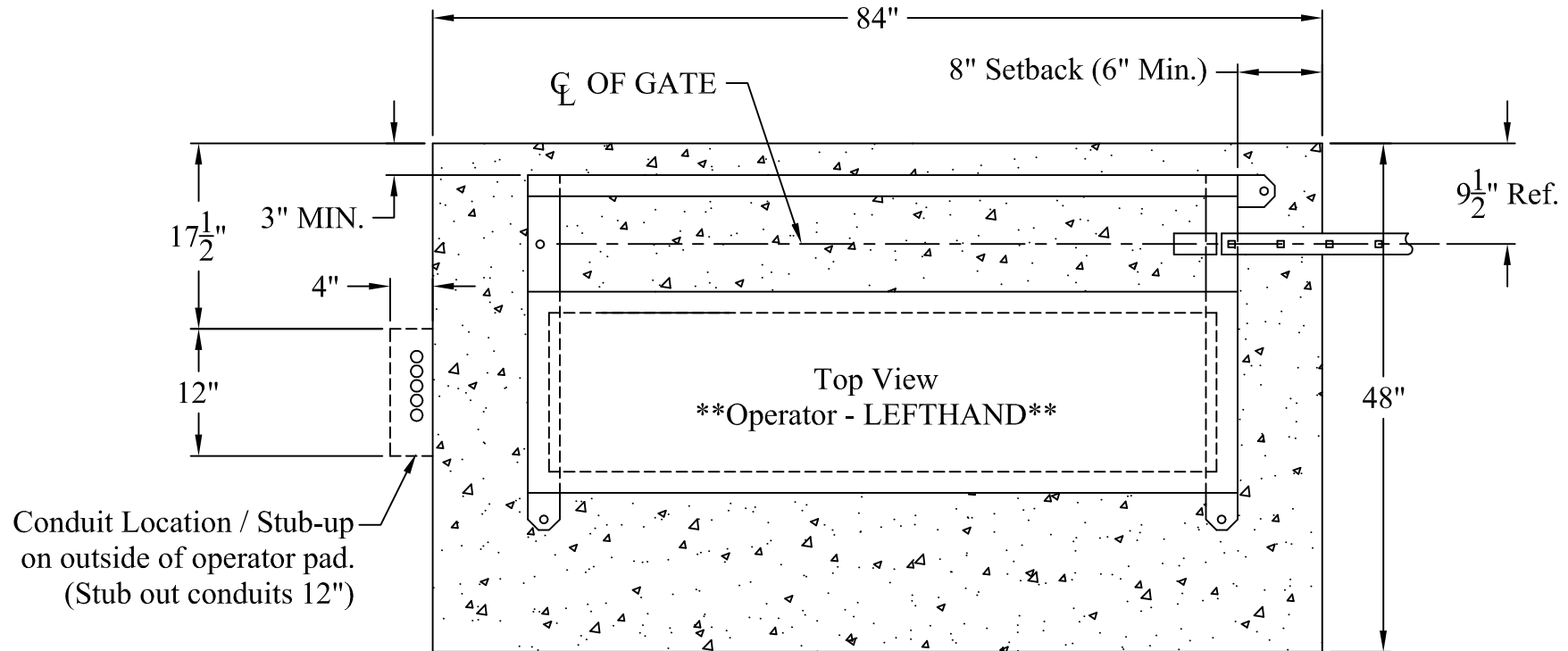
 AutoGate Gate Entry Systems Berlin Heights, Ohio FAX: (419) 588-3514	
Date: 06/02/06	Dm. By: MKS
Ckd. By:	
Dwg.: 123	
Title: Right-hand VPL Profile (No Curbs or Slopes)	



DO NOT SCALE			NOTICE THE INFORMATION CONTAINED ON THIS DOCUMENT IS CONFIDENTIAL. ANY DISSEMINATION, UNAPPROVED DISCLOSURE OR COPYING OF THIS INFORMATION IS STRICTLY PROHIBITED	Date: 04/26/10 Drn. By: MKS Ckd. By: .	 AutoGate Gate Entry Systems Berlin Heights, Ohio FAX (419) 588-3514
			UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES ANGLES ± 1° X/X ± 1/32, .XX ± .01, .XXX ± .005	Dwg.: Conduits In Pad Title: Conduits in Pad	
Rev. No.:	Revisions:	Date:			
.	.	.			

LEFTHAND OPERATOR

Public Side



* Note: Use 3/4" Conduit Only

Private/Secured Side

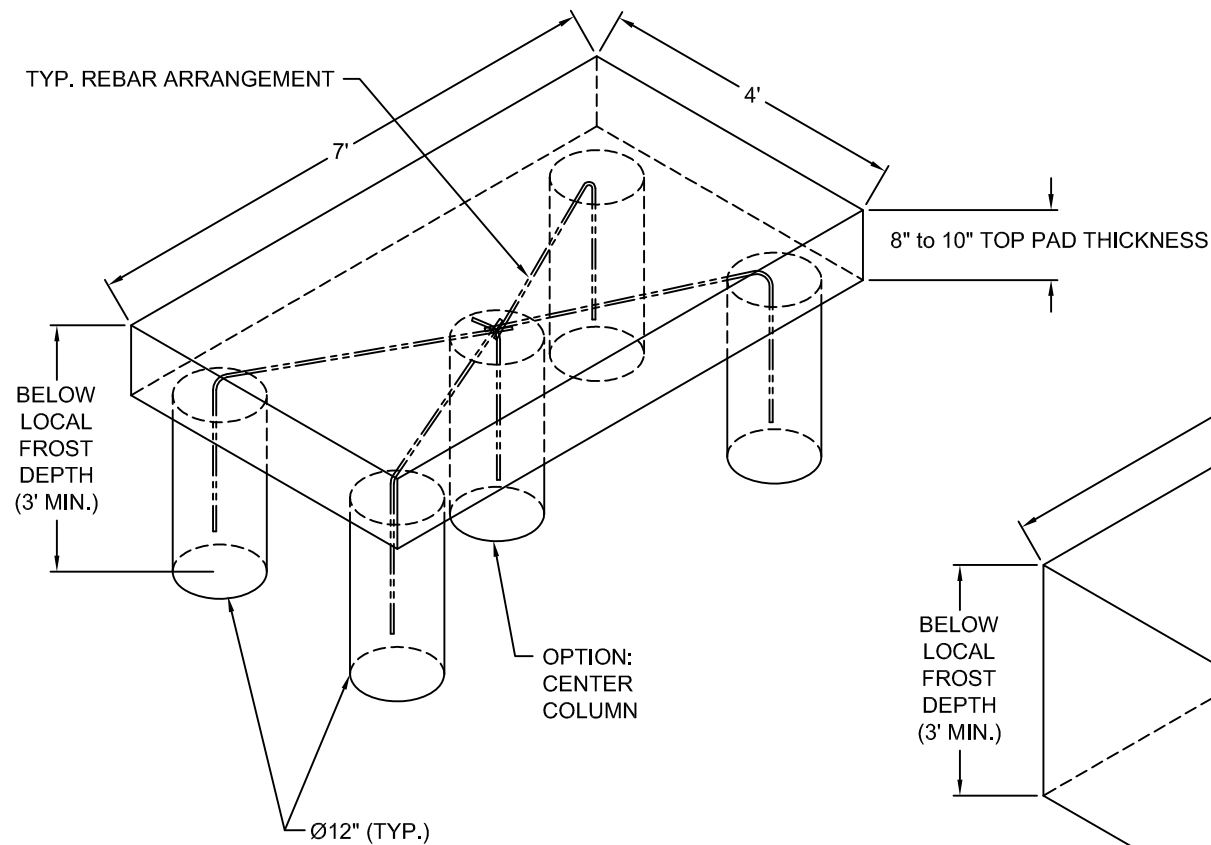
Possible Conduits:

- * 120 vac, min. 15 amp circuit
- * "Entrance" Keypad
- * "Exit" Keypad
- * Reversing/Safety Loops
- * Free Exit Loop
- * Office Communication
- * IFR Beam Power
- * Optional Spares

DO NOT SCALE			NOTICE THE INFORMATION CONTAINED ON THIS DOCUMENT IS CONFIDENTIAL. ANY DISSEMINATION, UNAPPROVED DISCLOSURE OR COPYING OF THIS INFORMATION IS STRICTLY PROHIBITED		Date: 12/07/05	 AutoGate Gate Entry Systems Berlin Heights, Ohio FAX (419) 588-3514
					Drn. By: MKS	
					Supercedes: 8/10/05	
Rev.:	Description:	Date:	Dwg.: 102C-L			Title: Lefthand Conduit Pad Location
A	Conduit locations were moved outside the pad	07/18/08 MS				
			UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES ANGLES ± 1° X/X ± 1/32, .XX ± .01, .XXX ± .005			

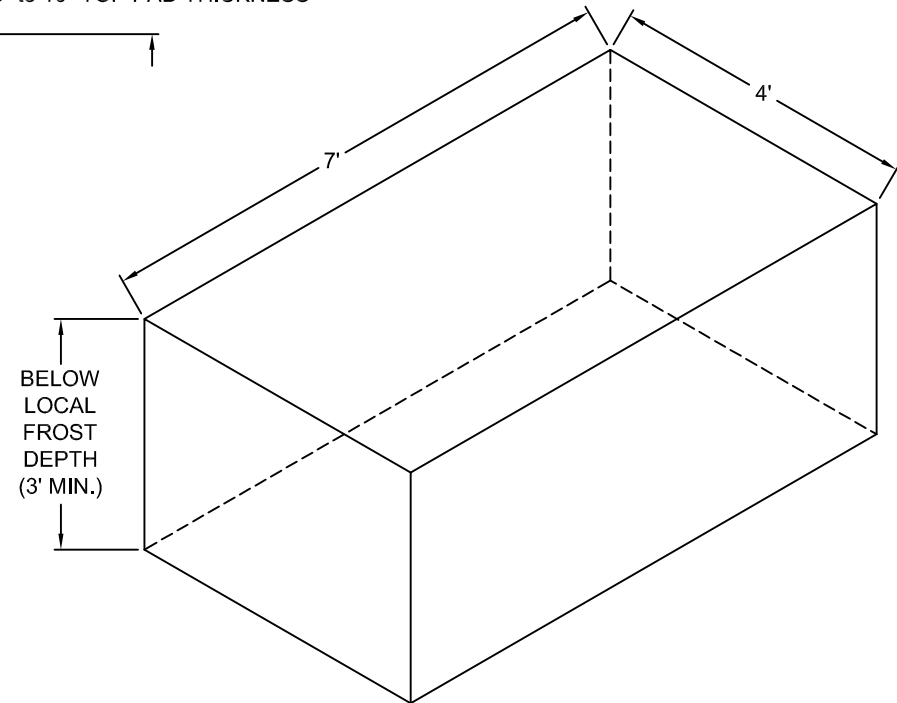
OPTION #1:

(4) or (5) MIN. 12" AUGURED HOLES, RE-BAR, AND AN 8" TO 10" TOP PAD



OPTION #2:

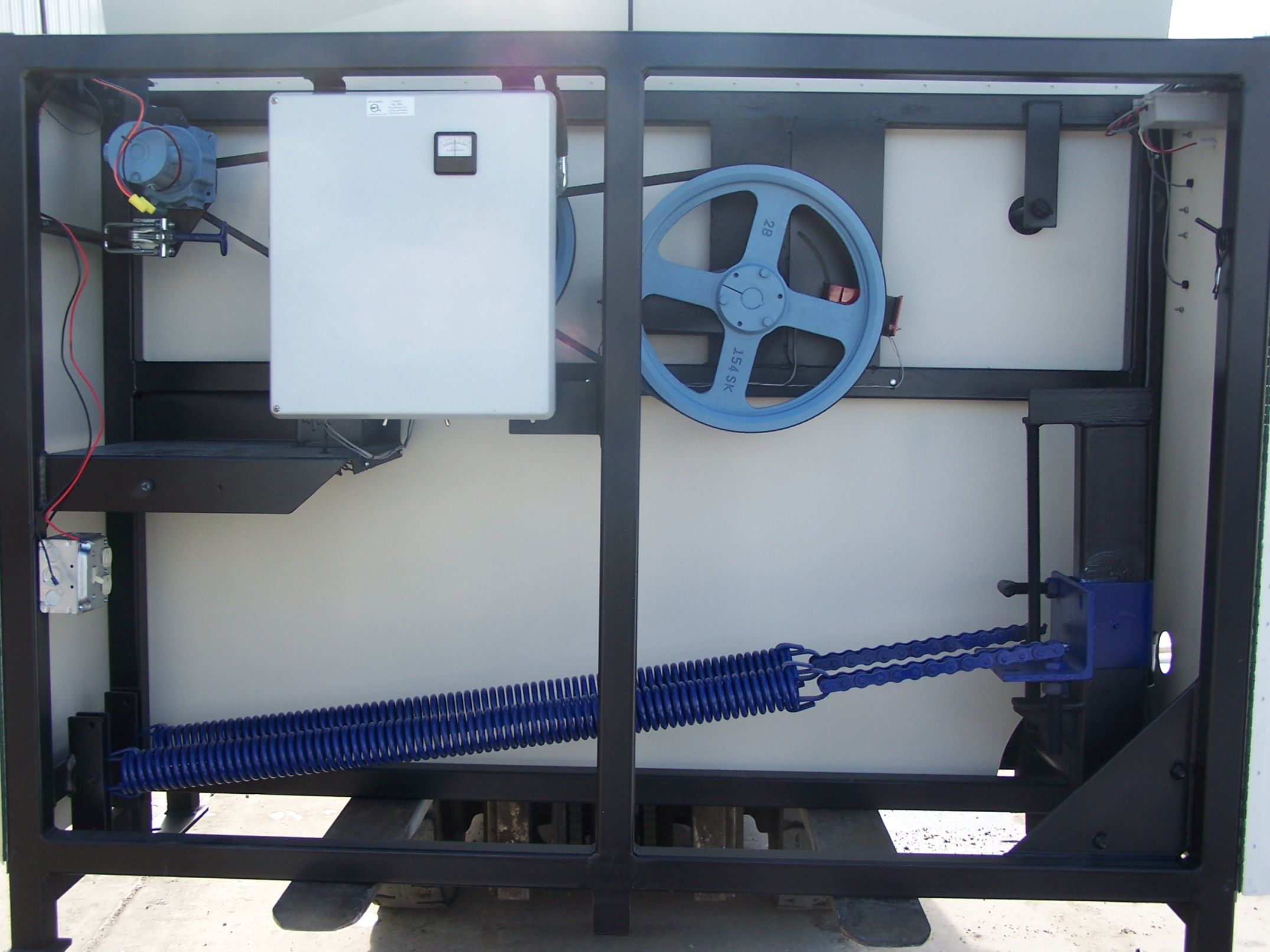
FULL CONCRETE PAD WITH RE-BAR WHERE APPLICABLE

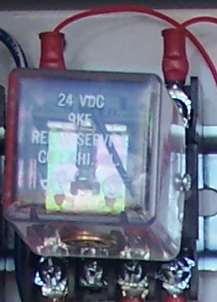


NOTES:

- * ALL PAD DEPTHS SHOULD BE BELOW LOCAL FROST DEPTH
- * TOP OF PAD SHOULD BE FLAT AND LEVEL

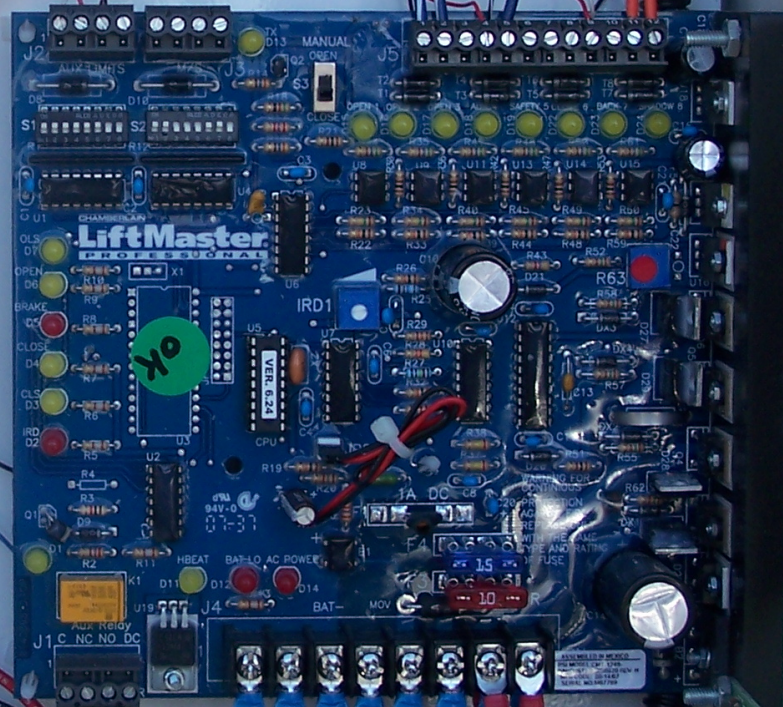
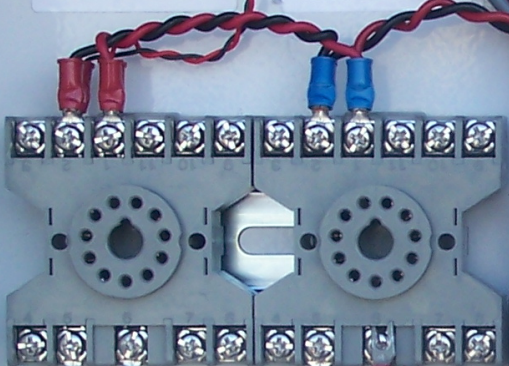
Date: 12/21/05	 AutoGate <i>Gate Entry Systems</i> Berlin Heights, Ohio FAX (419) 588-3514
Dwn. By: MKS	
Supercedes: 7/12/04	
Dwg.: 102-P	
Title: Operator PAD Layout / Options	



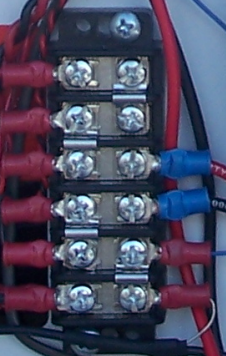


FREE EXIT

REVERSING



24
VDC
CLASS
II
SUPPLY



**SECTION 32 90 00
LANDSCAPE RESTORATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide landscaping and appurtenant work, complete and in place, in accordance with the Contract Documents.
- B. Landscaping as referred to herein shall include supplying and placing topsoil, soil preparation, installation of headers, weed control, finish grading, furnishing and installing plant materials, seeding, erosion control, cleanup, and maintenance guarantee.

1.2 DEFINITIONS

- A. The terms "plant material" or "plants" refer to all vegetation, including but not limited to seed and seeded areas, etc.
- B. "Quality" refers to general development without consideration of size or condition. "Standard quality" indicates the least acceptable quality. "Standard quality" seeded and germinated plants shall be typical of the species and variety of good average uniform growth, shall be well formed.
- C. "Condition" is the factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity at the same season of the year. Plants shall be free from physical damage or adverse conditions that would prevent thriving. "Condition" also sometimes refers to state of growth, i.e., whether "dormant condition" or "growing condition" and this state shall be comparable to plants of similar species in the vicinity for leaves, formation of buds, and the like.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:

ASTM D 422 Method for Particle-Size Analysis of Soils

ANSI Z60.1 Nursery Stock

American Association of Rules and Grading Provisions Nurserymen, Inc.

1.4 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01 33 20 - Contractor Submittals.
- B. Product Information
 - 1. Manufacturer's product information on slow release fertilizer, fertilizer tablets, seed, and erosion control materials.

2. **Topsoil Analysis Report:** A report certified by an analytical laboratory which shows results of analyzing representative samples of topsoil proposed for use. Approval of the report does not constitute final acceptance of the topsoil.
 3. Supplier's information and testing information on compost for soil amendment.
- C. Certificate
1. Certificates shall accompany each product delivery stating source, quantity, and type of material. All certificates shall be submitted to the Landscape Architect at the time of delivery.
 2. Certificates of inspection of plant material, as may be required by Federal, State, or other authorities having jurisdiction, which accompany the shipment, shall be submitted to the Landscape Architect at the time of delivery.
 3. Landscaping Subcontractor guarantee to perform seed maintenance and weeding services during the one-year correction of defects period.

1.5 QUALITY ASSURANCE

- A. General: All plants shall be true to type or name as indicated in the Contract Documents and shall be tagged in accordance with the standard practice recommended by the Agricultural Code of the State of Utah however, determination of plant species or variety will be made by the Landscape Architect.
- B. All plants shall comply with Federal and Utah State laws requiring inspection for plant diseases and infestations.
- C. The Contractor shall obtain clearance from the County Agricultural Commissioner, as required by law, before planting plants delivered from outside the County in which they are to be planted. Evidence that such clearance has been obtained shall be filed with the Engineer or Landscape Architect.
- D. Inspections will be made by the Engineer or Landscape Architect. The Contractor shall request inspection at least 24 hours in advance of the time inspection is required. Inspection is required on the following stages of the Work:
1. During preliminary grading, soil preparation, and initial weeding.
 2. When approved, amended topsoil is placed.
 3. When finish grading has been completed.
 4. When seed is to be applied.
 5. Once seed application has been complete and erosion control is in place.
 6. When all Work except the maintenance period has been completed.
 7. Final inspection before acceptance of the project.

1.6 CLEANUP

- A. Upon completion of all planting operations, the portion of the Site used for a work or storage area by the Contractor shall be cleaned of all debris, superfluous materials, and equipment. All such materials and equipment shall be entirely removed from the Site in accordance with Section 01 70 10 – Project Closeout.
- B. All walks or pavement shall be swept or washed clean upon completion of the Work of this Section.

C. During the entire Contract period, plant containers that have been cut or removed from plant materials shall be removed from the site daily.

D. All fertilizer packaging shall be cleared from the site at the end of every day.

1.7 MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. General: The Contractor shall be responsible for protecting and maintaining all seeded areas until final acceptance of all Work under the Contract.

B. Protection: The Contractor shall provide adequate protection to all newly seeded areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until the end of the correction of defects period.

C. The Contractor shall replace any materials or equipment that its employees or Subcontractors have damaged.

D. Partial utilization of the project shall not relieve the Contractor of any of the requirements contained in the Contract Documents.

E. Plants shall be maintained in a vigorous, thriving condition by watering, cultivating, weeding, pruning, fertilizing, spraying, and other operations necessary.

F. Maintenance shall include, in addition to the foregoing, cleaning, the repair of erosion, reseed bare areas, and all other necessary maintenance work. Sidewalks, retaining walls and paved areas shall be kept clean while seeding and maintenance are in progress.

1.8 FINAL INSPECTION AND GUARANTEE

A. Inspection of all planted areas will be part of final inspection under the Contract.

B. Written notice requesting inspection shall be submitted to the Landscape Architect at least 10 days prior to the anticipated inspection date.

C. Final acceptance prior to start of the guarantee period of the Contract will be on written approval by the Engineer or Landscape Architect, on the satisfactory completion of all Work, including maintenance, but exclusive of the replacement of plant material or reseed areas that have less than 60% coverage.

D. Any delay in the completion of any item of work in the planting operation which extends the seeding into more than one season shall extend the correction period in accordance with the date of completion given above.

E. The Contractor shall reseed, as soon as weather conditions permit, all bare areas or areas that show less than 60% seed germination which are noted at the end of the one-year correction period.

F. All Work under this Section shall be left in good order to the satisfaction of the Owner and the Landscape Architect, and the Contractor shall, without additional expense to the Owner.

1.9 MAINTENANCE AND GUARANTEE FOLLOWING ACCEPTANCE OF PROJECT

- A. General: The Contractor shall be responsible for a period of one year after date of acceptance of the Work of this Section, for maintaining all seeded areas, including fertilizing, controlling insects and diseases and weeding. The Contractor shall obtain a written guarantee from the landscaping Subcontractor embodying the provisions of this paragraph.
- B. The Work covered by the maintenance and guarantee portions of this paragraph includes providing all reseeding of seeding areas for the one year maintenance period or for 2 full growing seasons if the maintenance periods starts in the fall or winter, labor, materials, chemicals, equipment, and supplies and in performing all operations in connection with maintenance and guarantees.
- C. The Contractor shall clean-up and remove unused or waste materials from the Site and leave the area in a neat condition satisfactory to the Owner whenever it performs work during the maintenance period.
- D. Final Inspection: The Owner and Contractor shall make a final inspection at the end of the one-year maintenance and correction period. Any bare seed areas or less than 60% coverage at time of final inspection shall be reseeded within a time agreed upon by both parties. If it is outside of the seeding window for seeding, seeding shall take place within the next seeding window even though reseeding may run beyond the maintenance and correction period.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All landscaping materials including but not limited to, soil amendments, fertilizer, herbicides, pesticides, seed mixtures and erosion control materials shall be first-grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or furnished with each delivery. Delivery certificates shall be given to the Landscape Architect as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the Landscape Architect prior to final acceptance.

2.2 TOPSOIL

- A. Imported topsoil shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. Topsoil shall be subject to inspection and approval by the Landscape Architect at the source of supply and upon delivery to the site. All laboratory soil testing shall be ordered and paid by the Contractor.
- B. Onsite or imported topsoil shall be of uniform quality, free from toxic substances, subsoil, stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. **Topsoil shall contain no noxious weeds or noxious weed seeds.**
- C. Topsoil used for this Work shall meet the following requirements.
 - 1. Soluable salts (EJe) Less than 4 dS/m or mmho/cm

2. ph Between 5.0 and 7.5
3. Sand, silt, clay content Less than 30% clay
 - a. Less than 70% sand and
 - b. Less than 70% silt.
4. Soil texture Sand clay loam (SLC)
 - a. sandy loam (SL)
 - b. clay loam (CL)
5. Organic matter content (by weight) Minimum 0.5 Percent
6. SAR (sodium absorption ratio) Less than 7
7. Percent coarse fragments (rocks > 2mm) Less than 5 percent
8. Nitrate Nitrogen (ppm) Greater than 20
9. Phosphorus (ppm) Greater than 15
10. Potassium (ppm) Greater than 150
11. Iron (ppm) Greater than 10

2.3 FERTILIZER AND AMENDMENTS

- A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.
- B. Chemical fertilizers shall be a mixed commercial fertilizer with percentages of nitrogen, phosphoric acid, and potash at 16-16-8 slow release formula. Fertilizers shall be uniform in composition, dry, and free flowing.
- C. Fertilizer tablets shall be 12 grams each 20-10-5 "Agriform," "Lesslie", or equal.
- D. Compost: Onsite topsoil shall be amended with one part compost to 5 parts topsoil. Compost shall consist of composed leaves and yard grass. Compost shall meet the following requirements:
 1. Compost shall be dark brown to black in color,
 2. Compost shall have no objectionable odor,
 3. Compost shall have a particle size of ½ inch or less,
 4. Compost shall have a pH of 5.0 to 7.8,
 5. Compost shall have a soluble salt concentration (mmhos/cm or dS/m) of less than 5 and
 6. Compost shall have a carbon-to-nitrogen ration of less than 25:1.

2.4 NATIVE SEED

- A. Seed shall conform with applicable City, County, State, Federal regulations and meet Utah Seed Law. Seed shall be mixed by dealer. The Contractor shall furnish dealer's guaranteed germination figure for each variety. Grass seed shall not be delivered until samples have been approved in writing by the Engineer, Landscape Architect or its authorized landscape representative. Approval of samples, however, shall not affect the right of the Engineer, Landscape Architect or the authorized landscape representative to reject seed upon or after delivery. Seed that has become wet, moldy, or otherwise damaged prior to use will not be accepted.

- B. Grass seed shall be fresh, clean, new-crop seed, composed of the following varieties mixed in the proportions by weight. Purity and germination percentage shall be the results of testing.
- C. Weather Conditions: Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 5 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable conditions. Seeding shall not be conducted when temperatures exceed 80°F.
- D. Topsoil: Four inches of approved, onsite or imported, amended topsoil shall be placed in all areas delineated to be seeded. Imported, amended topsoil shall be placed and raked smooth prior to seeding or sodding
- E. Soil Preparation: The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.
- F. Supply seed on a pure live seed (PLS) basis.
- G. Obtain seed from lots that have been tested by a state certified seed testing laboratory. (Association of Seed Analyst (AOSA) or Society of Commercial Seed Technologists (SCST). Seed germination tests older than 18 months for grass seed, and 9 months for shrub or tree seed are not acceptable.
- H. Do not use wet, moldy or otherwise damaged seed.
- I. See plans for seed mix.
- J. In disturbed areas, complete all weed removal, final grading, trench settling, surface preparation and irrigation work (if applicable) before seeding begins.
- K. Roughen soil receiving seed.
- L. Do not install when seed or soil is saturated or frozen.
- M. MAINTENANCE
 - 1. During the maintenance period the contractor shall be responsible for removing weeds and maintaining the site to provide as good of conditions as possible for seed to grow.
 - 2. Contractor shall plan on one re-seeding if the native stand has not established at the end of the warranty period.

2.5 DRILL SEEDING

- A. Drill seeding of the native seed may occur between October 30 and February 28. The actual seeding period must be approved by the Engineer or Landscape Architect because weather conditions vary from year to year. No seed shall be conducted until approved.
- B. All areas that are designated for seeding with the native seed mixutre in the Contract Documents shall be seeded by drilling unless otherwise approved in writing by the Engineer or Landscape Architect. Only those areas that are too steep to drill may be hydroseeded.

- C. Seeding: Seed shall be uniformly drilled to an average depth of 1/4 to 1/2 inch at the rate specified using equipment having drills not more than 6-1/2 inches apart. Row markers shall be used with the drill seeder. Drill seeding shall take place 3 days after application of herbicide.
- D. Rolling: Immediately after seeding, the entire area shall be firmed with a roller not exceeding 90 pounds for each foot of roller width. Areas seeded with drills equipped with rollers shall not be rolled.
- E. Hydromulch: Apply hydromulch over the entire seeded area at a rate of 2000 pounds per acre. Hydromulching operation shall be conducted as described in Section 3.13 Hydroseeding.

2.6 HYDROSEEDING

- A. Hydroseeding shall only be used in areas that are too steep for drill seeding.
- B. Hydroseeding of the native seed mix may occur between October 30 and February 28. The actual seeding period must be approved by the Engineer or Landscape Architect because weather conditions vary from year to year. No seed shall be conducted until approved.
- C. Hydromulch or slurry shall conform to the following:
 - 1. Echofiber or Conwed or approved equal wood fiber mulch, applied at a rate of 2000 pounds per acre.
 - 2. M-binder or Plantego tackifier, applied at a rate of 100 pounds per acre.
 - 3. 16-16-8 slow release fertilizer, applied at a rate of 150 pounds per acre
 - 4. Water at a rate of 4000 gallons per acre.
- D. Hydromulch shall be applied using a hydro-seeding equipment manufactured by Finn or Bowie or approved equal. Machines shall be equipped with heavy duty cast iron pumps and agitators capable of thoroughly mixing the slurry.
- E. Spray of hydromulch shall begin immediately after the tank is full and the slurry components are mixed.
- F. Apply hydromulch in a downward drilling motion using a fan stream nozzle. It is important to ensure that all of the components enter and mix with the topsoil.
- G. Only qualified and trained personnel shall perform hydroseeding to insure the uniformity of the hydroseeding application.

2.7 EROSION CONTROL BLANKET

- A. Erosion Control Blanket shall be AEC Premier Coconut or approved equivalent and placed on slopes 3:1 or greater.
- B. Erosion control blanket shall be keyed in at the top of the slope as per manufacturer specifications.

- C. Anchorage devices shall be 9-inch, two-legged staples furnished by the manufacturer, or staples of the proper length as recommended by the manufacturer for specific soil conditions.

PART 3 - EXECUTION

3.1 GENERAL

- A. The landscape work shall not be performed at any time when it may be subject to damage by climatic conditions.
- B. The Contractor shall carefully scale or otherwise verify all dimensions in the Contract Documents. Dimensions and plant locations shall be coordinated with Engineer or Landscape Architect and final location shall be Site-oriented by the planter and Engineer or Landscape Architect. Any discrepancies or inconsistencies shall be brought to the attention of the Engineer.
- C. In case of conflict between the Plant List totals and total plant count of the Contract Documents, the Contractor shall provide the higher number of plants.
- D. Delivery of materials may begin only after samples and tests have been approved by the Engineer or Landscape Architect. Materials provided shall be not less quality than the approved sample.
- E. Substitutions for the indicated plant materials may be considered pursuant to the Contract Documents.
- F. The Contractor shall provide temporary fencing, barricades, covering, or other protections to preserve existing landscaping items indicated to remain and to protect the adjacent properties and other structures when they may be damaged by the landscape work.
- G. Waste materials shall be removed and disposed of off the Site, unless otherwise indicated.
- H. It shall be the responsibility of the Contractor to obtain information regarding utilities in the area of work and to prevent damage to the same. The Contractor shall protect the utilities as necessary.
- I. Burning of combustible materials on the Site shall not be permitted.
- J. The Contractor shall protect structures, sidewalks, pavements, existing irrigation system, and other facilities that are subject to damage during landscape work. Open excavations shall be provided with barricades and warning lights which conform to the requirements of governing authorities and the State's OSHA safety requirements from dusk to dawn each day and when needed for safety.
- K. Planting areas include all areas to be landscaped unless indicated otherwise.

3.2 SOIL PREPARATION

- A. The landscape work shall not begin until all other trades have repaired all areas of settlement, erosion, rutting, etc., and the soils have been re-established, recompact, and refinished to finish grades. The Engineer or Landscape Architect shall be notified of all areas that prevent the landscape work from being executed.
- B. Areas requiring grading by the landscaper including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10-ft above or below required finish elevations.
- C. The landscape work shall not proceed until after walks, roads, vaults, trenching, and reservoir construction is in place. Work under the Contract shall be completed to a point where the landscape areas will not be disturbed. The subgrade shall be free of waste materials of all kinds.
- D. During grading, waste materials in the planting areas such as weeds, rocks 3-inches and larger, building materials, concrete rubble, wires, cans, glass, lumber, masonry, sticks, etc., shall be removed from the Site. All weeds shall be dug out by the roots.
- E. Fertilizers, soil additives, seed, etc. subject to moisture damage shall be kept dry in a weatherproof storage place.
- F. After removal of waste materials, the planting and sod area subgrade shall be scarified and pulverized to a depth of not less than 6 inches, and all surface irregularities below the cover of topsoil shall be removed.
- G. Finish grading shall consist of:
 - 1. Final contouring of the planting areas.
 - 2. Removal of 6 inches of hardpan material and placement of four inches of imported, amended topsoil over all areas to be planted, deeded or sodded unless indicated otherwise.
 - 3. Placing all soil additives and fertilizers.
 - 4. Tilling of planting areas.
 - 5. After tilling, bringing areas to uniform grades by floating and/or hand raking.
 - 6. Making minor adjustment of finish grades as directed by the Engineer or Landscape Architect.
 - 7. Removing waste materials such as stones, roots, weeds or other undesirable foreign material and raking, disking, dragging, and smoothing soil ready for planting.
 - 8. Finished grades shall be one inch below the top of curbs, sills and walkways in all areas for seed, one and a half inches for sod and three inches for areas with mulch or groundcover.
 - 9. Finished grades shall be smoothed to eliminate puddling or standing water.
- H. Any unusual subsoil condition that will require special treatment shall be reported to the Engineer or Landscape Architect.
- I. **Unless otherwise specified, seeding areas shall receive a minimum of 4 inches of topsoil.**

- J. Surface drainage shall be provided as indicated by shaping the surfaces to facilitate the natural run-off of water. Low spots and pockets shall be filled with topsoil and graded to drain properly.
- K. Finish grade of all planting areas shall be 1-1/2 inches below finish grade of adjacent pavement of any kind.

END OF SECTION

DIVISION 33
UTILITIES

SECTION 33 05 16
PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide precast concrete manholes, catch basins, drop inlets, potable water vaults; meter vaults, and other pre-cast concrete structures complete and in place, in accordance with the Contract Documents.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-in-place Concrete
- B. Section 31 23 00 – Earthwork

1.3 SPECIFICATIONS, CODES AND STANDARDS

- A. Commercial Standards

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 877	Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.4 CONTRACTOR SUBMITTALS

- A. General: Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.
- B. Shop Drawings:
1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
 2. Structural design calculations for vaults and boxes shall be stamped and signed by a structural engineer registered in the state of Utah.

C. Manufacturer's Certification for Manholes and Vaults: Written certification that the structure complies with the requirements of this Section.

D. Manufacturer's Test Results: Pull out force for manhole steps.

1.5 QUALITY ASSURANCE

A. Inspection: After installation, the Contractor shall demonstrate that manholes and vaults have been properly installed, level, with water-tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

B. Any precast concrete which arrives on site with voids, cracked, or damaged, or is cracked or damaged during installation shall be cause for rejection. Contractor shall remove precast section(s) from the project site and replace with new undamaged sections at no additional cost to OWNER.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle precast units in positions consistent with their shape and design. Lift and support only from the support points indicated on the shop drawings.

B. Embedded Lifting or Handling Devices: Capable of supporting units in positions anticipated during manufacturing, storage, transportation and installation.

C. Block and brace units during storage. Provide lateral bracing which is sufficient to prevent bowing and/or warping and will not inhibit curing of the exposed surfaces.

PART 2 - PRODUCTS

2.1 MANHOLES

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Cement used in manufacturing the manholes shall be Type II modified portland cement in accordance with ASTM C 150

1. Manholes, adjusting rings, grout channels and other concrete components of manholes and vaults used in raw sewage, plant drain, drain, or other potentially corrosive environments shall be constructed of concrete that is resistant to hydrogen sulfide corrosion by the addition of the Dynastone admixture. Shop drawings for these manholes shall clearly indicate that the Dynastone admixture is used and each component shall be clearly marked for ready identification in the field of structure containing Dynastone.

B. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

- C. Axial length of sections shall be selected to provide the correct total height with the fewest joints. Joints shall be minimized and shall be located as close as possible to the top of the structure to help minimize opportunity for groundwater infiltration.
- D. Conical sections shall have an eccentric shape and shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.
- E. Design Criteria: Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:
 - 1. AASHTO H-20 loading applied to the cover.
 - 2. Unit weight of soil of 120 pcf located above all portions of the manhole.
 - 3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.
 - 4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.
 - 5. External pressures and uplift forces due to groundwater elevations 2 feet below finish grade.
 - 6. Dead load of manhole sections fully supported by the base and transition.
 - 7. Additional reinforcing steel in walls to transfer stresses at openings.
 - 8. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.
- F. Joints shall have lipped male/female ends which shall provide uniform and continuous interior wall surfaces and shall be watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990.
- G. Raw Sewage, Plant Drain, drain manholes, plant effluent and all vaults shall also have each joint wrapped with an external joint sealant meeting ASTM C 877. Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 03 30 00 – Cast-In-Place Concrete.
- H. Barrel section to sewer pipe (Raw sewage, plant drain, drain, and plant effluent) connections shall be sealed with flexible, resilient connectors complying with ASTM C 923 and appropriate for the pipe material being used. Mechanical devices shall be stainless steel.
- I. Manhole steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches. Furnish test results demonstrating step capability to resist a pull out force of 2200 pounds.
- J. Manhole riser sections shall be greater than 12 inches in height.
- K. Manhole Manufacturers, or Equal
 - 1. AMCOR Precast, Ogden, UT
 - 2. Geneva Pipe, Orem, UT

2.2 FRAMES AND COVERS

- A. Castings: Castings for manhole frames, covers, and grates shall be non-rocking with machined flat bearing surfaces, and shall conform to the requirements of ASTM A 48, Class 30. Unless

otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter. Covers shall have cleated surfaces with pick holes and shall be ventilated in improved areas and have a solid lid design in landscape or native areas.

- B. Manhole covers shall be with embossed with lettering saying "Sewer", "Storm Sewer", or "Water". Manhole covers on Plant Drain or Raw Sewage lines shall be molded with "Timpanogos Special Sewer District" imprinted on the lid.
- C. All frames and covers shall be designed for H-20 traffic loading. Grates and curb inlets in traffic areas shall be designed for H-20 traffic loading.
- D. Castings Manufacturers, or Equal
 - 1. D & L Supply
 - 2. Neenah Foundry Co.
 - 3. Olympic Foundry

2.3 VAULTS

- A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.
- B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V or Type II modified portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.
- C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:
 - 1. $L = 90 h$, plus surcharge of 240 psf in areas of vehicular traffic
 - 2. Where $L =$ loading in psf
 - 3. $h =$ depth of fill in feet.
- D. Design loading shall also take into account the lateral and uplift pressure resulting from a groundwater elevation 2 feet below existing grade.
- E. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint. All openings through the precast structure shall be reinforced to transfer loads.
 - 1. Joints shall be sealed watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990. In addition, all joints shall be wrapped with an external joint sealant meeting ASTM C 877.
- F. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required

covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

- G. Covers for access openings shall be provided. Frames for covers shall be fabricated from aluminum, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.
- H. Where penetrations of the pre-cast concrete vaults are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or wall sleeves, as indicated. Storm drain structures may also use thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. With the exception of vaults on pressurized water system, vaults need not be designed to resist thrust from piping passing through the vault.
- I. Lifting holes shall be plugged with a precast concrete plug sealed with a non-shrink grout.
- J. Vault Manufacturers, or Equal
 - 1. AMCOR Precast, Ogden, UT
 - 2. Geneva Pipe, Orem, UT

2.4 FABRICATION

- A. Maintain plant records and quality control program during fabrication of structural precast concrete sections. Make all quality control records available to ENGINEER upon request.
- B. Use molds that are rigid, and constructed of material that will result in uniform finished surfaces.
- C. If self consolidating concrete is not used, thoroughly vibrate concrete to ensure proper consolidation, elimination of cold joints, and to minimize trapped air on at the concrete surface.
- D. Fabricate and provide the required lifting devices which are compatible with embedded components.
- E. Ensure reinforcing steel, anchors, inserts, plates, angle and other cast-in items are sufficiently embedded, properly secured, and correctly located. Ensure the reinforcing steel is properly supported to prevent movement or shifting during fabrication. Inadequate concrete cover over reinforcing shall be cause for rejection.
- F. Cure precast concrete sections under identical conditions to develop specified concrete quality.

PART 3 - EXECUTION

3.1 GENERAL

- A. Prior to accepting manholes on site, ensure that manhole meet the requirements of these specifications, are constructed of the correct materials, and are not cracked or damaged in any other way.
- B. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.
- C. Buried pre-cast concrete vaults and manholes shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults and manholes shall be set to grade, plumb and level, and oriented to provide the required dimensions and clearances from pipes and other structures.
- D. Prior to backfilling vaults, pipe and conduit penetrations and other, openings shall be sealed with polyurethane sealant or as indicated in the drawings. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

3.2 MANHOLES

- A. Connect pipe to manhole with flexible connection, as recommended by connection manufacturer. Provide a pipe joint or additional flexible connection 18 inches from the outside of the manhole. Grout around pipe after installation is complete, unless otherwise indicated. All connections shall be watertight.
- B. Place top section, cone section or flat slab on top riser section, with the opening positioned over the steps. Top of cone section or flat slab shall be from 10 to 18 inches below finished grade.
- C. Install grade rings as required to adjust top of lid and frame to match finish grade elevation. Maximum height of grade rings shall be 12 inches. Maximum number of grade rings shall be two.
- D. In paved areas and as indicated in the plans, concrete collars shall be constructed around manhole covers as indicated. Collars shall be of 4000 psi concrete. Collars shall be constructed after pavement has been placed.
- E. Steps shall be cast-in-place or vibrated into green concrete.
- F. Steps shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole cover.

- G. After manhole base has been completed, furnish and install temporary pipe plugs to seal all interior pipe opening. Plugs shall remain in place until final review and acceptance of completed pipeline. Plugs shall then be removed and shall be property of Contractor.

3.3 QUALITY CONTROL

- A. Manholes shall be tested and accepted per the requirements of Section 33 08 00 – Gravity Piping Testing and Inspection.
- B. Do not install precast concrete units until concrete has attained its design compressive strength.

END OF SECTION

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SECTION 33 08 00
GRAVITY PIPING TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall perform all pipeline flushing and testing, complete, for gravity piping systems or other yard piping systems as required in the Contract Drawings, and as specified herein; in accordance with the requirements of the Contract Documents.
- B. The Contractor shall be responsible for providing and conveying flushing water to the point of usage and also for disposal, as required, of water used in the flushing operations.
- C. For the purpose of this specification, gravity piping, sewer or gravity sewer piping refers to all pipes with flows that are driven by gravity in an open channel flow condition and convey liquids associated with the treatment plant processes and byproducts (e.g. plant drain, raw sewage, etc).

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
ASTM C924	Standard Practice for Testing Concrete Pipe Sewer Line by Low-Pressure Air Test Method
ASTM C1244	Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill
UNI-B-6	Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor's proposed plans for testing, and for water conveyance, control, and disposal, shall be submitted in writing. The Contractor shall also submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

- A. Temporary valves, plugs, bulkheads, and other air pressure testing and water control equipment and materials shall be provided by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to pipeline structure and future

function. Air test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the Contractor's expense prior to the leakage test, if required by the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

- A. All testing operations shall be performed in the presence of the Engineer.
- B. All water required for cleaning and testing of the sewer pipes shall be furnished by the Contractor.

3.2 CLEANING

- A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.
- B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, or cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.
- C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.
- D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.3 TESTING OF PIPING

- A. General: All gravity sewer pipes and service laterals shall be air tested and mainlines shall be checked for deflection, as specified. All manholes, vaults and boxes directly conveying flows shall be tested for leakage, as specified. Manholes and piping shall be tested following backfill placement. All leakage tests shall be completed and approved prior to the placement of permanent surfacing. When leakage exceeds the amount allowed by the Specifications, the Contractor shall locate the leaks and make the necessary repairs or replacements required to eliminate the leakage. Any individually detectable leaks shall be repaired, regardless of the results of the tests.
- B. Leakage Tests: Gravity sewer systems shall be tested for leakage as follows:
 - 1. Air Pressure Test - Gravity sewers shall be air pressure tested in accordance with UNI-B 6 and/or ASTM F1417 as outlined below.
 - a. The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer.
 - b. The Contractor may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of lateral connection

sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

- c. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the main sewer line and the upper ends of all lateral connection sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.
- d. Test pressure shall be 4.0 psig, unless groundwater elevation exceeds the invert elevation of the pipe. Where the normal groundwater elevation exceeds the invert elevation of the new pipe, the test pressure shall be adjusted for back pressure created by the groundwater. The new test pressure shall be determined by:
$$P_t = 4.0 + \frac{H}{2.35} \leq 9.0 \text{ psig}$$
- e. Where P_t is the new test pressure and H is the difference in feet between the groundwater elevation and the lowest invert elevation of the pipe being tested. In no case shall the test pressure exceed 9.0 psig or the maximum pressure allowed by the pipe manufacturer.
- f. After a manhole to manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked, the plugs shall be placed in the line at each manhole and inflated to manufacturer's recommended inflation pressure. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches test pressure. At least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period minimum pressure (at the beginning of test time shall be test pressure minus 0.5 psig), the air hose from the control panel to the air supply shall be disconnected.
- g. For pipe diameters 4"-36", the portion of line being tested shall be termed "Acceptable" if the allocated line pressure decreases less than 1.0 psi in the time shown for the given diameters and lengths in Table 1.
- h. For pipe diameters greater than 36", the portion of line being tested shall be termed "Acceptable", if the allocation line pressure decreases less than 0.5 psi in the time shown for the given diameters and lengths in Table 2.
- i. Required test times for lines consisting of multiple pipe diameters shall be determined in accordance with UNI-B-6 and or ASTM F1417.
- j. If the installation fails to meet these requirements, the Contractor shall determine the source of leakage. He shall perform a leak location test and then repair or replace all defective materials and/or workmanship. This work shall be completed at no additional cost to the Owner.

Table 1
Low Pressure Air Test Times for 1.0 PSIG Pressure Drop

Pipe Diameter (in.)	Minimum Time for 1.0 PSIG Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
4	03:47	597	.380 L
6	05:40	398	.854 L
8	07:33	298	1.520 L
10	09:27	239	2.374 L
12	11:20	199	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.674 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L
33	31:10	72	25.852 L
36	34:00	66	30.768 L

Table 2
Low Pressure Air Test Times for 0.5 PSIG Pressure Drop

Pipe Diameter (in.)	Minimum Time for 0.5 PSIG Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
42	19:50	57	20.939 L
48	22:40	50	27.349 L
54	25:30	44	34.614 L
60	28:30	40	42.733 L
66	31:10	36	51.707 L
72	34:00	33	61.535 L
78	36:50	31	72.219 L
84	39:40	28	83.756 L
90	42:30	27	96.149 L
96	45:20	25	

- C. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent surfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

- D. Video Inspection: After the sewer pipe has been installed and cleaned; and the trench has been backfilled, the sewer pipe shall be visually inspected by video camera to locate defects in the sewer pipe. Video Inspection shall be performed by an independent testing agency acceptable to the Owner. All sewer pipes shall be video inspected.
1. Notify the Engineer, 48 hours prior to any televised inspections.
 2. The inspection shall be in digital video format, saved to a DVD or CD (enclosed within a protective case) and shall be given to the Engineer for review and final records
 3. The Contractor shall ensure safe access to each manhole as required by the testing agency.
 4. Video equipment shall include a pipe inspection video camera with the following capabilities: panorama tilt, radial viewing, pans plus and minus 75 degrees, rotates 360 degrees, and has optical zoom from 6 or less inches to infinity. Equipment shall produce a high quality, full color video image.
 5. Video equipment shall be equipped with a device that can accurately measure the depth of any ponding encountered in the pipe. Measuring device shall be clearly visible in the video image.
 6. The video equipment shall have an accurate footage counter accurate to within 1 foot per 500 foot of pipe. Footage shall be continuously displayed on the video at all times.
 7. Pipelines shall be cleaned and flushed immediately prior to video inspection. Pipelines that were cleaned and flushed more than 24 hours prior to video inspection shall be cleaned and flushed again. All dirt/debris, including pipe grease, in the line which could cover a defect shall be removed.
 8. Jetting of the lines in conjunction with the video inspection is prohibited.
 9. If during the video inspection, foreign material which prohibits an acceptable video inspection is discovered the line shall be cleaned and video inspected again.
 10. The video camera shall travel through the pipe at a maximum rate of travel of 30 feet per minute. Video shall be continuous for each pipe segment between manholes or other access points.
 11. The video camera shall pause at each tee, lateral or other connection and the camera shall be rotated and tilted to provide an image of the branch for inspection. The image shall remain clear and in focus at all times while zooming to the full extent of the camera. The camera operator shall stop at each fitting and change in pipe type and complete a 360 degree view of the fitting at a rate slow enough to identify any defects.
 12. Glare shall be avoided and shall not interfere with viewing the pipe segment.
 13. Provide DVDs or CDs with labels indicating project number, segment number, date televised, date submitted, starting manhole number, ending manhole number, pipe diameter, pipe length and street name.
 14. Lines to be video inspected shall be flushed within 24 hours prior to beginning of inspection.
 15. The video inspection shall be used to identify defective construction such as sags, debris, separated joints, etc. Any Work not conforming to the Specifications or Drawings shall be promptly removed, replaced and retested at no cost to the Owner. The Engineer shall make all final determinations if the severity of the defect constitutes failure and requires subsequent removal or repair of the segment in question.
 - a. Conditions identified by the video inspection that require removal and replacement or, but are not limited to:
 - 1) Alignment (Vertical or Horizontal) is outside the specified limits.

- 2) Water ponds in any section with depths equal to or greater than 2 times the grade tolerance specified in the Contract Documents.
- 3) Pipe section with visible defects, such as: open joints, pinched gaskets, cracked barrels or bells, leaks, or other defects as determined by the Engineer.

3.4 TESTING OF MANHOLES AND OTHER APPURTENANT STRUCTURES

A. Manholes and other structures

1. Vacuum tests shall be conducted on the newly constructed manholes. Preliminary manhole testing may take place following construction after all connections are made, and before backfilling. Test results derived from this test will allow time for necessary repairs to be completed before further construction proceeds and hinders such repairs. Final tests must be performed after the manhole has been backfilled.

B. Procedures

1. Plug all manhole entrances and exits other than the manhole top access using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warnings for proper and safe installation of such plugs. Plugs should be inserted a minimum of 6 inches beyond manhole wall. Make sure such plugs are properly rated for the pressures required for the test. The standard test of 10 inches Hg. (mercury) is equivalent to approximately 5 PSIG (.3 bar) backpressure. Unless such plugs are mechanically restrained, it is recommended that the plugs are used with a minimum two times (2x) safety factor or a minimum of 10 PSIG (0.7 bar) backpressure usage rating.
2. Close vacuum inlet/outlet ball valve and monitor vacuum for specified test period (see table). If vacuum does not drop in excess of 1" Hg., manhole is considered acceptable and the manhole passes the test. If manhole fails the test, complete necessary repairs and repeat test procedures until satisfactory results are obtained.

Minimum Test Times for Various Manhole Diameters													
Depth, Feet	Diameter, Inches												
	48	54	60	66	72	78	84	90	96	10 2	10 8	11 4	12 0
	Time, Seconds												
8	20	23	26	29	33	35	38	41	45	48	51	54	57
10	25	29	33	36	41	44	48	52	56	60	63	67	71
12	30	35	39	43	49	53	57	62	67	71	76	81	85
14	35	41	46	51	57	62	67	72	78	83	89	94	10 0
16	40	46	52	58	67	70	76	83	89	95	10 1	10 8	11 4
18	45	52	59	65	73	79	86	93	10 0	10 7	11 4	12 1	12 8
20	50	53	65	72	81	88	95	10 3	11 1	11 9	12 6	13 5	14 2
22	55	64	72	79	89	97	10 5	11 4	12 2	13 1	13 9	14 8	15 6
24	59	64	78	87	97	10 6	11 4	12 4	13 3	14 3	15 2	16 1	17 0
26	64	75	84	94	10 5	11 4	12 4	13 4	14 4	15 5	16 4	17 5	18 5
28	69	81	91	10 1	11 3	12 3	13 3	14 5	15 5	16 7	17 7	18 8	19 9
30	74	87	98	10 8	12 1	13 2	14 3	15 5	16 6	17 8	18 9	20 2	21 3

(The values listed above are taken from ASTM Specification C1244-93 "Standard Test Method for Concrete Manholes by the Negative Air Pressure (Vacuum) Test.")

3. Repeat the above test procedure after backfilling manhole for final acceptance test.
4. Manholes shall be watertight. All joints, penetrations, etc., shall be sealed watertight prior to acceptance of manhole.

END OF SECTION

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SECTION 33 11 11
STEEL PIPE (AWWA C200, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide mortar-lined steel pipe coated as specified herein, complete, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards: The following standards are listed for convenience only. All specified standards, whether listed or not, shall apply to the Work.

ANSI/ASTM A 20	General Requirements for Steel Plates for Pressure Vessels
ASTM E 165	Practice for Liquid Penetrant Examination
ASTM A 370	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 516	Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ANSI/AWWA C200	Steel Water Pipe 6 In and Larger
ANSI/AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In and Larger - Shop Applied
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service 4 in to 144 in
ANSI/AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
ANSI/AWWA C209	Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
ANSI/AWWA C214	Tape Coating Systems for the Exterior of the Steel Water Pipelines
ANSI/AWWA C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
ANSI/AWWA C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

ANSI/AWWA C218	Coating the Exterior of Above Ground Steel Water Pipelines and Fittings
ANSI/AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
ANSI/AWWA C602	Cement-Mortar Lining of Water Pipelines 4-In (100 mm) and Larger - In Place
ANSI/ASTM A 36	Carbon Structural Steel
ANSI/ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 570	Steel Sheet and Strip, Carbon, Hot-Rolled Structural Quality
ASTM A 572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM C 150	Portland Cement
ANSI/AWS D1.1	Structural Welding Code – Steel
API Standard 1104	Welding Pipelines and Related Structures
AWWA M-11	Steel Water Pipe - A Guide for Design and Installation
ASME	Boiler and Pressure Vessel Code

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 20 – Submittal Procedures, and the following supplemental requirements as applicable. Fittings and specials shall conform to Section 33 11 12 - Steel Pipe Fabricated Specials. Contractor's submittals for steel pipe and specials shall be coordinated between the sections.
- B. Fabrication Information
 - a. Pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; manufacturing tolerances; maximum angular joint deflection limitations; and all other pertinent information required for the manufacture and installation of the product.
 - b. Welded joint details shall be submitted for all joint types, including beveled ends for alignment conformance and deep bell or butt strap joints required for control of temperature stresses.
 - c. Rubber gasket joint design and details complete with dimensions, tolerances, and performance or test data.
 - d. Pipe Fabricator's Credentials: Submit the credentials of the pipe manufacturer/fabricator. Credentials shall include reference names, telephone numbers, and descriptions of projects for pipe conforming to

AWWA C200 that is of similar diameter, length, and wall thickness to the pipe in this project. Project description shall include length, diameter, wall thickness, steel metallurgy, location of facility where pipe was manufactured/fabricated, and names of key plant personnel responsible for the manufacturing process. Submit names and qualifications of current plant personnel to be responsible for manufacture of the pipe in this project. [To demonstrate ability to meet the schedule requirements of this project, submit project descriptions and manufacturing/fabrication schedules for other currently contracted pipe projects at the Fabricator's plant. The manufacturing / fabrication schedule for the pipe in this project shall be identified on schedule submittals under Section 01 32 21 - CPM Construction Schedule.

- e. Manufacturer's Written Quality Assurance/Control Program.
- 2. Materials: Material lists and steel reinforcement schedules which include and describe all materials to be utilized. Metallurgical test reports for steel proposed for use on the project. Submit chemical and physical test reports from each heat of steel that indicate the steel conforms to the Project Specifications.
- 3. Line Layout Information
 - a. Line layout and marking diagrams compatible with the requirements of AWWA Manual 11 (M-11) and which indicate the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and centerline elevation at all changes in grade or horizontal alignment; the station and centerline elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment. The location of all metered pipe sections, beveled ends for alignment conformance, and deep bell or butt strap joints for temperature stress control shall be clearly indicated on the diagrams.
 - b. Dimensional drawings of all valves, fittings, and appurtenances as specified in Section 40 05 00 – Piping, General.
 - c. Drawings showing the location and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.
 - d. Details and locations of closures for length adjustment, temporary access manways, vents, and weld lead pass holes as indicated and as required for construction convenience.
- 4. Welding Information
 - a. Information regarding location, type, size, and extent of all welds with reference called out for Welding Procedure Specifications (WPS) numbers shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them.
 - b. Written welding procedures for shop and field welds, including Welding Procedure Specifications (WPS's) and Procedure Qualification Records (PQR's).
 - c. Written nondestructive testing procedure specifications, and nondestructive testing personnel qualifications for shop and field welds.

- d. Current welder performance qualifications (WPQ's) shall be submitted for each welder used prior to its performing any Work either in the shop or field. Qualification testing shall be as specified in Article 1.4 - Quality Assurance, Paragraph F, in this Section.
 - e. Submit the credentials of the Contractor's certified welding inspectors (CWI's) and quality control specialist for review prior to starting any welding in the shop or field. The credentials shall include, but not be limited to, American Welding Society QC-1 Certification.
 - f. Submit all nondestructive testing (NDT) data for each shop-welded and field-welded joint. This data shall include all testing on each weld joint, including re-examination of repaired welds, using radiographic, magnetic particle, dye penetrant examination, ultrasonic, or air test examination methods specified. Test data shall be reviewed and signed by the welding inspector(s).
 - g. Submit a welder log for field and shop welding. Log shall list all welders to be used for the Work and the types of welds each welder is qualified to perform.
 - h. Submit a welding map showing the sequence of welds for all field welds.
 - i. Submit a written weld repair procedure for each type of shop and field weld proposed for use on the Project.
 - j. Submit a written rod control procedure for shop and field operations demonstrating how the Contractor intends to maintain rods in good condition throughout the Work. The rod control procedure shall also demonstrate how the Contractor intends to ensure that the proper rods are used for each weld.
5. Handling and Support Information: Detail drawings indicating the type, number and other pertinent details of the slings, strutting and other methods proposed for pipe support and handling during manufacturing, transport, and installation. Calculations supporting the handling and support system design shall be submitted. Drawings and calculations shall be sealed by a registered professional engineer.
6. Control of Temperature Stresses
- a. Submit proposed sequencing of events to control temperature stresses in the pipe wall during installation prior to starting of any field welding.
 - b. Submit the proposed sequencing of events or special techniques to minimize distortion of the steel as may result from shop welding procedures.
 - c. Submit plan for monitoring pipeline temperatures.
7. Field Lining
- a. Submit field lining contractor's credentials.
 - b. Submit a description of lining equipment and personnel to be used.
 - c. Submit written procedures for pipe surface preparation, lining application, and curing.
 - d. Submit cement mortar mix design.
- C. Certifications: Furnish a certified affidavit of compliance for all pipe and other products, materials, or related work provided under this Section, as specified in ANSI/AWWA C200, C205, C602, and C206, respectively, and the following supplemental requirements:
- 1. Compliance with the additional requirements included in these Contract Documents.
 - 2. Physical and chemical properties of all steel.
 - 3. Hydrostatic test reports.
 - 4. Results of production weld tests.
 - 5. Sand, cement, and mortar tests.
 - 6. Rubber gasket tests.

7. All materials are NSF approved for use with potable water.
 8. Pipe temperature complies with Specifications prior to pouring pipe zone material, during and between periods of CLSM placement, and prior to and during welding temperature control joints (including supporting data).
 9. All welds were performed in conformance with these documents.
- D. All expenses incurred in making samples or collecting data for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe, linings, welds, coatings, and related work shall be subject to inspection at the place of manufacture and/or the place the Work is performed in accordance with the provisions of ANSI/AWWA C200, C205, C206, C602, C209, C214, C215, and C222 as applicable, as supplemented by the requirements herein. Notify the Engineer in writing not less than 14 calendar days prior to the start of any phase of the pipe manufacture, welding, lining, coating, testing, or field operations.
- B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of ANSI/AWWA C200, C205, C206, and C602, as applicable.
1. After the joint configuration is completed and prior to lining with cement-mortar, if applicable, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 75 percent of the minimum yield strength of the pipe steel. Test pressure shall be maintained for a sufficient time to observe the weld seams. There shall be no leaks. Any leaks shall be repaired and the pipe retested.
 2. Production weld tests as required in ANSI/AWWA C200, except weld tests shall be conducted on each 5,000 feet of production welds at a minimum, and at least one set of tests per operator per work shift shall be performed.
- C. Perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.
- D. In addition to those tests specifically required, the Engineer may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.
- E. Welding Procedure Specifications: All welding procedures used to fabricate and install pipe shall be in accordance with the ASME Boiler and Pressure Vessel Code (BPVC) for shop welds and ANSI/AWS D1.1 for field welds. Written welding procedures shall be required for all welds, both shop and field. Welds qualified per the ASME BPVC shall include Supplementary Essential Variables for notch-tough welding. All provisions of ANSI/AWS D1.1 pertaining to notch-tough welding shall apply.
- F. Welder Performance Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified by the Contractor under the provisions of ASME BPVC for

shop welds and ANSI/AWS D1.1 for field welds. Furnish all material and bear the expense of qualifying welders.

- G. Shop Nondestructive Testing: Nondestructive testing shall be performed for various weld categories as specified below. Testing shall include submitting written documentation of procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
1. Butt Joint Welds: Spot radiographically examine pipe in accordance with Paragraph UW-52 of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. If, in the opinion of the Engineer, the butt joint welds cannot readily be radiographed, they shall be 100 percent ultrasonically examined.
 2. Fillet Welds: 100 percent examine all fillet welds using the magnetic particle inspection method.
 3. Groove Welds: 100 percent ultrasonically examine all groove welds that cannot be readily radiographically spot examined.
 4. All Welds: Certified welding inspector shall 100 percent visually examine all welds as a minimum.
 5. In addition to weld tests hereinbefore specified, doubler pads shall be air tested as stated in AWWA C206.
 6. Refer to Section 33 13 00 – Water Pipeline Testing and Disinfection for field non destructive testing.
- H. Onsite Observation: The pipe fabricator shall provide an experienced staff member to train the contractor's installation crews regarding pipe handling, jointing, and backfilling. Training shall be provided for a minimum of two weeks at the beginning of the project, and as needed during construction. The staff member's duties shall include, but not be limited to, the following:
1. Observe the installation and welding of the pipe and fittings.
 2. Report any concerns to the Engineer's onsite observer.
 3. Answer questions and provide assistance to the Engineer and the Contractor.
- I. Certified Welding Inspector (CWI): Furnish the services of a certified welding inspector(s) for all shop and field welding as specified in AWWA C200 and C206. The certified welding inspector(s) shall 100 percent visually inspect all welds, verify proper procedures are being followed using qualified welders, supervise Contractor's non-destructive testing, and witness Engineer's non-destructive testing. The welding inspector(s) shall submit written certification that all welds were performed in conformance with these documents. All shop weld tests shall be reviewed and signed by the inspector(s).
- J. Pipe Manufacturer/Fabricator: The manufacturer or fabricator of the pipe shall be experienced in fabricating pipe of similar diameters and wall thicknesses required for this Work and shall have the manufacturing capability to meet the schedule requirements of this project. Experience shall include successful fabrication to AWWA C200 standards 72-inch and larger pipe with wall thicknesses 0.375- inch or larger within the 4-year period preceding the bid date. This experience requirement shall apply to the fabrication plant facility and responsible personnel, not to the firm which owns the facility or employs the personnel.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise indicated, steel pipe, linings and coatings shall conform to ANSI/AWWA C200, C205, C602, C209, C214, C215, C216, and C222, as applicable, subject to the following supplemental requirements. The pipe shall be of the diameter and wall thickness shown, shall be furnished complete with welded or gasket joints, as indicated in the Contract Documents, and all specials shall be provided as required in Section 33 11 12 - Steel Pipe Fabricated Specials. For pipe larger than 24 inches in diameter, the inside diameter after lining shall not be less than the nominal diameter indicated unless otherwise shown. Pipe 24 inches in diameter and smaller may be provided in standard outside diameters.
- B. Markings: Legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word "top" shall be painted or marked on the outside top spigot of each pipe section.
- C. Handling and Storage: The pipe shall be handled by use of wide slings, padded cradles, or other devices, designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The ends of all pipe shall be securely bulkheaded or otherwise sealed during transport to the jobsite. All pipe handling equipment and methods shall be acceptable to the Engineer.
- D. Pay the cost of replacement or repair of pipe which is damaged at no increased cost to the Owner.
- E. Strutting: Adequate strutting (stulling) shall be provided on all specials, fittings, and straight pipe so as to avoid damage or distortion to the pipe and fittings during handling, storage, hauling, and installation. The following requirements shall apply:
 - 1. The strutting shall be placed as soon as practicable after the pipe is fabricated or the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed and backfilled at the jobsite.
 - 2. The strutting materials, size and spacing shall be the responsibility of the Contractor and shall be adequate to prevent deflection and support the earth backfill plus any greater loads which may be imposed by the backfilling and compaction equipment. One strut shall be placed vertical oriented with the top of pipe. One set of struts shall be set 2 feet from each end of each pipe section and at a maximum interval of 15 feet in-between
 - 3. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

- F. Laying Lengths: Maximum pipe laying lengths shall not be limited unless specifically required by the Drawings. Contractor shall select lengths to accommodate the Contractor's operation.
- G. Lining: The pipe lining shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.
- H. Cathodic Protection System: Cathodic protection systems shall be applied to pipelines as shown on the Drawings. Refer to Section 13 47 13 - Cathodic Protection System. Provide cathodic protection appurtenances, including insulating flanges and DC blockers as shown in the Drawings. Maintain electrical continuity except where isolation is indicated in the Drawings.
- I. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of correction pieces and closure assemblies shall be shown on the pipe layout diagrams and shall be subject to the Engineer's review. Any change in location or number of said items shall be approved by the Engineer.
- J. Shop-Welded Surfaces: All weld seams on pipe surfaces that will have a flexible tape or plural component epoxy coating in accordance with Section 09 97 01 - Pipeline Coatings. Seams shall be ground such that the maximum weld bead height will not exceed 1/32 inch. All ground weld seams shall be smooth and free of all burrs. Do not grind into, or gouge, the adjacent pipe wall material.

2.2 MATERIALS

- A. Cement: Cement for mortar shall conform to the requirements of ANSI/AWWA C205; provided, that cement for mortar coating shall be Type V, and mortar lining shall be Type II or V, per ASTM C 150. Fly ash or pozzolan shall not be used as a cement replacement.
- B. Steel: Provide steel coils for spiral welded steel pipe or steel plate for straight seam welded steel pipe per AWWA C200 and as follows:
 - 1. Yield Strength: 40,000 psi minimum. Measured yield strength shall not exceed 85% of measured tensile strength.
 - 2. Minimum Tensile Strength: 60,000 psi
 - 3. Coils: Steel coils shall be made from the continuous cast process or continuous cast slabs, fully killed, fine-grain practice conforming to the physical and chemical characteristics of ASTM A1018/A1018M, SS Grade 40 Type 2. For sheet steel, the maximum allowable thickness variation shall be 0.010 inch under or over the nominal thickness.
 - 4. Plate: Steel plate shall be fully killed, conform to ASTM A20, and be manufactured to fine-grain practice conforming to the physical and chemical characteristics of ASTM A572/A572M, Grade 50. For plate steel, the maximum allowable thickness variation shall be 0.010 inch under or over the nominal thickness.

- C. Pipe shall be manufactured as fabricated pipe per AWWA C200 as modified herein. ASTM pipe manufacturing standards referenced in AWWA C200 shall not be used. Pipe sections shall be fabricated by either of the following methods:
1. Pipe sections may be spirally welded or fabricated from short cylindrical courses joined circumferentially by complete penetration butt joint welds with not more than two longitudinal seams per course. Longitudinal seams shall be staggered on both sides of the pipe.
 2. Pipe sections may be rolled or pressed from no more than three sheets the full length of the pipe and welded with no more than three longitudinal seams. Patching inserts, overlays, or pounding out of dents will not be permitted. Repair of notches or laminations on second ends will not be permitted. Damaged ends shall be removed as a cylinder and the section end properly prepared. Distorted or flattened lengths shall be rejected. A buckled section shall be replaced as a cylinder.
- D. Charpy Tests
1. General. Steel used in production manufacturing of pipe and specials shall be tested for notch toughness using Charpy V-Notch tests per ASTM A 370. The test acceptance shall be 25 foot-pounds at a test temperature of 30 degrees F.
 2. Charpy V-Notch tests shall be conducted on all steel used in fabricating pipe and reinforcement materials 0.5-inch or greater in thickness. Test outside diameter wrap of two coils minimum per heat lot.
 3. The Owner may elect to increase the Charpy testing to include more steel than indicated above at a negotiated price.

2.3 SPECIALS AND FITTINGS

- A. Unless otherwise required, all specials and fittings shall be in accordance with Section 33 11 12 - Steel Pipe Fabricated Specials and shall conform to the dimensions of ANSI/AWWA C208.

2.4 DESIGN OF PIPE

- A. General: The pipe shall be steel pipe, mortar-lined and flexible or mortar-coated as shown on the Drawings, with field welded joints or gasket as indicated. The pipe shall consist of a steel cylinder, lined with portland cement-mortar as indicated, with an exterior coating as indicated in Section 09 97 01 – Pipeline Coatings. Field lining will only be allowed where specifically indicated on the Drawings.
- B. The pipe shall be manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C200.
- C. Pipe Dimensions: The pipe shall be of the diameter and wall thickness shown on the Drawings. The minimum steel cylinder thickness for each pipe size shall be as indicated.
- D. Specials Dimensions: The specials shall be of the diameter and wall thickness indicated on the Drawings, or as specified in Section 33 11 12 - Steel Pipe Fabricated Specials.
- E. Joint Design: Unless otherwise shown, the standard field joint for steel pipe shall be [butt-welded or a double-welded (fully circumferential)] [single-welded (fully circumferential)] lap joint. Mechanically coupled, or flanged joints shall be required where indicated on the

Drawings. Butt-strap joints shall be used only where required for closures or where indicated. The joints furnished shall have the same or higher pressure rating as the abutting pipe. Provide air test tapped holes for each double welded lap joint as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection.

- F. Lap joints prepared for field welding shall be in accordance with ANSI/AWWA C200. The method used to form, shape and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by the pipe being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. The ends shall not be rolled. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.
- G. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths of pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels and maximum joint deflections are not exceeded. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be 75 percent of the manufacturer's recommendations or the angle which results from a ¾-inch pull out from normal joint closure, whichever is less. In no case shall pulled joints result in a gap between the bell and spigot at the weld location that exceeds 1/8 inch. All horizontal deflections or fabricated angles shall fall on the alignment, as shown.
- H. All vertical deflections shall fall on the alignment within laying tolerance as described in Section 3.1.
- I. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated or as otherwise acceptable to the Engineer. Holdback areas shall be coated as hereinafter specified.
- J. Temperature Control Lap Joint: A special longer bell end (temperature control lap joint) shall be provided at a maximum spacing of [400] feet to account for movement of the installed pipe due to temperature changes. The pipe manufacturer shall determine the length required for the longer bell as defined by the Contractor's pipe laying procedures and the location of the special bell. Minimum temperature control lap joint length shall be as shown on the Drawings.
- K. Joint Shop Coating: All holdback areas for welded joints, all butt straps, and all bell and spigot joint rings for rubber-gasketed joints shall be thoroughly cleaned and given a shop coat of rust-inhibitive primer. The surface preparation and primer shall be compatible with the intended finish coating as specified in Section 09 90 00 - Painting, and Section 09 97 01 - Pipeline Coatings, as applicable.
- L. Shop Fit Test
 - 1. To ensure that joints may be fully assembled and that excessive annular space between spigots and bells does not exist, and that the pipe meets the requirements of AWWA C200, the pipe fabricator shall perform a shop fit test on a minimum of

- five joints. The joints to be tested shall be selected by the Engineer based on pipe measurements.
2. The shop fit test shall join the pipe ends in the shop with the proposed adjacent pipe end.
 3. Record the actual annular space, with the data to include as a minimum:
 - a. Maximum space at any point.
 - b. Minimum space at any point.
 - c. Space at 90-degree intervals--top, bottom, and spring line on both sides.
 4. The pipe ends shall be match marked after shop assembly.

2.5 CEMENT-MORTAR LINING

- A. Cement-Mortar Lining for Shop Application: Where indicated on the Drawings, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C205. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at the delivery site, or after installation, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the Owner.
- B. The minimum lining thickness shall be as follows, with a tolerance of plus 1/8-inch or minus 1/16-inch:
- | | | |
|----|-------------------------------|--------------------------|
| 1. | Nominal Pipe
Diameter (in) | Lining Thickness
(in) |
| | 4 - 10 | 1/4 |
| | 11 - 23 | 5/16 |
| | 24 - 36 | 3/8 |
| | over 36 | 1/2 |
- C. The pipe shall be left bare where field joints occur as indicated. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.
- D. Defective linings, as determined by the Engineer, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with cracks wider than 1/16 inch shall be rejected or repaired per C205 at the discretion of the Engineer.
- E. The progress of the application of mortar lining shall be regulated in order that all hand work, including the repair of defective areas is cured in accordance with the provisions of ANSI/AWWA C205. Cement-mortar for patching shall be the same materials as the mortar for shop or machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

- F. Cement-Mortar Lining: Unless otherwise indicated, all steel pipe shall be mortar-lined. The materials and design of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602 and the following supplementary requirements:
1. Pozzolan material shall not be used in the mortar mix.
 2. Admixtures shall contain no calcium chloride.
 3. The minimum lining thickness shall be as indicated for shop-applied cement-mortar lining and finished inside diameter after lining shall be as indicated.
 4. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with mortar cracks wider than 1/16 inch shall be rejected or repaired at the discretion of the Engineer.
 5. Field applied mortar lining shall meet the requirements of this Subparagraph F.
 6. Grout mixture for field applied joint lining shall include two parts sand to one part Type II Portland Cement by volume and potable water. NSF approved acrylic latex admixture (Flex-Con, or equal) shall be added to mortar as needed to make dough like consistency for hand packing into joint area.
- G. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied cement-mortar linings, provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 EXTERIOR COATING OF PIPE

- A. Exterior Coating of Steel Pipe: The exterior coating of all steel pipe shall be in accordance with Section 09 97 01 – Pipeline Coating.

2.7 PIPE APPURTENANCES

- A. Pipe appurtenances shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

2.8 PIPELINE MARKING TAPE

- A. Metallic Tape: Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be 12 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, and shall read "JVWCD - WATER LINE BURIED BELOW". Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D"), Allen (Detectatape), or equal.
- B. Plastic Tape: Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalis acids, and chemicals and solvents which are likely in the soil. Tape shall be 12 inches wide and lettering shall be 1-inch tall permanent black on a blue background. Lettering shall read: "JVWCD - WATER LINE BURIED BELOW." Tape shall be manufactured by Reef Industries (Terra Tape), Allen (Markline), or equal.

2.9 MARKERS

- A. Provide pipeline markers at the locations indicated. Markers in open areas shall be High Visibility Tri-View Utility Marking Posts as manufactured by Rhino Marking and Protection Systems (www.rhinomarkers.com)). Coordinate color and lettering with Owner prior to

installation. Markers shall be provided at maximum intervals of 250-feet, or as otherwise indicated on the plans.

- B. Brass Caps: Caps shall be 2-1/2-inch diameter brass caps with posts set by epoxy into holes drilled into the curb adjacent to the pipeline. Brass caps and monuments shall be provided in locations as described in the plans. Caps shall be LIETZ 8/34-06 or equal, stamped with the following information:
1. "JVWCD".
 2. Lateral name, e.g. "FWR Inlet".
 3. Appurtenance designation, ["Drainvalve"] ["Buried Manhole"] ["Bifurcation, FB"] ["Air Valve, AV"] ["Lateral Centerline, C/L"].
 4. Station number.
 5. Distance and direction to appurtenance or lateral centerline.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE

- A. Handling and Storage: All pipe, fittings, and specials shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. Pipe shall be handled and stored at the trench site in accordance with the requirements stated below. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks or other damage that may be harmful as determined by the Engineer. Such damaged lining and coating/interior and exterior surfaces, shall be repaired to the satisfaction of the Engineer, or a new undamaged pipe shall be furnished.
- B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor at no additional cost to the Owner.
- C. Inspect each pipe and fitting to insure that there are no damaged portions of the pipe. Remove or smooth out any burrs, gouges, weld splatter or other small defects prior to laying the pipe.
- D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.
- E. Lifting points shall be no closer than the 1/3 and 2/3 points along the length of the Section. Contractor shall be responsible for selecting lifting points that when used, do not result in damage to the pipe.
- F. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

- G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, short lengths of pipe, by the use of beveled joint rings, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer or the amount that results in more than a 1/8-inch gap at the weld location, whichever is less. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.
- H. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.
- I. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying, provided, that the deflection of the pipe during and after backfilling does not exceed that specified. After the backfill has been placed to a minimum of 3-feet, the struts shall be removed by the Contractor and shall remain the property of the Contractor. Struts shall not be removed with a torch or any other method that may damage the pipe lining or coating. The parent pipe material shall not be nicked, gouged, or damaged during strut removal. All repairs of gouges or nicks in the parent material shall be made using 3/32-inch maximum diameter E-6010 welding electrodes with a maximum heat input of 5.6 kj per inch. Tack welds, stull metal, weld splatter, slag, and burrs that remain attached to the parent metal surface after cutting shall be ground to within 1/32 inch of the parent metal. Grinding shall not penetrate the parent metal. The Contractor shall notify the Engineer prior to grinding. Following grinding, all pipe surfaces at the tack weld shall be visually inspected for defects. All defects deeper than 1/16 inch shall be repaired by welding in accordance with ANSI/AWSD.1.1 and AWWA/ANSI C206. All inspection work shall be performed by a certified welding inspector.
- J. For pipe backfilled with CLSM, the pipe shall be laid directly on moist sandbags or other suitable supports approved by the Engineer in preparation for CLSM pipe zone material. Sandbags shall be placed to provide at least 6 inches of CLSM below the bottom of the pipe. Sandbags shall be spaced at a maximum interval of 8 feet and one set shall be placed within 3 feet on both sides of each joint. The Contractor shall provide additional sandbags as needed to support the pipe on line and grade. For pipe bedded in granular material, no blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- K. At all times, means shall be provided to prevent the pipe from floating. Take all necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. The Contractor shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition

and grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

L. Bulkheads

1. Prior to shipment of pipe with cement mortar lining the lining shall be wetted then a suitable bulkhead shall be attached to each end of the pipe section. This bulkhead shall remain in place and in good condition through transit to the Project.
2. During construction the openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe. Introduce water into the pipe as needed to keep the mortar moist where moisture has been lost due to damaged bulkheads.

M. Pipe Cleanup: As pipe laying progresses, keep the pipe interior free of all debris. Completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

N. Installation Tolerances: Each section of pipe shall be laid in the order and position shown on the laying diagram and the following requirements:

1. Each section of pipe having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1 inch vertical deviation.
2. Each section of pipe having nominal diameter 48 inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.
3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.
4. Pipe deflection, after backfill but prior to installation of field-applied cement mortar lining, if applied, shall not exceed 2.25 percent for flexible coated pipe and 1.5 percent for cement mortar coated pipe. Deflection shall be measured by the difference in vertical inside diameter in the installed pipe and the manufactured pipe.
5. Pipe not conforming to these criteria or which otherwise impact the ability to complete the Work shall be removed and reinstalled in full conformance with the Contract Documents at no additional cost to the Owner.
6. For each section of pipe, record the invert elevation at the lower end and incorporate the data on the Record Drawings.

O. Protection of Pipe: At locations where the Contractor proposes to cross the installed pipeline with heavy equipment, precautions as approved by the Engineer shall be taken to protect the pipe from damage. Acceptable precautions include: backfilling the pipe trench as necessary to protect the pipe, concrete encasing the pipe, and placing steel plating over the pipe. Any damage to the pipe caused by the Contractor's operation or his equipment shall be repaired at no additional cost to the Owner.

3.2 WELDED JOINTS

A. Welding Procedures, Welding Qualifications, and Testing

1. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.
 2. For field welding, the welder qualification testing shall be performed at the site. Previous qualifications will not be accepted. The Contractor shall obtain the services of an independent testing laboratory to perform the welder qualification onsite. Copies of all test data and certifications shall be provided to the Engineer. All costs for welder qualification testing shall be at no increased cost to the Owner.
 3. Upon completion of each field-welded joint, the welding operator shall mark his regularly assigned identification number and the last two numbers of the year in which the Work was completed, or the Contractor may have a records system that traces a welder's work completion to a specific joint. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round nose types, are used.
 4. All single welded lap joints will be inspected by the Contractor in the presence of the Engineer using magnetic particle or dye penetration methods. Field butt welds will be inspected by the Contractor in accordance with the requirements of API 1104 by the radiographic method and the acceptance criteria of API 1104. Magnetic particle testing is not required for seal welds.
 5. All double welded lap joints and butt strap joints shall be air tested by the Contractor in the presence of the Engineer in accordance with Section 33 13 00 - Water Pipeline Testing and Disinfection. Repairs and retesting shall be required if any loss of pressure occurs.
 6. The Contractor shall inform the Engineer before completed weld joints are to be backfilled so that the joint may be inspected. The Contractor shall assume all costs of exposing backfilled joints for inspection when backfilling preceded the inspection.
 7. Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.
 - a. The Engineer may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein. Except as otherwise specified herein, all costs for the independent testing laboratory to inspect and test field welds will be paid for by the Owner. If the weld is defective, the inspection costs shall be paid for by the Contractor. Defective welds shall be repaired and retested at the Contractor's expense.
 - b. Test reports of all laboratory tests shall be submitted as provided in the quality control section.
- B. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.
- C. Lap Welded Joints: During installation of welded steel pipe in either straight alignment or on curves, the pipe shall be laid so that at any point around the circumference of the joint there is a minimum lap as shown on the Drawings.
- D. Butt Straps: Where used or required, shall be as shown on the Drawings.

- E. After the pipe and pipe joint are properly positioned in the trench, weld and provide external joint protection for all joints except the special temperature control lap joint hereinafter specified. The length of pipe between special temperature control joints shall be backfilled to at least one foot above the top of the pipe as hereinafter specified. The special temperature control joints shall be welded after the pipe is backfilled to at least one foot above the top of the pipe for the full distance between the temperature control joints upstream and downstream. Joint protection shall be provided for special temperature control joints after completion of the joint welds and tests as specified. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the special temperature control joint.
- F. Control of Temperature Stresses
1. Control temperature stresses in accordance with AWWA C206, the approved temperature stress control submittal, and these Specifications. Provide special temperature control lap joints at intervals of **400** feet or less, unless otherwise approved by the Engineer.
 2. To control temperature stresses, the unbackfilled special temperature control joint areas of all pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The "temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the pipe backfill between it and the other control joints in each direction. The term "special temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the backfill between it and the other control joints in each direction. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.
 3. At intervals not exceeding 400 feet along welded reaches of the pipeline, at the first regular lap-welded field joints outside concrete encasements and structures, and where shown, the pipe shall be supplied with a special temperature control lap joint and laid with an initial lap of not less than 3 inches greater than the typical lap joint. Where temperature control lap joints occur in a traveled roadway or other inconvenient location, the location of the joint may be adjusted, as acceptable to the Engineer.
 4. Provide and install thermocouple temperature gauges to monitor the temperature of the steel pipe wall on the inside top of the pipe as it lays in the trench. All pipe temperature requirements specified herein shall be measured at the top inside of the steel cylinder. Specific temperature requirements for the pipeline steel cylinder shall be met prior to installation of the controlled low strength material (CLSM), during and after placement of CLSM, and during welding of the special temperature control joints. If atmospheric conditions do not allow the conditions to be met, supplemental cooling shall be required by the Contractor. The following outlines the specific temperature control requirements.
 - a. Prior to and during placement of the CLSM, the pipeline steel temperature shall be at or below 90 degrees F. The specified temperature shall be maintained for at least three hours after the placement of CLSM. The specified temperature shall be maintained until the line is fully backfilled. Provide supplemental cooling as required.

- b. Placement of CLSM shall proceed in the direction of pipe laying from one special temperature control joint to the next. During placement of CLSM, the lead end of the pipe section (toward the next special temperature control joint) shall be left unbackfilled or otherwise unrestrained such that the end of the pipe is free to move in response to expansion or contraction due to temperature changes. CLSM shall not be placed in a direction which would result in CLSM placement proceeding in a direction toward previously or simultaneously placed CLSM without the written permission of the Engineer. The direction of CLSM placement will not be limited for placement at the short unbackfilled section immediately adjacent to the special temperature control joints.
 - c. During periods between CLSM placement operations, any section of pipeline that is backfilled with CLSM shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The temperature of the partially backfilled pipe shall not be allowed to exceed 110 degrees Fahrenheit at any time. Provide supplemental cooling as required. Shading materials shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the partially backfilled pipe need not be performed when the Contractor can demonstrate to the satisfaction of the Engineer, using thermocouple data, that shading is not necessary to the Contractor to meet the specified temperature requirement.
 - d. Prior to welding the special temperature control joints, the pipeline extending [400] feet each direction from the joint shall be maintained at or below 85 degrees F. Additionally, the pipeline extending [400] feet each direction from the joint shall be backfilled with CLSM to at least one foot over the top of the pipe. At the specified temperature, the special temperature control joints can be welded. Begin and complete the weld during the coolest interval of suitable length within a 24-hour day. Use the thermocouple temperature data to demonstrate to the Engineer the coolest interval of the day.
 - e. After welding any temperature control joint, the pipe temperature for 150 feet in each direction from the control joint shall be maintained below 110 degrees F for a minimum of 24 hours after the temperature control joint area has been backfilled to at least 1 foot over the top of the pipe. This requirement is in addition to the shading and CLSM placement temperature requirements indicated herein.
- G. Prior to the beginning of pouring CLSM or beginning the welding procedure, any tack welds or joint stops used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with ANSI/AWWA C206. Where more than one pass is required, all dirt, slag, and flux shall be removed before the succeeding bead is applied.
- H. Testing of Joints: The pipeline joints shall be tested as specified herein and in Section 33 13 00 - Water Pipeline Testing and Disinfection.

- I. Following tests of the joint, the exterior joint spaces shall be coated in accordance with these Specifications after which backfilling may be completed.
- J. Joints: The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as indicated.
- K. Repair of Welds: All welds that are defective shall be repaired by the Contractor to meet the requirements of this Section at no additional cost to the Owner. Defects in welds or defective welds shall be removed, and that section of the joint shall then be rewelded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.

3.3 JOINT COATING AND LINING

- A. General: The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe. The grout for joint coating and lining shall be cement grout in accordance with Section 03 60 00 - Grouting, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency
- B. Joint Coating: In accordance with the requirements of Section 09 97 01 – Pipeline Coating.
- C. Joint Lining:
 - 1. Clean joint to remove dirt, debris, and other contaminants.
 - 2. Apply a single application of NSF approved acrylic latex bonding admixture (Flex-Con, or equal) to wet out joint for the promotion of adhesion.
 - 3. The grout for joint lining shall be cement grout in accordance with Section 03 60 00 – Grouting, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency. NSF approved acrylic latex admixture shall be added to develop a dough like consistency.
 - 4. Mortar mixture is hand packed into the joint area.
 - 5. Joint is troweled smooth to create a uniform transition between existing mortar lined pipe.
 - 6. Joint area is swept clean of debris.
 - 7. After the backfill has been completed to final grade, the interior joint recess of shop-lined pipe shall be filled with grout, tightly packed into the joint recess and troweled flush with the interior surface. All excess shall be removed. At no point shall there be an indentation or projection of the grout exceeding 1/16 inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout containing one part cement to two parts sand. The spigot end then shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.

3.4 CEMENT-MORTAR LINING, FIELD-APPLIED

- A. Unless otherwise indicated, the Contractor shall construct the cement-mortar lining in-place after the pipeline is backfilled to approximate finished grade. The application of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602.

1. The lining machine shall be of a type that has been used successfully for a similar size of pipe. Perform all Work in a thorough and workmanlike manner by trained personnel, under the supervision of experienced personnel skilled in machine application of cement-mortar lining to pipelines of size comparable to this Work.
2. Curing of the in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602, except the Contractor shall be responsible for curing and maintaining the lining until final acceptance by the Owner. Provide a system to maintain a suitably moist environment within the pipe to properly cure and maintain the lining. Provide additional protective devices as required to ensure that the airtight covers, which maintain a moist condition in the pipeline, are not damaged.
3. Defective areas encompassing the full diameter of the pipe shall be replaced by machine wherever the length measured along the pipe centerline is greater than 5 feet; otherwise defective areas may be replaced by hand.

3.5 INSTALLATION OF PIPE APPURTENANCES

- A. Protection of Appurtenances: Where the joining pipe is concrete or coated with cement mortar, buried appurtenances shall be coated with a minimum thickness of one inch of cement mortar having one part cement to not more than two parts plaster sand. Following coating with cement mortar, the appurtenances shall be coated with a protective overcoat in accordance with the paragraph entitled "Protective Coating."
- B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. Adjust all stem packing and operate each valve prior to installation to insure proper operation. Valves (body and seat) shall not be subjected to test pressures greater than manufacturer's recommendation. In some cases this may require an increase in the valve pressure class.
- C. All buried valves shall be coated and protected in accordance with Section 09 97 01 - Pipeline Coating.
- D. All valves shall be installed so that the valve stems are plumb and in the location indicated.
- E. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved and calibrated torque wrench. All clamping torque shall be applied to the nuts only.
- F. All buried flanges shall be coated and protected in accordance with Section 09 97 01 - Pipeline Coating.
- G. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.

- H. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable, approved and calibrated torque wrench set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.
- I. Upon completion of the coupled joint, the coupling and bare metal of the pipe shall be cleaned, primed and protected in accordance with the requirements of Section 09 97 01 - Pipeline Coating.

3.6 CORROSION CONTROL

- A. Cathodic Protection: Corrosion mitigation and testing materials shall be provided where indicated and in accordance with Section 26 42 14 – Corrosion Monitoring System.

3.7 MARKING TAPE INSTALLATION

- A. Continuously install metallic marking tape along the pipe at the depth and shown on the Drawings.

3.8 PIPELINE TESTING

- A. The steel pipe shall be hydrostatically tested as specified in Section 33 13 00 – Water Pipeline Testing and Disinfection.

END OF SECTION

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SECTION 33 11 12
STEEL PIPE FABRICATED SPECIALS (AWWA C200, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide all bends, reducers, wyes, tees, crosses, outlets, manifolds and other steel plate specials, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASME B 16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASTM E 165	Practice for Liquid Penetrant Examination
ANSI/AWWA C200	Steel Water Pipe 6 In and Larger
ANSI/AWWA C205	Cement Mortar Lining and Coating – Shop Applied
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks
ANSI/AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
ANSI/AWWA C602	Cement-Mortar Lining of Water Pipelines - 4 In (100 mm) and Larger - In Place
ASTM A234	Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ANSI/AWS D.1.1	Structural Welding Code - Steel
API Standard 1104	Welding Pipelines and Related Structures
AWWA M-11	Steel Water Pipe - A Guide for Design and Installation
ASME	Boiler and Pressure Vessel Code

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Submit shop drawings including line and layout diagrams of all steel pipe fabricated specials in accordance with the requirements in Section 01 33 20 – Submittal Procedures. All submittals required for steel pipe and related work as listed in Section 33 11 11 - Steel Pipe, shall also be required for specials. Shop drawings shall indicate the type, size, and location of all reinforcement pieces.

- B. Design calculations shall be submitted to the Engineer for review prior to manufacture of steel pipe fabricated specials.
- C. Certifications: A certified affidavit of compliance with referenced Specifications and these Contract Documents shall be furnished for all steel pipe fabricated specials and other products or materials provided under this Section.

1.4 QUALITY ASSURANCE

- A. Inspection: All specials shall be subject to inspection at the place of manufacturer/ fabrication as outlined in Section 33 11 11 - Steel Pipe.
- B. Shop Testing of Steel Pipe Fabricated Specials:
 - 1. If steel pipe fabricated specials have been fabricated from untested straight pipe, they shall be hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure shown on the Drawings. If steel pipe fabricated specials have been fabricated from successfully tested straight pipe, no hydrostatic test shall be required unless otherwise indicated. In no case shall shop test pressure be less than 150 psi. All tees with crotch plates shall be hydrostatically tested as indicated regardless of whether or not the straight pipe sections used were previously tested.
 - 2. All welds shall be non-destructive tested at the specials fabricator's facility as specified below for various weld categories. Testing shall include submitting written documentation of procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
 - a. Butt Joint Welds: Spot radiographically examine pipe in accordance with paragraph UW-52 of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. If, in the opinion of the Engineer, the welds cannot readily be radiographed, they shall be 100 percent ultrasonically examined.
 - b. Fillet Welds: 100 percent examine all fillet welds using the magnetic particle inspection method.
 - c. Groove Welds: 100 percent ultrasonically examine all groove welds that cannot be readily radiographically spot examined.
 - d. Welds on pipe seams for previously successfully tested straight pipe do not need to be retested.
 - e. All Welds: Contractor's certified welding inspector shall 100 percent visually examine all welds as a minimum.
 - f. In addition to weld tests herein before specified, doubler pads shall be air tested as stated in AWWA C206.
 - g. Refer to Section 33 13 00 - Water Pipeline Testing and Disinfection for field non-destructive testing.
 - 3. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with all finished plate edges ground smooth, straight, recoated and prepared for the field joint.
 - 4. Testing shall be performed before pipe and joints have been coated or lined.
 - 5. Perform tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor, provided that the Contractor's schedule is not delayed for the convenience of the Engineer.

6. In addition to those tests specifically required, the Engineer may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.
- C. Field Testing: Field testing shall conform to the requirements of Section 33 13 00 - Water Pipeline Testing and Disinfection.
- D. Welding Procedure Specifications: All welding procedures used to fabricate pipe shall be in accordance with Section 33 11 11 - Steel Pipe.
- E. Welder Performance Qualifications: All welder performance qualifications shall be in accordance with Section 33 11 11 - Steel Pipe.
- F. Certified Welding Inspector: A certified welding inspector shall be provided for shop fabricated work and shall have the responsibilities outlined in Section 33 11 11 - Steel Pipe.
- G. The specials fabricator shall be experienced in the fabrication of fittings and specials similar to those required for the Work. All previous Work shall be for projects requiring fabrication to AWWA C200 and C208 standards. The fabricator shall have continuous experience with specials fabrication of the size shown and as specified for at least 3 years prior to the beginning of the Work.
- H. Fabrication: All specials shall be fabricated in the shop. No field fabrication of specials will be allowed.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Steel pipe fabricated specials (specials) are defined as fittings, closure pieces, bends, elbows, reducers, wyes, tees, crosses, outlets, manifolds, steel pipe wall sleeves, and other steel plate specials wherever located, and all piping above ground or in structures.

2.2 DESIGN

- A. Design: Except as otherwise provided herein, specials shall be fabricated from materials or straight pipe in full conformance with the requirements of Section 33 11 11 - Steel Pipe, ANSI/AWWA C200, and the dimensions of ANSI/AWWA C208. All fittings and specials shall be properly reinforced to withstand the internal pressure, with circumferential and longitudinal, or external loading conditions, whichever is greater. The minimum thickness of plate for pipe from which specials are to be fabricated shall be no less than the thickness of the adjacent mainline pipe, the thickness shown, or the following, whichever is thicker:

Nominal Pipe Diameter (in)	Pipe Manifolds	Elbows
	Piping Above Ground Piping in Structures	Bends Reducers
30 and under	Standard Weight	Standard Weight
Over 30	3/8-inch	Same as Adjacent Pipe

- B. Pipe installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi. Design shall be in accordance with the provisions of Chapter 7 of AWWA M-11, and other applicable industry standards.
- C. Joints: All joints and related work for field assembly of the pipe and specials shall conform to Section 33 11 11 - Steel Pipe. All shop joints shall be complete penetration butt-welds unless otherwise shown.

2.3 FABRICATION AND MATERIALS

- A. General: Reinforcement for wyes, tees, outlets, and nozzles shall be as shown. Shop welding shall conform to the applicable provisions of the ASME Boiler and Pressure Vessel Code. Field welding shall conform to ANSI/AWS D1.1 and ANSI/AWWA C206. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees resulting in a maximum deflection angle of 22.5 degrees per miter weld as recommended in AWWA C208.
- B. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application, using the same materials as are used for the pipe and in accordance with the applicable AWWA or ASTM Standards, and as modified in Section 09 97 01 - Pipeline Coating, or by other applicable sections in these Specifications. Coating and lining applied in this manner shall provide thickness and protection equal to that specified for the pipe. Fittings may be fabricated from pipe that has been mechanically lined and/or coated. Areas of lining and coating that have been damaged by such fabrication shall be removed and reapplied by hand-applications.
- C. Access manholes with covers shall be as indicated. All threaded outlets shall be forged steel suitable for 3,000-psi service, and shall be as manufactured by Vogt or equal.
- D. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths of pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels and maximum joint deflections are not exceeded. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be 75 percent of the manufacturer's recommendations or the angle which results from a 3/4-inch pull out from normal joint closure, whichever is less. In no case shall pulled joints result in a gap between the bell and spigot at the weld location that exceeds 1/8 inch. All horizontal deflections or fabricated angles shall fall on the alignment, as shown.
- E. All vertical deflections shall fall on the alignment and at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures, the pipe angle points shall match the angle points indicated.
- F. Outlets, Tees, Wyes, and Crosses
 - 1. Outlets 14-inch and smaller shall be fabricated from ASTM A 53, Type E or S, Grade B, standard weight steel pipe in the standard outside diameters, i.e., 14, 12-3/4-inch, 10-

- 3/4-inch, 8-5/8-inch, 6-5/8-inch, and 4-1/2-inch. Wall thickness and collar reinforcing shall be as shown.
2. In lieu of collar reinforcement as shown, pipe or specials with outlets may be fabricated in their entirety of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.
 3. Where required by Manual M-11 or other industry standard, the design procedure for crotch plate reinforcement, such reinforcement shall be required.
- G. Steel Welding Fittings: Steel welding fittings for pipe spools and fittings smaller than 24 inches in diameter shall be in accordance with ANSI B16.9 conforming to ASTM A 234. Use standard weight. Taper pipe wall at welds at 4:1 for connection to pipe of different wall thicknesses. The Contractor shall be fully responsible for coordinating the difference in diameter convention between these specials and AWWA C200/C208 pipe and fittings to provide complete piping systems as shown.
- H. Ends for Mechanical-Type Couplings: Except as otherwise indicated, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved.
- I. Lining: All requirements pertaining to thickness, application and curing of cement mortar lining indicated for straight pipe shall apply to specials, with the following provision. If the special cannot be lined centrifugally or with field lining equipment, it shall be lined by hand. In such case, the lining shall be reinforced with welded wire fabric positioned approximately in the center of the lining and in accordance with AWWA C205 for lining of specials.
- J. Coating: All requirements pertaining to thickness, application and curing of coating indicated for straight pipe shall apply to specials. Unless otherwise indicated the coating on the buried portion of a pipe section passing through a structure wall shall extend to the center of the wall, or to the wall flanges, if one is indicated. Pipe above ground or in structures shall be shop primed and field-painted in accordance with Section 09 90 00 - Coatings and Painting.
- K. Marking: A mark indicating the true vertical axis of the special shall be placed on the top and bottom of the special.
- L. Shop Welded Surfaces: All weld seams on pipe surfaces that will have a flexible tape or polyolefin coating in accordance with AWWA C209, C214, C215, or C216 shall be ground such that the maximum weld bead height will not exceed 1/32 inch. All ground weld seams shall be smooth and free of all burrs.
- M. Portions of wall sleeves that penetrate into hydraulic structures and will be embedded into concrete shall be shop lined and coated in accordance with requirements for submerged conditions as outlined in Section 09 90 00 - Coatings and Painting.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide all fittings, closure pieces, elbows, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other steel plate specials, bolts, nuts, gaskets, jointing materials, and all other appurtenances as indicated to provide a complete and workable installation. Where pipe support details are indicated, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically indicated. Where indicated, concrete thrusts blocks and welded joints shall be provided. At all times when the Work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals and foreign materials.
- B. Take all necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. The Contractor shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.
- C. Unless otherwise indicated, all specials shall be installed in full conformance with Section 33 11 11 - Steel Pipe, and other applicable sections of these Contract Documents.

END OF SECTION

**SECTION 33 13 00
WATER PIPELINE TESTING AND DISINFECTION**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall perform flushing and testing of all pressure pipelines and appurtenant piping and disinfection of all pipelines and appurtenant piping for potable and fire water, complete.
- B. This specification applies to all pipelines requiring hydrostatic tests (water medium) regardless of the pipeline service medium.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C651	Disinfecting Water Mains

1.3 CONTRACTOR SUBMITTALS

- A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval a minimum of 7 days before testing is to start.
- B. A copy of the Utah Pollutant Discharge Elimination System (UPDES) permit application shall be submitted a minimum of 30 days prior to the proposed date to start testing. A copy of the approved UPDES permit shall be submitted prior to the start of testing.
- C. Chlorine residual test data and bacteriological test data shall be submitted to document the results of the pipeline disinfection. Tests shall be conducted 24 hours after the start of disinfection.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

- 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 function.

- B. Used pressure gauges shall be recertified prior to testing.
- C. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.
- D. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301. Liquid chlorine shall be used only:
 - 1. In combination with appropriate gas flow chlorinators and ejectors;
 - 2. Under the direct supervision of an experienced technician;
 - 3. When appropriate safety practices are observed.
- E. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300 - Hypochlorite.

PART 3 - EXECUTION

3.1 GENERAL

- A. Cleaning: Prior to hydrostatic testing, the pipe shall be thoroughly cleaned by sweeping. Foreign matter adhering to the pipe walls shall be removed. Debris from all sources shall be removed from the pipe. Pipe smaller than 24-inch shall be flushed in accordance with AWWA C 651 - Disinfecting Water Mains. A final inspection for cleanliness will be scheduled immediately prior to testing and disinfection.
- B. Water for testing and disinfecting water pipelines shall be furnished by the Owner. The Contractor shall make all necessary provisions for conveying the water from the source to the points of use, and disposal of the water (and dechlorinating - where applicable).
- C. All potable water and pressure pipelines shall be tested. Disinfection shall be accomplished by chlorination for all pipelines providing potable water or connected to a potable water system. All chlorinating and testing operations shall be performed in the presence of the Engineer.
- D. Disinfection operations shall be scheduled as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Bacteriological testing (coliform bacteria) shall be performed by a certified testing laboratory approved by the Owner, and at the expense of the Contractor. Results of the bacteriological testing shall be satisfactory with the Utah DEQ or other appropriate regulatory agency.
- E. Pipeline pressure tests will include the following tests:
 - 1. Air test of double welded lap joints.
 - 2. Hydrostatic pressure test of all pipelines, either in sections or as a unit. Separate hydrostatic tests shall be conducted on each side of mainline valves.
 - 3. Contractor shall conduct the discharge in accordance with the Utah Pollutant Discharge Elimination System (UPDES) permit from the Utah Division of Environmental Quality (UDEQ). The Contractor shall apply a reducing agent to the discharged water to neutralize the chlorine residual and meet the chlorine residual limit required under the permit. The Owner shall conduct the water quality sampling

of the discharge as required by the permit. The Contractor shall notify local agencies, secure appropriate other permits and approvals, and provide erosion control measures for any releases as appropriate. Release of water after pipeline testing and disinfection have been completed shall be only if acceptable to the Engineer.

- F. Notification: Notify the Engineer at each of the following stages:
1. Three working days prior to the start of filling the pipeline with water.
 2. Three working days prior to the start of chlorination.
 3. Twenty-four hours before withdrawing samples for bacteriological testing.
 4. Three working days prior to the start of flushing.

3.2 HYDROSTATIC TESTING OF PIPELINES

- A. Test Pressure: The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 2 hours with zero leakage. The test pressure for distribution and transmission pipelines shall be 150 percent of the design pressure or 200 psi, whichever is greater, measured at the lowest point of the pipeline section being tested. The test pressure for yard piping shall be as shown or specified on the Drawings measured at the lowest point of the pipeline section being tested. All visible leaks shall be repaired in a manner acceptable to the Engineer.
- B. Field Pressure Testing: Pressure test installed valves, as installed in the field, and adjust as necessary to drip-tight performance. Butterfly and sleeve valves shall be tested with specified minimum pressure applied to each side independently, and the valve tested for drop tight performance with zero pressure on the other side of the valve. Other valves shall be tested from the upstream side only. If pipeline testing is to be bulkheaded with any valve, the valve shall be tested and adjusted before the pipeline test is applied. Provisions, satisfactory to the Engineer, shall be made for verifying "0" leakage within the duration of test selected.
- C. Air Testing of Pipeline Joints: All welded joints, at butt straps and restrained joints in pipe larger than 24-inch diameter, shall be air tested to a minimum of 40-psi for a period of 10 minutes per AWWA C206 in the presence of the Engineer. Any loss of pressure during an air test shall result in repairs as necessary, and retesting as many times as necessary, until the joint satisfactorily passes the test.
1. For payment purposes, a satisfactory joint test shall be presumed as a satisfactory test of the two adjacent pieces of pipe to the next joint on either side of the tested joint. However, the pipe lengths shall be subjected to the hydrostatic test of the remainder of the pipeline and defective pipe identified during that testing operation shall be repaired to the satisfaction of the Engineer, or replaced, at the Contractor's expense.
- D. Hydrostatic Pipeline Testing: Hydrostatic testing of the pipelines shall be performed as follows:
1. No section of the pipeline shall be hydrostatically tested until all field-placed concrete or mortar has attained a minimum age of 7 days unless other methods of thrust restraint are simultaneously provided. The test shall be made by closing valves, when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The Contractor shall be responsible for ascertaining that all test bulkheads are suitable restrained to resist the thrust of the test pressure without

damage to, or movement of, the adjacent pipe. Any un-harnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. The Contractor shall provide sufficient temporary air tappings in the pipelines to allow for evacuation of all entrapped air in each pipe segment to be tested. After completion of the tests, such taps shall be permanently plugged. Care shall be taken to see that all air vents are open during filling.

2. The pipeline shall be filled at a rate which will not cause any surges exceeding 50 psi pressure above static pressure, or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline, or section thereof, has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, concrete pressure collars, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.
3. All visible leaks during a test, regardless of leakage rate, shall be repaired and the pipeline retested until no visible leaks occur.
4. In the case of pipelines that fail to pass the prescribed leakage test, the Contractor shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines.
5. The Contractor shall repeat the repairing and testing procedures until the leakage is less than the specified leakage rate, at no additional cost to the Owner.
6. The bacteriological test must be completed before performing the pressure test. Care must be exercised during the pressure test not to contaminate water in the new pipeline.

3.3 DISINFECTING PIPELINES

- A. General: All potable water pipelines shall be disinfected in accordance with the requirements of ANSI/AWWA C651, using the Continuous-Feed Method, as modified below.
- B. Chlorination: A chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be not less than 50 mg/l. Care shall be taken to prevent the strong chlorine solution in the line being disinfected, from flowing back into the line supplying the water.
- C. Retention Period: Chlorinated water shall be retained in the pipeline at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 100 mg/l. Sampling points shall be not greater than 3,000 feet apart.
- D. Chlorinating Valves: During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

- E. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline, dechlorinated and disposed of per Section 01 74 19 – Disposal of Water.
- F. Bacteriological Testing: After final flushing and before the pipeline is placed in service, a sample, or samples shall be collected by the Contractor from the end of the line and at other locations as designated by the Engineer, and shall be tested by the Owner for bacteriological quality in accordance with the requirements of the Utah DEQ or other appropriate regulatory agency. For this purpose the pipe shall be refilled with fresh potable water and left for a period of 24 hours before any sample is collected. Should the initial disinfection treatment fail to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated as many times as needed, until acceptable results are obtained, at no additional cost to the Owner.
- G. Coliform bacteria and e. Coli tests must be run and must be negative for both total coliforms and e. Coli (P/A Method is acceptable). Heterotrophic plate counts also need to be run on each sample (Simplate Method is acceptable) with results of less than 30 MPN/mL.

3.4 CONNECTIONS TO EXISTING SYSTEM

- A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

END OF SECTION

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SECTION 33 13 01
HYDRAULIC STRUCTURES TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform cleaning, flushing, disinfection and testing of all hydraulic structures and appurtenant piping, including conveyance of test water from Owner-designated source to point of use, and including all disposal of testing and disinfection water, complete and acceptable, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE STANDARDS

- A. Commercial Standards:

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C651	Disinfecting Water Mains
ANSI/AWWA C652	Disinfection of Water-Storage Facilities
ANSI/AWWA C653	Disinfection of Water Treatment Plants
APHA/AWWA/WPCF Standard Methods for the Examination of Water and Wastewater (16th edition)	

1.3 CONTRACTOR SUBMITTALS

- A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection, shall be submitted in writing for approval a minimum of 2 days before testing is to start..

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All temporary valves, bulkheads, or any other control equipment shall be as determined by the Contractor subject to the Engineer's review.
- B. Chlorine for disinfection shall be in the form of liquid chlorine or sodium hypochlorite solution. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301; sodium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300. Liquid chlorine shall be used only (1) in combination with appropriate gas flow chlorinators and ejectors; (2) under the direct supervision of an experienced technician; and (3) when appropriate safety practices are observed.

PART 3 - EXECUTION

3.1 GENERAL

- A. Water for testing and disinfecting will be furnished by the Owner; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use. The Contractor shall be responsible for all costs associated with retesting. Water supplied by the Owner for retesting will cost the Contractor \$150 per acre foot for water used.
- B. All hydraulic structures and appurtenant pressure piping shall be tested; those for potable water shall also be disinfected. Disinfection shall be accomplished by chlorination. All chlorinating and testing operations shall be done in the presence of the Engineer. In the case of a reservoir, testing and disinfecting operations shall be combined.
- C. Disinfection operations shall be scheduled by the Contractor as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Release of water from structures, after testing and disinfecting have been completed, shall be acceptable to the Engineer.

3.2 PRELIMINARY CLEANING AND FLUSHING

- A. Prior to both testing and disinfecting, all hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle. All water, dirt, and foreign material accumulated in this cleaning operation shall be removed from the structure. The water supply for the washdown system is supplied by JVWCD. The Owner will pay for the initial cleaning and flushing. Any additional cleaning and flushing shall be at the Contractor's expense.

3.3 TESTING OF HYDRAULIC STRUCTURES AND PIPELINES

- A. General: Testing shall be performed prior to backfilling. Testing shall be performed no sooner than 14 days after all portions of structure walls and associated roof systems have been completed. The structure shall be filled with water to the maximum operating water surface. The rate of filling shall not exceed 24 inches of depth per day. All leakage shall be repaired.
- B. Leakage Test Requirements: After the structure has been filled, the water loss leakage test shall be performed as follows: an initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure, after allowance is made for evaporation loss. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period. Should the structure fail to pass the test, the test shall be repeated for up to 3 additional 7-day test period. If, at the end of 28 days, the structure still fails to pass the leakage test, the Contractor shall empty the structure as acceptable to the Engineer and shall examine the interior for evidence of any cracking or other conditions

that might be responsible for the leakage. Piping shall be tested as specified in Section 33 13 00 - Water Pipeline Cleaning, Testing and Disinfection.

Structural Repairs: The CONTACTOR shall repair any cracks. Cracks shall be grooved and sealed with Xypex in accordance manufacturer's instructions and Contract Drawings. Any evidence of leakage shall be repaired. Following these operations, the Contractor shall again test the hydraulic structure. The structure will not be accepted as completed until the water loss leakage test is passed and all visible leakage repaired. In the case of a reservoir, the retesting shall again be combined with disinfection.

3.4 DISINFECTION OF HYDRAULIC STRUCTURES AND PIPELINES

- A. General: Hydraulic structures which store or convey culinary potable water shall be disinfected by chlorination. Chlorination of hydraulic structures shall be performed in accordance with the requirements of ANSI/AWWA C652 using a combination of chlorination Methods 2 and 3 as modified within this Section. All piping shall be disinfected as specified in Section 33 13 00 - Water Pipeline Cleaning, Testing and Disinfection.
- B. Chlorination: A chlorine solution (about 200 mg/l) shall be sprayed on all interior surfaces of the structure. The structure shall then be partially filled with water to a depth of approximately one-foot. During the partial filling operation, a chlorine-water mixture shall be injected by means of a chlorinating device in such a way as to give a uniform chlorine concentration during the entire filling operation. The point of application shall be such that the chlorine solution will mix readily with the inflowing water. The dosage applied to the water shall be sufficient to provide a chlorine residual of at least 50 mg/l upon completion of the partial filling operation. The Contractor's attention is directed that all precautions shall be taken to prevent the chlorine solution from flowing back into the inlet water supply lines. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the lines with the chlorinated water.
- C. Retention: Chlorinated water shall be retained in the partially filled structure and appurtenant piping long enough to destroy all non-spore-forming bacteria, and in any event, for at least 24 hours. After the chlorinated water has been retained for the required time, the free chlorine residual in the structure and appurtenant piping shall be at least 25 mg/l. all valves shall be operated while the lines are filled with the heavily chlorinated water.
- D. Final Filling: After the chlorine residual has been checked, and has been found satisfactory, the water level in the structure shall be raised to its working water level elevation by adding potable water. Before final filling is commenced, the quantity of chlorinated water remaining in the structure after filling the piping shall, unless otherwise acceptable to the Engineer, be sufficient, when the water level is raised to its final elevation to produce a free chlorine residual of between 1 and 2 mg/l. After the structure has been filled, the chlorine residual of the water shall be determined. If the chlorine residual is less than 1 mg/l, an additional chlorine dosage shall be added to the water in the structure. If the chlorine residual is greater than 2 mg/l, the structure shall be partially emptied and additional potable water added. In no case shall water be released prior to the expiration of the required retention period.

3.5 BACTERIOLOGICAL SAMPLING AND TESTING

- A. Disinfected water storage facilities shall be sampled and tested in accordance with ANSI/AWWA C652. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner and paid for by the Contractor. Results of the testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.

3.6 CONNECTIONS TO EXISTING WATER SYSTEM

- A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until all discolored water is eliminated.

END OF SECTION

SECTION 33 41 01
DRAINAGE PIPELINE SYSTEM TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall perform all pipeline flushing and testing, complete, for drainage system piping as specified herein and in accordance with the requirements of the Contract Documents.
- B. The Contractor shall be responsible for conveying flushing water from the source to the point of usage and also for disposal, as required, of water used in the flushing operations.
- C. For the purposes of this specification, drainage or drain pipelines are storm drains.

1.2 CONTRACTOR SUBMITTALS

- A. The Contractor shall submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the Engineer. The Contractor's proposed plans for water conveyance, control, and disposal shall also be submitted in writing.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. All testing operations shall be performed in the presence of the Engineer.
- B. All drainage pipes shall be tested for alignment, joint displacement and deflection as specified herein. All pipes shall be backfilled prior to testing. Any pipe found to be defective shall be repaired or replaced to the satisfaction of the Engineer.
- C. Pipe sizes from 12-inch through 30-inch in diameter shall require a displacement test. Pipe sizes from 36-inch diameter and larger shall require a displacement test and visual walk-through inspection. All flexible and semi-rigid pipe shall require a deflection test.

3.2 TESTING OF PIPING

- A. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular

portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

- B. Displacement Test: The displacement test shall be performed by flashing a light between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned, or displaced pipe or other defects, the defects designated by the Engineer shall be repaired to the satisfaction of the Engineer.
- C. Visual Test: A visual test shall be conducted on pipes 36-inch in diameter and larger. The test shall be conducted after the pipes have been flushed or otherwise cleaned. The test shall be performed by the Engineer or his representative and a representative of the Contractor. The interior of the pipe shall be visual inspected for alignment, cracking, displaced or improper joints or other defects. Defects shall be repaired to the satisfaction of the Engineer.
- D. Televised Inspection: After the drain pipe has been installed and cleaned; and the trench has been filled, the Contractor shall televise the drain pipe to locate defects in the drain pipe.
 - 1. The Contractor shall arrange for the televised inspections.
 - 2. The Contractor shall ensure safe access to each manhole for the television trucks.
 - 3. Lines to be video inspected shall be flushed within 24 hours prior to beginning of inspection.
 - 4. Any Work not conforming to these Design Standards and Construction Specifications shall be promptly removed, replaced and retested at no cost to the Owner.
 - a. In addition to other requirements identified in the Design Standards and Construction Specifications, the following conditions identified during video inspection shall be promptly corrected by removal, replacement and retesting of the unsatisfactory pipe by the Contractor at no cost to the Owner:
 - 1) Alignment (Vertical or Horizontal) is outside the specified limits.
 - 2) Water ponds in any section with depths equal to or greater than 2 times the grade tolerance specified in the Contract Documents.
 - 3) Pipe section with visible defects, such as: open joints, pinched gaskets, cracked barrels or bells, leaks, or other defects as determined by the Engineer.
 - 5. A copy of televised inspection shall be provided to the Owner in a format selected by the Owner (DVD, etc.).
 - 6. Video equipment shall be equipped with a device that can accurately measure the depth of any ponding encountered in the pipe. Measuring device shall be clearly visible in the video image.

END OF SECTION

SECTION 33 41 02
PVC NON-PRESSURE PIPE, RUBBER JOINTS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide PVC non-pressure pipe and appurtenant work, complete and in place, in accordance with the Contract Documents.
- B. This Section covers pipe from 4 to 48 inches diameter nominal size.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM D 1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM F 1803	Standard Specification for Poly (Vinyl Chloride)(PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter
ASTM D 2444	Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ASTM D 3212	Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals
ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Gravity Sewer Pipe and Fittings
ASTM F 794	Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 913	Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.3 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 20 – Submittal Procedures.
- B. Shop Drawings: The Contractor shall submit shop drawings and laying diagrams of pipe, joints, bends, special fittings, and piping appurtenances.
- C. Certificates: The Contractor shall submit manufacturer's certificate that pipe conforms to these specifications.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and minimum pipe stiffness in psi.
- B. The Contractor shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.2 PIPE

- A. Pipe shall conform to one of the following requirements
 1. Solid Wall Pipe (4" through 15") - ASTM D 3034, SDR 35.
 2. Solid Wall Pipe (18" through 48") -- ASTM F 679 – 46 psi.
 3. Ribbed Pipe (21" through 48") - ASTM F 794
 4. Closed Profile Wall Pipe (21" through 54") - ASTM F 1803 (Vylon or approved equal only)
- B. Material for PVC pipe shall conform to the requirements of ASTM D 1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds, for cell classification 12454-C or 12364-A as defined therein. The manufacturer shall test a sample from each batch according to ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
- C. Joints shall conform to ASTM D 3212. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F 477, ASTM F 913 - Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2.3 FITTINGS

- A. All fittings shall be of the same material as the pipe, molded or formed to suit the pipe size and end design, in required configurations.
- B. The stiffness of the fittings shall be not less than the stiffness of adjoining pipe.

PART 3 - EXECUTION

3.1 GENERAL

- A. Laying, jointing, and testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.
- B. Installation shall conform to the requirements of ASTM D 2321, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

- A. Handling
 - 1. Handling of the PVC pipe shall be done with implements, tools, and facilities as recommended by the pipe manufacturer to insure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.
 - 2. Pipe shall be inspected both prior to and after installation in the trench and all defective lengths shall be rejected and immediately removed from the working area.
 - 3. Fittings shall be lowered into trench by means of rope, cable, chain, or other means without damage. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope, or other device be attached through the fitting interior for handling or shall pipe or fittings be dropped or dumped into the trench.
- B. Storage: Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

- A. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork and the Drawings.

3.4 LAYING PIPE

- A. Pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of slope.
- B. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.

- C. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.
- D. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the Work shall be the Contractor's responsibility.
- E. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, protection of existing utility structures shall be the Contractor's responsibility.

3.5 FIELD JOINTING

- A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.
- B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. A thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.
- C. Fittings shall be carefully connected to pipe, and joint shall be checked to insure a sound and proper joint.
- D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the Engineer, the trench conditions or weather are unsuitable.

3.6 SMALL DIAMETER LATERALS (SEWER LATERAL CONNECTIONS)

- A. Laterals shall extend from the manhole, wye branch or similar fitting, as indicated in the Drawings. Wye fitting or other connection shall be positioned in the mainline such that it enters the mainline at an angle of at least 45 degrees from horizontal. Connections requiring a connection angle of less than 45 degrees shall be approved by the Engineer.
- B. Install a 22.5 degree or 45 degree bend, or combination of bends, as required on the mainline wye to obtain the proper alignment and grade.
- C. Lateral connections to manhole shall be made as directed in Section 33 05 16 – Precast Concrete Manholes and Vaults.

- D. Laterals shall be installed along the indicated horizontal alignment with a uniform slope, free of low spots or adverse grades. Minimum slopes shall be 1/4 inch per foot for 4" diameter laterals and 1/8 inch per foot for 6" diameter laterals.
- E. Cleanouts shall be installed on laterals at a horizontal spacing not to exceed 100 feet and at the locations indicated in the Drawings.
- F. Any one bend (horizontal or vertical) shall not exceed 45 degrees and no more than two bends (horizontal or vertical) shall be installed without a cleanout.
- G. Laterals shall be installed in accordance with all applicable requirements of the local plumbing codes.

3.7 INSTALLATION OF METALLIC LOCATING TAPE

- A. Polyvinyl chloride pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade OR above top of pipe. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.8 TESTING

- A. Field testing of gravity sewer pipe shall conform to the requirements of Section 33 08 00 – Gravity Piping Testing and Inspection.

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SECTION 33 41 03
REINFORCED CONCRETE PIPE (ASTM C 76, MODIFIED)

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall construct all reinforced concrete culvert, storm drain conduits, complete, including connection to existing and new structures, all in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:

ASTM C76	Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
ASTM C443	Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
ASTM C1479	Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall furnish certificates to the Engineer guaranteeing that the pipe furnished hereunder is in compliance with the requirements of these Specifications.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture, in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
- C. Test: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- D. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

- E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.
- F. Any concrete pipe which arrives on site with voids, cracked, damaged, or with inadequate concrete cover over reinforcement or exposed reinforcement, or is cracked or damaged during installation shall be cause for rejection. Contractor shall remove precast section(s) from the project site and replace with new undamaged sections at no additional cost to Owner.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Handle concrete pipe in positions consistent with their shape and design. Lift and support only from the support points indicated on the shop drawings.
- B. Embedded Lifting or Handling Devices capable of supporting pipe in positions anticipated during manufacturing, storage, transportation and installation.
- C. Block and brace pipe during storage. Provide lateral bracing which is sufficient to prevent bowing and/or warping and will not inhibit curing of the exposed surfaces.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

- A. Reinforced Concrete Pipe: Reinforced concrete pipe shall conform to the requirements of ASTM Designation C 76 meeting the pipe class as shown on the drawings. Bell and spigot joints including rubber gaskets, shall conform to the requirements of the latest revision of ASTM C443. Pipe joints shall be so designed as to provide for self centering and when assembled, to compress the gasket to form a watertight seal. The gasket shall be confined in a groove on the spigot end of pipes larger than 12 inches so that pipe movement or hydrostatic pressure cannot displace the gasket. All pipe shall be manufactured with Type II modified cement. Each pipe section shall be identified by a stamp indicating:
 - 1. Name of Manufacturer
 - 2. Date of Manufacture
 - 3. D-loading in pounds and/or Pipe Class

2.2 CONCRETE END SECTIONS

- A. End Sections: Precast reinforced concrete end sections shall have at least one line of reinforcement conforming to the requirements of AASHTO M170 equivalent to the square inches per linear foot for elliptical reinforcement for circular pipe, Class II, Wall B.

2.3 FABRICATION

- A. Maintain plant records and quality control program during fabrication of structural precast concrete sections. Make all quality control records available to Engineer upon request.

- B. Use molds that are rigid, and constructed of material that will result in uniform finished surfaces.
- C. If self-consolidating concrete is not used, thoroughly vibrate concrete to ensure proper consolidation, elimination of cold joints, and to minimize trapped air on at the concrete surface.
- D. Fabricate and provide the required lifting devices which are compatible with embedded components.
- E. Ensure reinforcing steel, anchors, inserts, plates, angle and other cast-in items are sufficiently embedded, properly secured, and correctly located. Ensure the reinforcing steel is properly supported to prevent movement or shifting during fabrication. Inadequate concrete cover over reinforcing shall be cause for rejection.
- F. Chairs or spacers between the reinforcement and forms shall be stainless steel or a nonferrous material.
- G. Cure concrete pipe under identical conditions to develop specified concrete quality.

PART 3 - EXECUTION

3.1 GENERAL

- A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.
- B. Installation shall conform to the requirements of ASTM C 1479, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 TRENCHING AND BACKFILL

- A. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork.

3.3 INSTALLATION

- A. The pipe shall be installed accurately to the defined line and grade. Variance from established line and grade shall not be greater than one thirty-second (1/32) of an inch per inch of pipe diameter and not to exceed one-half (1/2) inch, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe due to non-concentricity of joining surface and pipe interior surfaces does not exceed one sixty-fourth (1/64) inch per inch of pipe diameter or one-half (1/2) inch maximum.

- B. All concrete pipe installation shall proceed up grade on a stable foundation with joints closely and accurately fitted. Rubber gaskets shall be fitted properly in place and care shall be taken in joining the pipe units to avoid twisting of gaskets. Joints shall be clean and dry before a joint lubricant, as recommended by the pipe supplier, shall be applied uniformly to the mating jointing surfaces to facilitate easy positive joint closure.
 - C. Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe bells.
 - D. Place circular concrete pipe that contains elliptical reinforcing so that the reference line designating the top of the pipe is not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe.
 - E. Pipe zone material shall be compacted around the pipe to firmly bed the pipe in position. If adjustment of position of a pipe length is required after being laid, it shall be removed and rejointed as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material.
 - F. In addition to the above-mentioned requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.
 - G. During pipe installation, the trench shall be sufficiently dewatered that the joints will be free of water when jointed.
 - H. Grout all fittings to provide a smooth interior and exterior surface.
- 3.4 FIELD QUALITY CONTROL:
- A. All installations of reinforced concrete pipe shall be subject to the testing, inspection and acceptance requirements of Section 33 41 01 – Drainage Pipeline Testing and Inspection.

END OF SECTION

SECTION 33 41 05
DUCTILE IRON PIPE (AWWA C151, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install ductile iron pipe and all appurtenant Work, complete in place, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21.4	Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile Iron Piping and Fittings for Water
ANSI/AWWA C110/A21.10	Ductile Iron and Gray Iron Fittings, 3-in. through 48-in. for Water and Other Liquids
ANSI/AWWA C111/A21.11	Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
ANSI/AWWA C115/A21.15	Flanged Ductile Iron and Gray-Iron Pipe with Threaded Flanges
ANSI/AWWA C150/A21.50	Thickness Design of Ductile Iron Pipe
ANSI/AWWA C151/A21.51	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
ANSI/AWWA C153/A21.53	Ductile Iron Compact Fittings, 3-in. through 12-in. for Water and Other Liquids
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
ANSI/AWWA C600	Installation of Ductile Iron Water Mains and their Appurtenances
ASTM C150	Specification for Portland Cement

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements of Section 01 33 20 – Submittal Procedures, the requirements of the referenced standards and the following supplemental requirements as applicable and specified herein.
 - 1. Marking plan and details of standard pipe section showing dimensions, pipe joints, fitting and special fitting pressure rating and thickness, size, coating and lining data.
 - 2. Pipeline layout drawings showing the location of each pipe section, each special length, closure sections, location and angle of bends, outlets, location of valves, and other special fittings.
- B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section, as specified in the referenced standards and the following supplemental requirements:
 - 1. Physical and chemical properties.
 - 2. Hydrostatic Test Reports
- C. Sample Costs: All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture, in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
- C. Test: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- D. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.
- E. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner

PART 2 - PRODUCTS

2.1 GENERAL

- A. Standards: Mortar-lined and polyethylene-wrapped ductile iron pipe shall conform to ANSI/AWWA C151, C104, and C105, subject to the following supplemental requirements.

The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all flanges, specials and fittings shall be provided as required under the Contract Documents.

- B. Handling and Storage: The pipe shall be handled by devices acceptable to the Engineer, designed and constructed to prevent damage to the pipe coating/exterior. The use of equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling. All other pipe handling equipment and methods shall be acceptable to the Engineer.
- C. Laying Lengths: Maximum pipe laying lengths shall be 20 feet with shorter lengths provided as required by the Drawings.
- D. Finish: The pipe shall have smooth and dense interior surfaces, and shall be free from fractures, excessive interior surface crazing, and roughness.
- E. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings. The locations of correction pieces and closure assemblies are shown on the Drawings. Any change in location or number of said items shall be acceptable to the Engineer.
- F. Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.

2.2 PIPE DESIGN CRITERIA

- A. General: Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150 as applicable and as modified in this Section.
- B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.
- C. Pipe Wall Thickness for External Load: The pipe shall also be designed with a net thickness to withstand internal loads using ANSI/AWWA C150 Design Equation (2) with the appropriate bending moment and deflection coefficients for Laying Condition Types 4 and 5 as applicable.
- D. The pipe deflection shall be checked using ANSI/AWWA C150 Design Equation (3) and the coefficients stated above. The allowable deflection shall not exceed 0.0225 times the nominal diameter.
- E. In lieu of ANSI/AWWA C150 Design Equation (4), the earth loads will be computed using the following two equations for trench or embankment loading as applicable:
 - 1. Trench Condition:
 - a. $W_d = C_d w B_d^2$,
 - b. Where:
 - W_d = Earth load in pounds per linear foot
 - c. C_d = Calculation Coefficient
 - d. $Ku1$ = 0.13
 - e. w = 120 lb/ft³

- f. B_d = Trench width at top of pipe, feet
- 2. Positive Projecting Embankment Condition:
 - a. $W_c = C_c w B_c^2$
 - b. Where:
 - W_c = Earth load in pounds per linear foot
 - c. C_c = Calculation Coefficient (based on r_{sdP} of 0.25)
 - d. K_{u1} = 0.13
 - e. w = 120 lb/ft³
 - f. B_c = Trench width at top of pipe, feet

F. The above two formulas are based on a depth of cover of 10 feet or greater. For depths of cover of less than 10 feet, HS-20 live load shall be included. For depths of cover of three feet or less, HS-20 live load plus impact shall be included. The determination of live load and impact factors shall be as recommend by AASHTO in "Standard Specifications for Highway Bridges."

G. If the calculated deflection, $Defl_x$, exceeds 0.0225 times the nominal diameter, the pipe class shall be increased.

H. Minimum Pipe Wall Thickness: In addition to the requirements of this Section, the minimum wall thickness shall be in accordance with Table 50.5 of ANSI/AWWA C150.

2.3 MATERIALS

A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.

B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104, provided that cement for mortar lining shall be Type V. A fly ash or pozzolan shall not be used as a cement replacement.

C. Polyethylene Sleeve: Material for the polyethylene sleeve shall conform to the requirements of ANSI/AWWA C105.

2.4 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inch shall conform to the above-referenced standard with the necessary modifications for the larger size.

2.5 DESIGN OF PIPE

A. General: The pipe furnished shall be ductile iron pipe, mortar-lined and polyethylene-wrapped with rubber-gasketed joints as shown.

B. Manufacturing Requirements: The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and, except as hereinafter modified, shall conform to ANSI/AWWA C151.

- C. Pipe Dimensions: The pipe shall be of the diameter and class shown. The minimum wall thickness for each pipe size shall be as specified or shown.
- D. Fitting Dimensions: The fittings shall be of the diameter and class shown.
- E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.
 - 1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11.
 - 2. Restrained Joint:
 - a. Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe without setscrews or devices with shoes or wedges activated by setscrews.
 - b. Rated at minimum working pressure equal to or greater than that of the pipe class.
 - c. The use of devices utilizing setscrews or with shoes or wedges activated by setscrews or bolts shall not be allowed. Except where allowed by governing agencies as temporary thrust restraint.
 - d. The use of field-lock, gripper ring type restraining devices shall be limited to only locations where unforeseen field conditions or closure places require the pipe to be field fit, cut, and joined, and as approved by the Engineer. Where field locking, gripper ring type restraining devices are used, the gripper ring shall be installed a minimum of one full pipe length away from the fitting or closure. The installation of gripper ring type restraining devices where used shall be in strict accordance with the manufacturer's installation instructions.
 - e. Field welding of ductile iron pipe and fitting shall not be allowed.
 - 3. Flanged joints shall conform to ANSI/AWWA C115/A21.15.
- F. Joint Clearances: For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.
- G. Coating and Linings Held Back: Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown, or as otherwise acceptable to the Engineer.

2.5 CEMENT-MORTAR LINING

- A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at the delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

- B. Lining Thickness: The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (in)	Minimum Lining Thickness (in)
3-12	1/8
14-24	3/16
30-54	1/4

- C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.6 EXTERIOR COATING OF PIPE

- A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09 90 00 – Painting and Coating.
- B. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately one mil thick.

2.7 SOURCE QUALITY CONTROL

- A. Factory Tests: In accordance with AWWA C104, C105, C110, C111, C115, C150, C151, C153, and C606.

PART 3 - EXECUTION

3.1 GENERAL

- A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.
- B. Installation shall conform to the requirements of AWWA C600, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 INSTALLATION OF PIPE

- A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe coating against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

- B. Damaged Pipe: All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.
- C. Contractor to Inspect Pipe: The Contractor shall inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe.
- D. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork. Care shall be taken to ensure that pipe zone material is compacted and in full contact with the haunches of the pipe and that the pipe is fully supported.
- E. Clean Pipe: Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon, and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.
 - 1. Remove lumps, blisters, and excess asphaltic type coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.
 - 2. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.
- F. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.
 - 1. Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of Engineer.
 - 2. Mechanical Joint, Push-On Joint, and Restrained Joint Pipe: After first length of pipe is installed in trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement. For restrained joint pipe and fittings, after each section is jointed and restraining devices are completely installed, fully extend the completed joint and place backfill as specified to prevent movement before installation of the next section of pipe or fitting.
 - 3. Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.
 - 4. When using movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.
 - 5. Do not allow foreign material to enter pipe while it is being placed in trench.
 - 6. Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from job.
- G. Joining Push-On Joint Pipe and Mechanical Joint Fittings:
 - 1. Join pipe with push-on joints and mechanical joint fittings in strict accordance with manufacturer's recommendations.
 - 2. Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.
 - 3. Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.
 - 4. Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe.

If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

- H. Founding Pipe: Pipe shall be laid directly on the Pipe Zone material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- I. Unforeseen Obstructions: Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum designed deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.
- J. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.
- K. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
- L. Pipe and Specials Protection: The openings of all pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.
- M. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing and disinfecting the completed pipeline.
- N. Cutting Pipe: General: Cut pipe for inserting closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to axis of pipe.
 - 1. Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.
 - 2. Dressing Cut Ends: Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.
- O. Field Welding:
 - 1. Field welding of ductile iron pipe shall not be allowed.
 - 2. Field welding of bars for restrained joint systems will not be allowed. All welding shall be performed in pipe manufacturer's shop.

- P. Field Installed Outlets: Field outlets may be installed with a saddle; however, the maximum nominal diameter of outlet for saddle shall be 2-inch. Opening in pipe shall be machine cut. Flame cut openings shall not be allowed.

3.3 RUBBER GASKETED JOINTS

- A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket, lubricated with an approved vegetable-based lubricant, shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.4 CORROSION PROTECTION

- A. Polyethylene Encasement: Buried ductile iron pipe shall be polyethylene encased in accordance with the requirements of ANSI/AWWA C105/A21.5.
1. Encase pipe, fittings, and valves in accordance with AWWA C105, Method A.
 2. Cut polyethylene tube approximately 2 feet longer than pipe length.
 3. Slip tube around pipe, centering to provide 1-foot overlap on each adjacent section.
 4. Pull encasement to take out slack and wrap snug around pipe.
 5. Secure overlap in place and fold at quarter points of pipe length.
 6. Wrap and tape encasement snug around fittings and valves.

3.5 INSTALLATION OF PIPE APPURTENANCES

- A. Protection of Appurtenances: Where the joining pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with ANSI/AWWA C209, Type II. Where pipe is encased in polyethylene sleeves, buried appurtenances shall also be encased in polyethylene.
- B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.
- C. Valve Installation: All valves shall be installed so that the valve stems are plumb and in the location shown on the Drawings.

3.6 INSTALLATION OF METALLIC LOCATING TAPE

- A. Buried pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade OR above top of pipe. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.7 FIELD TESTING AND DISINFECTION

- A. Field testing shall conform to the requirements of Section 33 13 00 – Water Pipeline Testing and Disinfection as applicable.

END OF SECTION

SECTION 33 46 00
RESERVOIR UNDERDRAINS AND ROOF DRAINS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install all specified drain piping, imported bedding, liners, geotextile fabrics and all appurtenant work, complete and in place, in accordance with the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 23 00 Earthwork
- B. Section 31 32 19 Geotextiles

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:

ASTM D 1785 Polyvinyl Chloride Pipe

1.4 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.
- B. Shop Drawings: Drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenance.
- C. Certificates: Manufacturer's certificates for all materials indicating conformance to the Contract Documents.
- D. Samples: Samples of all the materials proposed for use on the Work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions.

1.5 QUALITY ASSURANCE

- A. Testing: All materials testing will be based upon applicable ASTM Test Methods referenced herein for the materials specified.
- B. All costs of such inspection and testing shall be the Contractor's responsibility.

PART 2 - PRODUCTS

2.1 DRAIN PIPE

- A. Drain pipe used for footing drains and under drains shall be PVC pipe as specified herein. Drain piping shall be perforated and non-perforated as noted in the drawings. Perforations shall be as specified herein.
- B. Footing and under drain pipes shall be rigid PVC pipe conforming to the requirements of ASTM D 1785 Schedule 80 for polyvinyl chloride pipe and fittings. Perforations shall be located at four o'clock and eight o'clock positions. The perforations shall be drilled at a ¼-inch diameter spaced at 5 inches on center (on alternating sides of pipe).
- C. Perforated drain pipe used for the tank roof perimeter drain system shall be ADS N-12 pipe or approved equal as shown on the Drawings.

2.2 GRANULAR DRAINAGE MATERIALS

- A. When called for, granular drainage backfill material shall be as specified in Section 31 23 00 – Earthwork as follows:
 - 1. Graded drain rock shall be Type H material specified in Section 31 23 00 – Earthwork.

2.3 GEOTEXTILE FILTER FABRIC

- A. Geotextile filter fabric shall be of non-woven needle-punched construction and consist of long-chain polymeric fibers. The geotextile fabric shall be as specified in Section 31 32 19 – Geotextiles. All joints in the filter fabric shall be lapped a minimum of 18 inches.
 - 1. The geotextile filter fabric shall be as manufactured by Mirafi 180N, or equal.

2.4 WATERPROOF MEMBRANE LINER

- A. Waterproof membrane liner shall be EPDM liner of minimum thickness 45 mils. EPDM liner shall be supplied with suitable solvent or adhesive for sealing overlap joints per manufacturer's recommendations. All overlap joints shall have minimum lap width of 12 inches.
 - 1. Firestone PondGard, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. The Contractor shall notify the Engineer when the excavation has reached the final subgrade prior to placement of any under drain materials to allow examination of the foundation materials by the soils engineer.

- D. Drain pipe shall be bedded in the Type H gravel and the drain pipe installed with perforations placed down. The backfill of the drain pipe with drain rock shall proceed as detailed on the drawings placing the material around the pipe to provide a solid backing and to prevent lateral movement. Above the top of the pipe, compact the rock material with a vibratory plate.

3.2 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing, solidly in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirement indicated.
 - 1. Install piping pitched down in direction of flow, at a minimum slope of 0.25 percent or as noted on Drawings.
 - 2. Provide recessed in excavation bottom to receive bells and pipe bell ends. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
 - 3. Apply and compact impervious fill material to raise low areas or where unsatisfactory bearing soil may occur.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fitting being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Excavate for underfloor drainage system after subgrade material has been compacted but before drainage fill has been placed. Grade bottom of trench excavations to required slope and compact to firm, solid bed for drain system.
- D. Maintain swab or drag in piping with tight joints and pull past each joint as it is completed.
- E. Extend piping and connect to sumps and storm drainage system, of sizes and in locations indicated. Terminate piping as indicated.
- F. Provide piping with caps at locations indicated on the drawings. If pipe to be connected is already in place make connection.

3.3 FIELD QUALITY CONTROL

- A. Testing: After installing drainage fill to top of pipe, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.4 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION

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DIVISION 40
PROCESS INTEGRATION

**SECTION 40 00 01
PIPE SUPPORTS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide pipe supports, seismic restraints, hangers, guides, and anchors, complete and in place in accordance with the Contract Documents.
- B. Where specific pipe support elements and systems are not indicated on the Drawings, design and provide the necessary supports in accordance with this Section.

1.2 RELATED SECTIONS

- A. Section 01 81 10 Seismic Design Criteria
- B. Section 03 30 00 Cast-in-Place Concrete
- C. Section 09 90 00 Painting

1.3 REFERENCES

- A. ASTM International (ASTM) standards, most recent editions:
 - ASTM A123 Specification s for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - ASTM A575 Specification for Steel Bars Carbon, Merchant Quality, M-Grades
 - ASTM E84 Test Method for Surface Burning characteristics of Building Materials
- B. Manufacturers' Standardization Society of the Valve and Fittings Industry, (MSS) standards, most recent editions:
 - MSS SP 58 Pipe Hangers and Supports - Materials, Design, and Manufacture
 - MSS SP 69 Pipe Hangers and Supports - Selection and Application.

1.4 COORDINATION

- A. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports.

1.5 SYSTEM DESCRIPTION

- A. Be responsible for the design, engineering, construction, and safety of all pipe hangers and supports.
- B. Code Compliance: Properly support and anchor piping systems and pipe connections to equipment to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. Supports and parts thereof shall conform to the requirements MSS SP 58 and MSS SP 69 except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.
- C. Design, furnish, and install all bracing, supports, and appurtenances necessary to accommodate seismic loadings given in Section 01 81 10 Seismic Design Criteria.

1.6 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- B. Product Data
 - 1. Manufacturers' catalogs, literature, and engineering data for all hangers and supports.
- C. Shop Drawings
 - 1. Drawings of pipe supports, restraints, hangers, anchors, and guides.
 - 2. Schedule of support types, number, parts, and location of installations.
 - 3. Do not use Contract Drawings for erection drawings.
- D. Structural Calculations for special supports and anchors.

1.7 QUALITY ASSURANCE

- A. Qualifications
 - 1. Licensed Professionals in responsible charge of the designs specified herein shall be licensed to practice in the applicable discipline in the state of Utah.
- B. Component Supply and Compatibility
 - 1. Obtain all products included in this Section, regardless of the component manufacturer, from a single pipe hanger and support manufacturer.
 - 2. The pipe hanger and support product manufacturer is to review and approve or to prepare all shop drawings and other submittals for the components furnished under this Section.
 - 3. Pipe hanger and support product manufacturer must specifically construct all components for the specified service conditions and integrate into the overall assembly.
- C. Fabrication
 - 1. Fabricate and install pipe hangers, supports, and seismic restraints and using experienced welders and fitters. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in concrete in ample time to prevent delay of that Work.
- C. Acceptance at Site
 - 1. Inspect all boxes, crates, and packages upon delivery to the site. Notify Engineer, in writing, if any loss or damage exists to products or components. Replace loss and repair damage to new condition in accordance with manufacturer's original specifications and specific instructions.
- D. Storage And Handling Requirements
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 2. Store materials in covered storage off the ground and prevent condensation.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping and preventing excessive stress on equipment. Provide hangers with a means of vertical adjustment after erection. Design hangers to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. Design hanger rods for tensile loading only.
- B. Furnish standard and fabricated hangers and supports complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
- C. Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.
- D. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.
- E. Provide spring-type pipe hangers for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. Size spring-type hangers to the manufacturer's printed recommendations and the loading conditions encountered. Provide variable spring supports with means to limit misalignment, buckling, eccentric loading, or to

prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least four times the maximum travel due to thermal expansion.

- F. Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. Components shall be structurally suitable to withstand loads imposed.
- G. Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.
- H. Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.
- I. When it is not practical to support piping on the floor, support pipes from structural members. Where it is necessary to frame structural members between existing members, provide such supplementary members at no additional cost to Owner. Design all supplementary members in accordance with the requirements of the applicable building code. Designs must be acceptable to Engineer.
- J. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Support exterior, free-standing overhead piping on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.
- K. Support meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, equip all supports on PVC, FRP, and other plastic piping with extra wide pipe saddles or galvanized steel shields.
- L. To reduce transmission of noise in piping systems, wrap copper tubes in buildings and structures with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 MANUFACTURERS

- A. Subject to compliance with Contract Documents, the following manufacturers are acceptable:
 - 1. Pipe hangers and supports
 - a. Basic Engineers Inc., Pittsburgh, PA.
 - b. Bergen-Paterson Pipesupport Corp., Woburn, MA.
 - c. Grinnell Corp. (Supply Sales Company), Cranston, RI
 - d. NPS Products, Inc., Westborough, MA.
 - e. Power Piping Company, Pittsburgh, PA.
 - f. Engineer approved equal.
 - 2. Concrete inserts
 - a. Unistrut Corporation, Wayne, Michigan.
 - b. Elcan Metal Products Company, Franklin Park, ILL.

- c. B-Line.
- d. Anvil International
- e. Engineer approved equal.

2.3 MATERIALS

- A. Provide pipe support assemblies, including framing, hardware, and anchors, of steel construction, galvanized after fabrication, unless otherwise indicated.
- B. Submerged Supports: Support submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, with support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.
- C. Corrosive: Support piping in chemical and corrosive areas with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.
- D. Prevent contact between dissimilar metals when supporting copper tubing by using copper plated, rubber or vinyl coated, or stainless steel hangers or supports.
- E. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.

2.4 HANGERS AND SUPPORTS

- A. For necessary hangers and supports not shown on the Contract Drawings, provide in accordance with Drawing details, MSS SP58, and MSS SP 69.
- B. Chemical Piping Systems
 - 1. All pipe supports and fasteners used in chemical piping systems shall be glass fiber-reinforced plastic with a flame spread rating of 25 per ASTM E84.
 - 2. Materials manufactured by either the pultrusion or extrusion process.
 - 3. On all pipe supports, provide a surface veil over 100 percent of the surface which, along with a filler system, protects against degradation from ultra-violet light.
 - 4. Manufacture all fasteners from long glass fiber-reinforced polyurethane to ensure strength and corrosion resistance.
 - 5. Provide all-thread rods made from vinylester resin only.

2.5 ACCESSORIES

- A. Provide hanger rods conforming to ASTM A575 with square head nut on top and running thread on bottom end.
- B. Concrete Inserts:
 - 1. Provide concrete inserts conforming to MSS SP 58 malleable, Type 18.
- C. Steel Beam Clamps:
 - 1. Provide steel beam clamps of malleable iron and conforming to MSS SP 48, Type 32.

2.6 SUPPORT SPACING

- A. Space supports for piping with the longitudinal axis in approximately a horizontal position to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, modify the pipe support spacing in accordance with the pipe manufacturer's recommendations. Provide vertical supports to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1 - 1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe

Maximum Spans for Pipe Supported in Minimum 120 degree contact saddles (feet)										
Nominal Pipe Diameter (inches)	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	42	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	--	40	43	47	50	52	56			
45	--	40	44	47	50	53	57			
48	--	40	44	47	50	53	58	61		
51	--	41	44	48	51	53	58	62		
54	--	41	44	48	51	54	58	62		
57	--	41	44	48	51	54	59	63		
60	--	41	45	48	52	54	59	63	67	70
63	--	41	45	49	52	55	60	64	67	71

Maximum Spans for Pipe Supported in Minimum 120 degree contact saddles (feet)										
66	--	41	45	49	52	55	60	64	68	71
72	--	41	45	49	52	55	61	65	69	72
78	--	41	45	49	53	56	61	66	69	73
84	--	41	46	50	53	56	62	66	70	74
90	--	41	46	50	53	56	62	67	71	74
96	--	42	46	50	54	57	62	67	71	75

3. For steel pipe sizes not presented in this table, design the support spacing so that the stress on the pipe does not exceed 5,000 psi. Limit maximum deflection of pipe shall to 1/360th of the span as calculated by using the following formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

Where:

t	=	Thickness (inches)
D	=	Diameter (inches)
L	=	Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Normal Pipe Diameter (inches)	Maximum Span (feet)
All diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Normal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1 - 1/2	6
2 to 4	10
6 and greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1 - 1/4	5.5
1 - 1/2	5.75

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

7. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
- a. $\Delta L = L \times \Delta T \times \alpha$, where:
 - 1) ΔL = pipe length change (inches).
 - 2) L = pipe length between fixed anchors (inches).
 - 3) ΔT = change in temperature of 100 Degrees F.
 - 4) A = coefficient of thermal expansion (inch/inch/Degree F) for the pipe material.
 - b. Design expansion compensation as an integral part of the piping hanger, support, and anchorage system.

2.7 COATING

- A. Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A123.
- B. Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 09 90 00 – Painting and Coating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Position pipe supports and hangers to produce an orderly, neat piping system. Install hanger rods vertical, without offsets. Adjust hangers to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.
- B. Do not use chains, plumber's straps, wire, or similar devices for permanently suspending, supporting, and restraining piping.
- C. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.
- D. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

- E. Use flush shells only when specifically indicated on the Drawings.
- F. Do not use stud-type powder actuated fasteners for securing metallic conduit or steel pipe larger than 1 inch diameter to concrete, masonry, or wood.
- G. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves and anchor between expansion loops and direction changes to prevent axial movement through anchors.
- H. Locate hangers and supports to prevent vibration or swaying and to provide for expansion and contraction.
 - 1. Temperature differential specified in this Section.
 - 2. Support piping independently so that equipment is not stressed by piping weight or expansion.
 - 3. Support horizontal piping at maximum spacing given in this Section.
 - 4. Provide additional supports at the following locations:
 - a. Change in direction.
 - b. Branch piping and runouts over five feet.
 - c. Concentrated loads due to valves, meters, or other similar equipment.
 - 5. Unless shown otherwise, provide hanger types for horizontal piping as follows:
 - a. Forged steel adjustable clevis type, rod support for all services.
 - b. Slide Bases:
 - 1) Pipe stand, brackets, trapeze, or other equivalent structural support.
 - 2) For piping 2-inches and larger.
 - c. For pipe and covering, provide
 - 1) Saddles for rollers or slide bases.
 - 2) Protective shields or saddles for all other types of supports.
 - d. Threaded steel rods
 - 1) Two-inch vertical adjustment with two nuts on each end for positioning and locking.
 - 2) Size hanger rods according to the schedule below unless otherwise shown or noted:

Normal Pipe Diameter (inches)	Rod Diameter (inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8

- 3) For double rod hangers, provide one size smaller than above.
 - 4) Connection to structure for piping up to 2 inch diameter: Concrete inserts or general concrete anchors in shear into sides of beams.
 - 5) Connection to structure for piping 2-1/2 inch diameter and larger: Concrete inserts, beam clamps, or suitable bridging.
 - e. Vertical piping

- 1) Base support: Base elbow or welded equivalent, with bearing plate on structural support.
 - 2) Guides, not to exceed:
 - a) 25 feet for piping up to 2-inch diameter.
 - b) 36 feet for piping 2-1/2 inch diameter and larger.
 - 3) Top supports:
 - a) Provide special hanger or saddle in horizontal connection.
 - b) Allow for expansion.
 - 4) Intermediate supports:
 - a) Bolted or welded to pipe.
 - b) Extension ends bearing on structural steel or bearing plates on concrete.
 - 5) For multiple pipe installations, coordinate guides, bearing plates, and accessory steel as necessary.
- I. Install items to be embedded in concrete construction before concrete placement in accordance with Section 03 30 00 Cast-in-Place Concrete. Fasten embedded items securely to prevent movement during concrete placement.
- J. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.
- K. Bring all piping systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions and correct all support malfunctions.

END OF SECTION

SECTION 40 00 03
MILL PIPING – EXPOSED AND BURIED

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install all exposed and buried mill piping as shown and indicated, complete, including small steel pipe, stainless steel pipe, red brass pipe, copper tubing, solvent-welded PVC pipe, polypropylene pipe, polyvinylidene fluoride pipe, fiber glass reinforced plastic pipe, process glass pipe, cast iron soil pipe, corrosion-resistant cast iron pipe, fittings, gaskets, bolts, insulating connections, pipe insulation, and such other specialties as required for a complete and operable piping system in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/ASME B16.3 Malleable Iron Threaded Fittings

ANSI/ASME B16.4 Gray Iron Threaded Fittings,

ASME B16.5 Pipe Flanges and Flanged Fittings,

ANSI B16.11 Forged Steel Fittings, Socket-Welding and Threaded

ANSI B16.12 Cast-Iron Threaded Drainage Fittings

ANSI/ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250

ANSI B16.21 Nonmetallic Flat Gaskets for Pipe Flanges

ANSI B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASTM A 53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 74 Specification for Cast Iron Soil Pipe and Fittings

ASTM A 105 Specification for Carbon Steel, Forgings for Piping Applications

ASTM A 106 Specification for Seamless Carbon Steel Pipe for High Temperature Service

ASTM A 312 Specification for Seamless and Welded Austenitic Stainless Steel Pipe

ASTM A 518 Specification for Corrosion-Resistant High-Silicon Iron Castings

ASTM B 43 Specification for Seamless Red Brass Pipe, Standard Sizes

- ASTM B 62 Specification for Composition Bronze or Ounce Metal Castings
- ASTM B 88 Specifications for Seamless Copper Water Tube
- ASTM C 599 Specification for Conical Process Glass Pipe and Fittings.
- ASTM D 1785 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- ASTM D 2996 Specification for Filament-Wound Reinforced Thermosetting Resin Pipe
- ASTM D 3222 Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding, Extrusion, and Coating Materials
- ASTM D 4101 Specification for Propylene Plastic Injection and Extrusion Materials
- ASTM F 441 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
- Chlorine Institute Pamphlet 6 Piping Systems for Dry Chlorine

1.3 CONTRACTOR SUBMITTALS

- A. A. For the materials and equipment items supplied under the provisions of this Section, submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01 33 20 – Submittal Procedures.

PART 2 - PART 2 - PRODUCTS

2.1 SMALL STEEL PIPE

- A. Unless otherwise indicated, galvanized steel pipe and black steel pipe in sizes 6 inches in diameter and smaller shall conform to the requirements of ASTM A 53 or ASTM A 106, as called out in the piping schedule and shall be Schedule 40 or 80 as indicated. Galvanized steel pipe shall not be cement mortar lined unless otherwise indicated. Fittings for galvanized steel pipe shall be of galvanized malleable iron, with NPT or grooved ends. Black pipe may have welded joints, with standard or extra strong welding fittings, or fittings indicated.
1. Black steel pipe for chlorine pressure service shall conform to Chlorine Institute Pamphlet 6, ASTM A 106, Grade A or B, and shall be Schedule 80. Except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, and protective diaphragms for gauges and switches, all fittings shall be socket welded. Socket welded fittings shall conform to ASTM A 105 and ANSI B16.11, 3,000 pound, forged carbon steel. Bushings will not be allowed.
 2. Flanges for chlorine and sulfur dioxide service shall conform to ASTM A 105, ANSI B16.5, Class 300 and shall be 1/16-inch raised face.
 3. Unions for chlorine service shall be four-bolt tongue and groove, ammonia type, suitable for chlorine service. Unions shall have female thread and connection and matched tongue and groove flanges employing a lead gasket. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions.

Unions shall be rated for 500 lb CWP service pressure. Furnish reducing-type, straight-type or blind-type unions, as required for the installation. Blind unions shall be provided as cleanouts where shown. Provide a straight union adjacent to each threaded valve or piece of equipment.

4. Unions shall be as manufactured by Henry Valve Company; Vogt Valve Co.; or equal.
5. Gaskets for chlorine service flanges shall be 1/16-inch, high temperature compressed self-centering ring type conforming to ANSI B16.21.

2.2 STAINLESS STEEL PIPE

- A. Unless otherwise indicated, stainless steel pipe shall be Type 316 Schedule 40 threaded pipe conforming to ASTM A 312 with stainless steel threaded fittings, or with stainless steel welding fittings, where indicated. Lightweight stainless steel pipe shall be Type 316 Schedule 10 pipe conforming to ASTM A 312, with stainless steel welding fittings, or fittings as indicated.

2.3 RED BRASS PIPE

- A. Brass pipe shall conform to the requirements of ASTM B 43. Fittings shall be of bronze conforming to the requirements of ASTM B 62 with threaded ends, conforming to ANSI/ASME B16.15.

2.4 COPPER TUBING

- A. Copper tubing shall conform to the requirements of ASTM B 88 and shall be Type K, soft temper for buried tubing and hard-drawn for above-ground application. Fittings shall be soldered or sweated on and shall be of wrought copper conforming to ANSI B16.22. Soldered joints shall contain 95-percent tin and 5-percent antimony. No solders or fluxes containing more than 0.2 percent of lead shall be used.

2.5 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

- A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact Class 12454-B, Schedule 80, conforming to ASTM D 1785, unless otherwise indicated. Fittings shall be of the same material as the pipe. Unless otherwise indicated, joint design shall be for solvent-welded construction to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.

2.6 CPVC (CHLORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

- A. CPVC pipe, for hot, corrosive solutions and where indicated, shall be made from all new rigid unplasticized chlorinated polyvinyl chloride, Class 23447-B, and shall be Schedule 80 conforming to ASTM F 441, with solvent-welded fittings of the same material as the pipe. Joints shall be made to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.

2.7 PP (POLYPROPYLENE) PIPE

- A. PP pipe, for chemical drains and where indicated, shall be Type 1, Schedule 80 pipe conforming to ASTM D 4101, with drainage pattern fittings made of the same material, joined by the thermo-seal fusion process, or by threading, or flanging.

2.8 PE (POLYETHYLENE) TUBING

- A. Chemical Service:
 - 1. Polyethylene tubing, for all analyzers, turbidimeters, chemical conveyance, and testing apparatus shall be linear high density polyethylene tubing. All tubing shall have a minimum working pressure of 150 psi at 75 deg F.
- B. Potable Water Service
 - 1. Polyethylene tubing potable water service shall be multiple-layered, UV-protected, chlorine resistant cross-linked polyethylene. Tubing supplied shall have nominal CTS (copper tube size) outside diameter. The SDR rating shall be 9. The pressure rating of the tubing shall be 200 psi at 75 degrees. Potable water service tubing shall be Vanex Ultra Pex tubing or Engineer approved equal.

2.9 CAST IRON SOIL PIPE

- A. Cast iron soil pipe and fittings shall be made of gray cast iron, service weight, conforming to ASTM A 74, suitable for service in drainage, waste, vent, and sewer lines. The pipes and fittings shall have caulked lead bell and spigot joints, or hubless joints with stainless steel couplings over suitable elastomer sleeves.

2.10 CORROSION-RESISTANT CAST IRON SOIL PIPE

- A. Corrosion-resistant cast iron pipe and fittings shall be made of high-silicon cast iron conforming to ASTM A 518, service weight, suitable for chemical drains and vents. The pipes and fittings shall have caulked lead bell and spigot joints, or hubless joints with stainless steel couplings over suitable elastomer sleeves.

2.11 MONEL TUBING

- A. Monel Tubing shall be ASTM B-165 or equivalent seamless drawn monel with a minimum wall thickness of 0.049 inches. Fittings shall be Type 316 stainless steel doubled ferruled compression type. Attach tubing to aeration tank walls as indicated on the drawings with stainless steel clamps and anchors.

2.12 DRAIN TRAPS

- A. Drain traps shall be furnished and installed in accordance with the requirements of Section 40 05 00 - Piping, General.

2.13 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

- A. Mechanical-type couplings shall be furnished and installed in accordance with the requirements of Section 40 05 00 - Piping, General.

2.14 SLEEVE-TYPE COUPLINGS

- A. Sleeve-type couplings shall be furnished and installed in accordance with the requirements of Section 40 05 00 - Piping, General.

2.15 GASKETS AND BOLTS

- A. Except as otherwise indicated, gaskets for flanged joints shall be in accordance with the requirements of Section 40 05 00 - Piping, General.
- B. Except as otherwise indicated, bolts shall conform to the requirements of Section 05 50 00 - Metal Fabrications.

2.16 INSULATING CONNECTIONS

- A. General: Insulating bushings, unions, couplings or flanges, as appropriate, shall be used for joining pipes of dissimilar metals, and for piping systems where corrosion control and cathodic protection are involved, in accordance with the requirements of Section 40 05 00 - Piping, General.
- B. Material: Insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.17 PIPE SUPPORTS

- A. Pipe Supports, hangers, anchors, seismic restraints, and guides shall be in accordance with the requirements of Section 40 00 01 - Pipe Supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Small Steel Pipe: Buried galvanized or black steel pipe shall be coated as specified in Section 09 90 00 - Painting or provided with an extruded high density polyethylene coating with minimum thickness of 35 mils.
- B. Plastic Pipe: PVC, CPVC, and FRP pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise indicated. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. Obtain the services of the pipe manufacturer, to instruct the pipe fitters in the correct way of making solvent welded and threaded joints. Only clean, fresh primer and solvent shall be used at all times at the recommended temperatures.
- C. Drain Traps: Drain traps shall be installed at low points in air and gas lines or elsewhere where indicated. Liquid outlets shall be piped to the nearest floor drain or open sump.

- D. Couplings: Pipe couplings shall be installed in strict accordance with the manufacturer's printed recommendations, using the correct style coupling and gasket for any given application.
- E. Gaskets for Flanged Joints: Gaskets shall be in accordance with the requirements of Section 40 05 00 - Piping, General.
- F. Insulating Connections: All insulating connections shall be installed in accordance with manufacturer's printed instructions. Care shall be exercised to prevent damage to insulating fittings, while making up the joints.

3.2 CONTINUITY BONDS

- A. Where required by the Contract Documents, all metallic pipe joints, except field-welded joints and insulating joints, shall be continuity bonded in accordance with the requirements of Section 40 05 00 - Piping, General.

END OF SECTION

**SECTION 40 05 00
PIPING, GENERAL**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, seismic restraints, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.
- B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D 2000	Classification System for Rubber Products in Automotive Applications

1.3 CONTRACTOR SUBMITTALS

- A. Submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 01 33 20 – Contractor Submittals, and as indicated in the individual piping sections. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports and seismic restraints necessary to accommodate the equipment and valves provided in a complete and functional system.
- B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.
- C. Submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
- B. Tests: Except where otherwise indicated, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. Perform all tests at no additional cost to the Owner.
- C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.
- D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing Work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. Furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, furnish such assistance at no additional cost to the Owner.

1.6 MATERIAL DELIVERY, STORAGE, AND PROTECTION

- A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.7 CLEANUP

- A. After completion of the Work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All pipes, fittings, and appurtenances shall be furnished in accordance with the requirements of the applicable Sections of Divisions 2 and 15 and this Section.
- B. Miscellaneous Small Pipes: Miscellaneous small pipes and fittings shall be provided by the Contractor in accordance with the requirements of Section 40 00 03 - Mill Piping - Exposed and Buried and this Section.
- C. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 40 00 01 - Pipe Supports, and as indicated.
- D. Lining: All requirements pertaining to thickness, applications, and curing of pipe lining, are in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated.
- E. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. Pipes above ground or in structures shall be field-painted in accordance with Section 09 97 01 - Pipeline Coating.
- F. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection, or as indicated on the piping schedule.
- G. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided, if approved by the Engineer, in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping above and below ground within the property limits of pump stations, and similar installations. All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. The Contractor shall make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.

2.2 PIPE FLANGES

- A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.
- B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.
- C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.
- D. Flange Bolts: Contractor shall supply all bolts and nuts in conformance with Section 05 50 00 – Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.
- E. Insulating Flanges: Insulated flanges shall have bolt holes 1/4 inch diameter greater than the bolt diameter.
- F. Insulating Flange Sets: Insulating flange sets shall be provided by the Contractor where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inches or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. Insulating gaskets shall be full-face.
- G. Insulating Flange Manufacturers, or Equal
 1. JM Red Devil, Type E
 2. Maloney Pipeline Products Co., Houston
 3. PSI Products, Inc., Burbank, California.
- H. Flange Gaskets: Contractor shall provide flange gaskets for all pipe flanges. Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of asbestos-free aramid fiber base, with nitrile binder and nonstick coating, suitable for temperatures to 700 degrees F, a pH of 1 to 11, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the

entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

I. Flange Gasket Manufacturers, or Equal

1. John Crane, Style 2160.
2. Garlock, Style 3000.

2.3 THREADED INSULATING CONNECTIONS

- A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.
- B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other nonconductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

- A. Construction: Cast mechanical-type couplings shall be provided where shown. The couplings shall conform to the requirements of ANSI/AWWA C606. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. The Contractor shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation.
- B. Couplings for Steel Pipe, Manufacturers, or Equal
1. Victaulic Style 44 with Type D Heavy Duty Grooved Adaptor Ends.
- C. Ductile Iron Pipe Couplings, Manufacturers, or Equal
1. Gustin-Bacon.
 2. Victaulic Style 31 (flexible or rigid grooving).
 3. Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.
- D. Couplings for PVC Pipe, Manufacturers, or Equal
1. Gustin-Bacon.
 2. Victaulic Style 775.
 3. Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends. Grooved end couplings shall be used on PVC pipe only for Schedule 80 vent piping at the vaults. Grooved end couplings shall not be used for PVC C905 water pipe.

2.5 SLEEVE-TYPE COUPLINGS

- A. Construction: Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 unless otherwise indicated, and shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings. The middle ring shall be not less than 1/4 inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal Fabrications. Buried sleeve-type couplings shall be epoxy-coated at the factory.
- B. Pipe Preparation: The ends of the pipe, where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.
- C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer.
1. The rubber in the gasket shall meet the following specifications:
 - a. Color - Jet Black.
 - b. Surface - Nonblooming.
 - c. Durometer Hardness - 74 " 5.
 - d. Tensile Strength - 1,000 psi Minimum.
 - e. Elongation - 175 percent Minimum.
 2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.
- D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.
- E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.
- F. Manufacturers, or Equal
1. Dresser, Style 38.
 2. Ford Meter Box Co., Inc., Style FC1 or FC3.
 3. Smith-Blair, Style 411.

4. Baker, Series 200.

2.6 FLANGED END CONNECTORS

- A. Flanged coupling adapters, shall be in accordance with AWWA C219.
- B. Dismantling joints for connecting flanged pipe shall be AWWA C219 compliant. Provide studs and nuts to seal gasket separate and independent from tie-bar restraint system.
- C. All dismantling joints shall be the restrained type per AWWA M-11. Tie-bar restraint system shall conform to ASTM A193-B7 per AWWA M-11 and be designed to withstand the test pressure shown on the Drawings.
- D. All dismantling joints shall use standard flanges in accordance with AWWA C207. The thickness of the dismantling joint flanges shall be equal to or greater than the class of flange that is connected to as required by the test pressure as shown on the drawings. Buried flanges shall be wrapped with petroleum was tape per AWWA C217.
- E. Manufacturers, or Equal
 - 1. Smith-Blair, Style 972 or 975
 - 2. Baker, Series DJ

2.7 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown. The final material selection shall be approved by the manufacturer. Submit manufacturer's shop drawings and calculations.

2.8 EXPANSION JOINTS

- A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. Submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings.

2.9 PIPE THREADS

- A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1.

2.10 AIR AND GAS TRAPS

- A. Air and gas pipes shall be sloping to low points, provided with drip legs, shutoff valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.
- B. Manufacturers, or Equal
 - 1. Armstrong Machine Works.
 - 2. Spirax Sarco, Inc.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Divisions 31, 33 and 40. The lining manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints at screwed flanges shall be epoxy-coated, to assure continuous protection.
- B. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.
- C. Flanges shall be installed at least 6-inches from a wall. Fittings shall be installed with sufficient clearance for maintenance and removal and reinstallation.

END OF SECTION

SECTION 40 05 01
PIPING IDENTIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide identification for all exposed piping and valves, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards

ANSI A13.1 Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

- A. All submittals shall be in strict accordance with the requirements of Section 01 33 20 – Submittal Procedures.
- B. Submit samples of all types of identification devices to be used in the Work.
- C. Submit a list of suggested wording for all valve tags prior to fabrication.

PART 2 - PRODUCTS

2.1 IDENTIFICATION OF PIPING

- A. Identification of all exposed pipe shall be accomplished in accordance with the Owner's standard, and where no standard exists, in accordance with the following: by color-coding with bands and by lettering as specified in Part 3, herein, and in Section 09900 -Coatings and Painting. Color bands shall either be painted directly upon the pipe or shall be pressure-sensitive adhesive-backed vinyl cloth or plastic tape.
- B. Each pipe identification shall consist of two color-coded bands OR color-coded coating, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. All labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels or integral to the preprinted label.
- C. Letter sizes and colors for lettering, arrows, and background shall conform to ANSI A13.1.
- D. Preprinted identification devices shall be as manufactured by Marking Services Inc.; W.H. Brady Co.; Seton Nameplate Corp., or equal.

2.2 EXISTING IDENTIFICATION SYSTEMS

- A. In installations where existing piping identification systems have been established, continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves, and appurtenances to the level specified herein.

2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

- A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal or plastic tags as indicated.
- B. Metal tags shall be of type 304L or 316L stainless steel with embossed lettering. Plastic tags shall be of solid black plastic laminate with white embossed letters. All tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

PART 3 - EXECUTION

3.1 GENERAL

- A. All labels and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.

3.2 VALVE TAGS

- A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws or stainless steel wire.
- B. The wording on the valve tags shall describe the exact function of each valve, e.g., "HWR-BALANCING," "CLS THROTTLING", " PUMP SHUT-OFF," etc.
- C. Tags attached to valves must be placed in such a way that the operation of the valve is not hindered or jeopardized.

3.3 PIPE IDENTIFICATION

- A. Each pipe shall be identified at intervals of 20 feet, and at least one time in each room. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.
- B. Pipe identification shall consist of these elements, i.e., 2 color bands OR color coating as specified, a lettered label, and a directional label. If bands are used. The bands shall be arranged so that the lettered label and the directional arrow are placed between the 2 bands.

3.4 IDENTIFICATION SCHEDULE

- A. Application of identifying devices shall conform to the following color codes where no colors are indicated in the Owner's standard.

<u>Fluid Abbreviation</u>	<u>Function and Identification</u>	<u>Identification Color</u>
AV	Air Vent	
D	Drain	
HW	Domestic hot water	green
NG	Natural gas	yellow
PW	Potable water	blue
SA	Sample lines	blue
SPD	Sump pump discharge	green
TW	Tepid Water	green
UW	Utility Water	blue
V	Vent	

END OF SECTION

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**SECTION 40 05 50
MISCELLANEOUS VALVES**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 40 05 51 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 20.

PART 2 - PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

- A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.
- B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated. Provide specially designed Low Pressure Air Release Valve where working pressure is less than 20 psi. Valves shall include isolation valves as indicated on the drawings.
- C. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves. Provide specially designed Low Pressure Air Release Valve where working pressure is less than 20 psi. Valves shall include isolation valves as indicated on the drawings.
- D. Manufacturers, or Equal
 - 1. APCO (Valve and Primer Corporation)
 - 2. Crispin - Multiplex Manufacturing Company
 - 3. GA Industries
 - 4. Val-Matic (Valve and Manufacturing Corporation)

2.2 BACKFLOW PREVENTER VALVES

- A. General: Backflow preventers shall work on the reduced pressure principle. They shall consist of 2 spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.
- B. The number and sizes of backflow preventors required are given on the Contract Drawings.
- C. Manufacturers, or Equal
 - 1. Cla-Val Company
 - 2. Febco (CMB Industries)
 - 3. Hersey Products
 - 4. Watts, ACV
 - 5. Wilkins Regulator Division (Zurn Industries)

2.3 CORPORATION STOPS

- A. Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required. Note that corporation stops on special chemical diffuser ports shall be 316 stainless steel – unless indicated otherwise.
- B. Manufacturer, or Equal
 - 1. Ford Meter Box Company, Inc.
 - 2. James Jones Company (Watts, ACV)
 - 3. Mueller Company

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Backflow preventers shall be installed in utility water lines where required by applicable codes or regulations, and where indicated on Contract Drawings.
- B. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 40 05 51.
- C. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

END OF SECTION

**SECTION 40 05 51
VALVES, GENERAL**

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.
- C. Unit Responsibility: A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.
- D. Single Manufacturer: Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures
- B. Shop Drawings: Shop Drawings shall contain the following information:
 - 1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.
 - 2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.
 - 3. Cavitation limits for control valves.
 - 4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
 - 5. Data in accordance with Section 40 05 57 – Valve and Gate Actuators for electric motor-actuated valves.
 - 6. Complete wiring diagrams and control system schematics.
 - 7. Valve Labeling: A schedule of valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.
- C. Technical Manual: The Technical Manual shall contain the required information for each valve.
- D. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

- E. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. General: Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.
- B. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 40 05 57 - Valve and Gate Actuators.
- C. Protective Coating: The exterior surfaces of all valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 09 90 00 - Painting and Coating. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.
- D. Valve Labeling: Except when such requirement is waived by the construction manager in writing, a label shall be provided on shut-off valves and control valves except for hose bibs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 40 05 01 - Piping Identification Systems, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the construction manager.
- E. Valve Testing: As a minimum, unless otherwise indicated or recommended by the reference Standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:
 - 1. Hydrostatic Testing: Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valves rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.
 - 2. Seat Testing: Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

3. All valves 24 inches and larger shall be factory tested as complete assembled units including actuator and the tests shall be witnessed by the Engineer. The Contractor shall furnish notification to the Engineer a minimum of 4 weeks prior to testing. The Contractor shall submit all written factory testing results to the Engineer for review prior to shipment.
 4. Performance Testing: Valves shall be shop operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.
- F. Certification: Prior to shipment, the Contractor shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.
- G. Valve Marking: Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

- A. General: Materials shall be suitable for the intended application. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:
1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 2. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 3. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.
 4. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.
 5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
 6. PVC: Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.
 7. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.
 8. NSF Standard 14: Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

- A. Bodies: Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

- B. Valve End Connections: Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.
- C. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.
- D. Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Bronze valve stems shall conform to ASTM B 584, except that zinc content shall not exceed 16 percent.
- E. Stem Guides: Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.
- F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.
- G. Nuts and Bolts: Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 – Metal Fabrications.

2.4 VALVE ACCESSORIES

- A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

- A. The Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.6 MANUFACTURERS

- A. Manufacturer's Qualifications: Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. General: Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates

shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

- B. Access: Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.
- C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

END OF SECTION

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SECTION 40 05 57
VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.
- C. Unit Responsibility: The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.
- D. Single Manufacturer: Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.
- E. The requirements of Section 26 00 00 - Electrical General Provisions apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures and Section 40 05 51 - Valves, General.
- B. Shop Drawings: Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.
- C. Calculations: Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.
- D. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, butterfly valve manual actuators, and butterfly valve electric motor actuators under one cover and in accordance with the requirements of Section 01 33 20 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The Contractor shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques,

whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.

- B. Manufacturers: Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.
- C. Materials: Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.
- D. Actuator Mounting and Position Indicators: Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.
- E. Standard: Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Slide Gates.
- F. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 26 and instrumentation equipment indicated Division 40.
- G. Fasteners: Fasteners shall be in accordance with Section 05 50 00 – Metal Fabrications.
- H. Protective Coatings: Protective coatings shall be in accordance with Section 09 90 00 – Painting and Coating.

2.2 MANUAL ACTUATORS

- A. General: Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 30-inches in diameter and larger, and where so indicated, shall have worm gear actuators, hermetically-sealed water-tight and grease-packed. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.
- B. Buried Valves: Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required by the local

Utility Company or the Engineer. Wrench nuts shall comply with AWWA C 500 - Metal - Seated Gate Valves for Water Supply Service.

- C. Chain Actuator: Manually-activated valves with the stem located more than 7-feet above the floor or operating level shall be provided with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains provided by the valve manufacturer. The wheel and guide shall be of ductile iron, cast iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5-feet 6-inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.
- D. Floor Stands: Valve actuator floor stands shall be cast iron or fabricated steel pedestals. The centerline of the actuator shall be approximately 42 to 48 inches above the base of the pedestal.
- E. Floor Boxes: Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.
- F. Tee Wrenches: Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground, shall fit the operating nuts.
- G. Manual Worm Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. The worm gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof. Manual worm gear actuators shall be Limitorque HBC Series, no "Or-Equals".
- H. Traveling-Nut Actuator: The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of nipples. Gearing shall be designed for a 100 percent overload.
- I. Schedule for Manual Actuator Types: For a complete schedule of manual actuators required on project valves (4" diameter and larger), see Contract Drawing M-01.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adapter piece.
2. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. The spur or helical gears shall be of hardened alloy steel, and the worm gear shall be alloy bronze. Gearing shall be accurately cut with hobbing machines. Power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.
3. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
4. Switches
 - a. Switches: Limit switches shall be furnished to sense valve position at each end of travel. Limit switch adjustment shall not be altered by manual operation. One set of normally open and one set of normally closed contacts will be furnished at each end of travel. Contacts shall be of silver and capable of reliably switching the source power from the control system as shown on the drawings. A torque sensor shall be furnished. The torque limit may be adjusted from 40 to 100 percent of rating in 1 percent increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a "jammed valve" protection feature with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs. Valve actuators with limit switches shall be as manufactured by Limitorque or Rotork.
 - b. The actuator shall be wired in accordance with the schematic diagram. Wiring for external connections shall be connected to marked terminals. Two conduit connections shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Switches shall not be subject to breakage or slippages due to over-travel. Limit switches shall be of the heavy-duty open contact type with rotary wiping action.
5. Handwheel Operation: A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb.ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel. A clutch lever shall be provided to put actuator into handwheel operation. Valves with electric motor actuators having stems more than 7-feet above the floor shall be provided with chain activator handwheels. The clutch

lever shall be provided with a cable secured to the chain to allow disengagement for manual operation.

6. Motor: The motor shall be of the totally enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480 volt, 3-phase 60 Hz current (unless noted otherwise on Drawing M-01) and have Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. Bearings shall be of the ball type, and thrust bearings shall be provided where necessary. Bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. Two Class B thermal contacts or solid state thermistors imbedded within the motor windings shall be provided to protect against over-temperature damage. The motor shall be provided with a space heater suitable for operation on 120 volt, single phase, 60 Hz circuit unless the entire actuator is a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion. Each electric motor actuator shall be provided with a local disconnect switch or circuit breaker to isolate power from the motor and controller during maintenance activities.
7. Cycle time: Size open-close/throttling service valve motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes unless otherwise indicated elsewhere in the specifications.
8. Schedule for Electric AC Actuator Type: For a complete schedule of electric actuators required on project valves (4" diameter and larger), see Contract Drawing M-01.
9. Remote Actuator Control Station. Valves with electric motor actuators where the valve is located in the lowest level of a multi-level vault with a mezzanine, shall provide a remote actuator control station at the mezzanine level. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications. The actuator controls shall be handrail-mounted above the valve at a location approved by the Design Engineer.
10. All electric motor actuators shall be configured for Modbus TCP/IP communication protocol.

B. Electric Motor Actuators (AC Reversing (Open / Close) Control Type)

1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open / stop / close and local/off/remote selector switches on the actuator local control station.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station

may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at mezzanine elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.

3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 480 volt, 3-phase, 60 Hz current (unless otherwise noted on Drawing M-01). A control power transformer shall be included to provide a 120 volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120 volt ac, single phase, 60 Hz space heater to prevent moisture condensation on electrical components. A local power disconnect switch shall be provided with each actuator. A close-coupled, padlockable switch shall be provided with each actuator.
4. Local Control Station: Each actuator shall be provided with a local control station with the valve actuator assembly. The station shall include open, close, and stop push buttons, and a local/remote selector switch.
5. Manufacturers:
 - a. Rotork, IQ with worm gear, or IQT as appropriate for valve size.
 - b. Limitorque, MX with PT worm gear, or QX as appropriate for valve size.
 - c. No "Or-Equals" allowed.

C. Electric Motor Actuators (AC Modulating Control Type)

1. General: Where indicated, modulating electric motor actuators shall be the ac modulating type complete with a local control station with power disconnect switch or circuit breaker, provided with open/stop/close and local/off/remote selector switches on the actuator local control station, and open/close status lights.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at mezzanine elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Control Module: The control module shall be of the electronic solid-state ac type with control outputs for positioning the valve via 4 - 20 ma input signals.
4. Starter: The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications. Power supply shall be 480 volt, 3 phase, 60 Hz. A disconnect switch shall be included with each actuator.
5. Construction: The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and pushbutton calibration elements for field setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 - 20 ma. As an alternative to the construction

requirement, the motor shall be capable of modulating at a rate of 600 starts per hour at the 50 percent to 85 percent travel range of the valve. The system shall allow control of the open, close, or percent open function when the local/off/remote switch is in the remote position. Each actuator shall have a frequency shut down system which when pre-programmed, shall function as directed upon receipt of an ESD signal.

6. Manufacturers:
 - a. Rotork, IQ with worm gear, or IQT as appropriate for valve size.
 - b. Limitorque, MX with PT worm gear, or QX as appropriate for valve size.
 - c. No "Or-Equals" allowed.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

- A. Field Adjustments: Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

- A. Valve and gate actuators and accessories shall be installed in accordance with Section 40 05 51 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.
- B. Inspection, Startup, and Field Adjustment: An authorized representative of the manufacturer shall visit the Site and witness the following:
 1. Installation of the equipment for not less than one (1) Work Day.
 2. Inspection, checking, and adjusting the equipment for not less one (1) Work Day.
 3. Startup and field-testing for proper operation for not less than one (1) Work Day.
- C. Instruction of Owner's Personnel: The authorized service representative shall visit the Site for not less than 1 Day to instruct the Owner's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

END OF SECTION

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SECTION 40 05 61 GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide gate valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 40 05 51 - Valves, General apply to this Section.
- C. The requirements of Section 40 05 57 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures and 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Buried valves shall be of the inside screw, non-rising stem type. The valve actuators shall be as indicated, with counter-clockwise opening stems, in accordance with Section 40 05 57.
- B. Gate valves 18-inches and larger shall be provided with a bypass line and isolation valve.

2.2 RESILIENT-SEATED GATE VALVES

- A. General: Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the Engineer.
- B. Construction: Resilient-seated gate valves shall conform to AWWA C509 - Resilient-Seated Gate Valves for Water and Sewerage Systems. The valves shall be suitable for a minimum design working water pressure of 150 psig, with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber-coated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 1 of AWWA C509. The stem, stem nuts, glands, and bushings shall be bronze, with the stem seal per AWWA C509.
- C. Pressure Ratings:
 - 1. AWWA C509 valves that are 3, 4, 6, 8, and 12 inches in size shall be rated for 200 psig minimum design working water pressure, and 16-, 20-, 24-, and 30-inch valves shall be rated for 150 psig minimum design working water pressure.
- D. Protective Coating: Valves shall be factory coated in accordance with Section 09 90 00 – Coatings and Painting. The Contractor shall submit a test report from a coating inspector that

the coating is holiday-free. The Contractor shall be aware that it may retain the services of a third party coating applicator to achieve the holiday-free requirement.

- E. Actuators: Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 40 05 57.
- F. Manufacturers, or Equal
 - 1. American Flow Control
 - 2. Clow Valve Company
 - 3. Mueller Company
 - 4. M & H Valve Company.

PART 3 - EXECUTION

3.1 GENERAL

- A. Gate valves shall be installed in accordance with the provisions of Section 40 05 51. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 40 05 63
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 40 05 51 - Valves, General apply to this Section.
- C. The requirements of Section 40 05 57 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 METAL BALL VALVES (3-INCHES AND SMALLER)

- A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 40 05 57 - Valve and Gate Actuators.
- B. Metal ball valves for submerged service (reservoir washdown) shall be Type 316 SST.
- C. Body: Ball valves up to and including 1.5-inches in size shall have bronze or stainless steel 2 or 3 piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 3-inches in size shall have bronze or stainless steel 2 or 3 piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.
- D. Balls: The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings. Reservoir washdown valves shall have full port openings.
- E. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.
- F. Seats: The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.
- G. Manufacturers, or Equal
 - 1. Conbraco Industries, Inc. (Apollo)
 - 2. ITT Engineered Valves
 - 3. Neles-Jamesbury, Inc.
 - 4. Watts Regulator
 - 5. Worchester Controls

2.2 PLASTIC BALL VALVES (1.5-INCHES AND SMALLER)

- A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific fluid application. Valves shall have manual actuators in accordance with Section 40 05 57 - Valve and Gate Actuators, unless otherwise indicated.
- B. Construction: Plastic ball valves shall have true-union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges for easy removal. The balls shall have full size ports and teflon seats. Body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements of [Section 11258]. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. Ball valves for sodium hypochlorite solution service shall be drilled through the ball or body per valve manufacturer recommendation to relieve offgas and equalize pressure across the valve. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.
- C. Manufacturers, or Equal
 - 1. ASAHI-America
 - 2. George Fischer, Inc.
 - 3. NIBCO Inc., (Chemtrol)
 - 4. Plast-O-Matic Valves, Inc.
 - 5. Spears Mfg. Co.
 - 6. Watts Regulator

PART 3 - EXECUTION

3.1 GENERAL

- A. Valves shall be installed in accordance with Section 40 05 51. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

**SECTION 40 05 64
BUTTERFLY VALVES**

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 40 05 51 - Valves, General apply to this Section.
- C. The requirements of Section 40 05 57 - Valve Actuators apply to this Section.
- D. Valves shall be of the body type, pressure class, end joint, and actuator type as indicated on the valve schedules on Contract Drawing M-01.

1.2 QUALIFICATION REQUIREMENTS

- A. The valve manufacturer shall have manufactured waterworks double eccentric butterfly valve for at least 10 years. At the Owner's request, submit at least 10 of the manufacturer's butterfly valves installation of comparable size and complexity to units indicated in this Section or a project similar in size and technical requirements.
- B. The list shall include the following information:
 - 1. Name of facility, owner of facility, contract name, addresses and telephone number.
 - 2. Pressure class.
 - 3. Model number and size.
 - 4. Name, location and contact information of local representative.
- C. Published manufacturers literature showing the valve is intended for sale into the water market and typical application of the project. Only valves specifically designed for high velocity and continuous pressurized waterworks applications will be accepted. General service or industrial valves will not be accepted.
- D. Butterfly Valves shall have undergone FEA (Finite Element Analysis) to verify structural stress and deformation analysis as well as dynamic modal analysis and transient dynamic response. On more complicated and larger size applications, the owner reserves the right to review the manufacturers computational design output. Where a critical threshold headloss is communicated and required, CFD modeling shall be available.
- E. The manufacturer shall demonstrate structured compliance to a repeatable build design and shall be ISO 9000 certified.
- F. Valve manufacturer shall demonstrate a commitment to continuous improvement and quality control of their products. As such they shall have an "in use" and working in-house R&D lab. Valve testing shall be suitable for water hydraulic tests for sizes to a minimum of 12 inches. Photo documentation may be required.

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 40 05 51.
- B. Shop Drawings
 - 1. Complete Shop Drawings of butterfly valves and actuators.
 - 2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.
 - 3. Certification of proof-of-design test from the valve manufacturer.
 - 4. Certification: The Contractor shall obtain written certification from the butterfly valve manufacturer, addressed to the Owner, stating that the butterfly valves and the valve operators will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all butterfly valves and valve operators, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The Contractor shall submit all such certificates to the construction manager.
 - 5. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, manual operators, and electric motor valve operators under one cover and in accordance with the requirements of Section 01 33 20 – Submittal Procedures.
 - 6. Valve Labeling: The Contractor shall submit a schedule of butterfly valves to be labeled indicating in each case the valve location and the proposed wording for the label.
 - 7. Field Procedures: Written instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to delivery of the butterfly valves and valve operators.

1.4 QUALITY ASSURANCE

- A. FACTORY TESTS
 - 1. General: Inspection shall be made and tests performed at the manufacturer's facilities on the valves listed in this Subsection.
 - a. Submit test reports to the ENGINEER. Test reports shall include all factory and field required tests showing each valve is in conformance.
 - b. Notice of each type of valve test shall be given to the ENGINEER no later than 14 days prior to the scheduled tests.
 - 2. The CONTRACTOR shall perform factory tests in the following sequence with valve and actuator completely assembled as a unit.
 - a. Valve Body Hydrostatic Test: The test shall be performed with the valve positioned vertically as if installed in a horizontal pipeline, with both flanged ends bulkheaded and the disc in a slightly open position. Apply internal hydrostatic pressure twice the pressure rating of the valve to the inside of the valve. With the disc in the slightly open position and both flanges bulkheaded, water shall be allowed to enter and completely fill the cavity between both flanged ends; then compressed air or high-pressure water shall be applied through one of the bulkheads into the cavity supplying up to and maintaining the test pressure for a 5 minute test duration. During the hydrostatic test, there shall be no leakage through any portion of the valve, the metal, end

- flange joints or the valve shaft seal, and there shall be no permanent deformation of any valve component.
- b. Valve Shutoff Leak Test: All valves shall initially be tested per section 5.2 of ANSI/AWWA C504. Unless otherwise noted, all valves will be leak tested in both flow directions. A secondary test shall be performed with the valve positioned as if installed in a horizontal pipeline, and with one flanged end bulkheaded and the disc in the fully closed position. The test for valves shall be performed at a differential pressure equal to the pressure rating of the valve with the body flanges in a vertical plane and one end flange bulkheaded. The test shall be the same for valves larger than 72", except the differential pressure shall be equal to 100% of the design pressure. With the disc in the closed position, water shall be allowed to enter and completely fill the cavity between the disc and bulkheaded flange, and then compressed air or high-pressure water applied through the bulkheaded flange into the cavity, supplying up to and maintaining the test pressure for a 5-minute test duration. The entire surface of the valve disc shall be visible. There shall be no indication of any water or air leaks during the test period. Unless specifically noted, this test shall be performed in both flow directions.
 - c. Valve Actuator and Operations Test: Manually Actuated Valves: The torque required on the AWWA nut to unseat the valve under a differential pressure of 150 psi shall be recorded. Recording may be performed at the completion of the valve shutoff leak test by using a torque wrench on the AWWA nut before the pressure is released. The valve completely assembled with the actuator shall be manually operated two complete cycles, from the fully open to the fully closed position, under a no-flow condition to show smooth operation. At the end of the first cycle, 300 foot-pounds of input torque shall be applied to the AWWA nut for 15 seconds at both fully open and fully closed positions. No signs of permanent deformation or binding shall be evident. The valve shall be completely cycled a second time after the torque test. Over the full travel of the actuator, during all cycles, there shall be no sign of binding, scraping, misalignment of parts, permanent deformation, or other defects. Actuator stops shall be adjusted so that the valve disc will travel 90 degrees, plus or minus one-half degree, from the closed position to the fully open position and shall be 90 degrees, plus or minus one-half degree, to the flange face when fully open.
- 3. Protective Coating Testing: All valves 48 inch and larger shall be tested for coating thickness and porosity. Porosity shall be tested using the high voltage spark method. Test shall be taken at all locations with critical focus around seat and seal. Coating thickness measurements at raised cast lettering may be visual. Results and validation shall be signed and dated.

B. FIELD TESTS

- 1. Field Tests: An authorized service representative of the manufacturer shall visit the site for a minimum of one service day for each two valves which are electrically, pneumatically or hydraulically actuated. They shall sign and certify in writing that the equipment and controls have been properly installed, tested and readied for operation. Performance tests shall be made on all completely installed valves as follows:
 - a. Butterfly Valves, 16-Inch and larger:

- 1) Each valve shall be operated 3 times from fully closed to fully opened position, and the reverse, under a no-flow condition.
- 2) Valves shall be hydrostatically tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage. Repair any joints that show signs of leakage prior to final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test, they shall be properly protected. Repair any damage caused by the testing.
- 3) If possible a leak test will be conducted to verify that bubble tight shut-off has been achieved in both flow directions with operating pressure on one side of the disc and atmospheric pressure on the other. The owner reserves the right to field verify that valve leakage is zero.
- 4) Failure by the Owner to inspect or witness tests at the manufacturer's plant shall not be construed as waiving inspection upon delivery.

PART 2 - PRODUCTS

2.1 BUTTERFLY VALVES 4-INCH AND LARGER – CLASS 150B AND 250B

- A. General: The butterfly valve shall be designed expressly for waterworks applications and shall be of the double or triple offset design whereby the elastomeric seal is not compressed with the valve in the open position. Zero and single offset butterfly valve designs are not acceptable. Butterfly valves for water working pressures up to 150 psi shall conform to ANSI/AWWA C504 Class 150B (including lay-lengths) except that the valves rated working pressure shall be 250 psi excluding safety factors. Butterfly valves for water working pressures greater than 250 psi shall conform to the design requirements of ANSI/AWWA C-504, Class 250B but shall have a minimum of 350 psi working pressure and shall be subject to the following requirements. Valves shall be of the size and class indicated in the valve schedule or in the plans. All valves unless noted otherwise, shall be sized for bi-directional water service, full rated pressure and a line velocity of 16 feet per second and suitable for higher linebreak velocities of 50 fps. Lifting lugs will be provided for all valves 24" and larger.
- B. Flanges: Class 150B flanged valves shall have ANSI B16.1 Class 125 pound flanges. Class 250B flanged valves shall comply with ANSI B16.1 Class 250 up through 48-inch unless otherwise noted or if mating to ductile iron pipe. Above 48-inch, flange outside diameter, number of bolts, diameter of bolt circle, and diameter of bolts shall comply with ANSI/AWWA C 207 Class E and the flange thickness shall be designed in accordance with ASME Section VIII, flange design requirements.
- C. Body: Valve bodies shall be ductile iron, ASTM A536 65-45-12 or A536 60-40-18. Cast gray iron is not allowed due to near zero elongation and as it vulnerable to shear stress. The valve body shall include integrally cast support feet top and bottom. It shall be mechanically equipped with a fastened stainless steel stamped or engraved tag indicating manufacturer and reference build data. Valves 54 inch and larger shall include two tags diametrically opposed. The valve build data shall be made available upon request by the customer and shall be retained by the manufacturer for no less than 70 years unless noted longer. The entire

valve body and flanges shall be epoxy corrosion coat protected except for the valve shaft bores.

- D. Disc: The disc shall be ductile iron ASTM A536 65-45-12 or ASTM A536 60-40-18. The entire disc and all its wetted surfaces shall be coated without exception. The disc's elastomeric seal retainer shall be 304 or 316 stainless steel. Neither bronze nor carbon steel is acceptable. Both the disc and elastomeric seal retainer shall have recesses designed to retain a dual shouldered seal under extreme localized velocities, at full differential opening and/or linebreak closing. The disc shall be mechanically fastened to the valve shaft using tangential stainless steel shaft pins of type 316 or higher alloy. Disc pins shall extend completely through the valve and shall be mechanically fastened. The disc shall be completely coated except for the disc shaft bores.
- E. Shaft: Valve shafts shall be dual stub shafts of stainless steel ASTM A276 Type 316 or 420. The valve shaft material and thickness shall be suitable for the applications pressure and velocity without the use of its safety factors. Shafts may not be turned down to fit drive splines without accompanying torsional strength reduction calculations and its effect on the safety factor.
- F. Elastomeric Seal and Seal Ring: Valve seals shall be EPDM, secured to a completely coated valve disc by a 316 stainless steel, continuous non-segmented seal ring and secured by 316 stainless steel fasteners. The seal shall not scallop, cold flow or tear at localized velocities less than 300 fps. The elastomeric seal shall not be penetrated by fasteners. The valve shall be bi-directionally leak free. The elastomeric seal shall be double shouldered and extend no greater than 0.25 inches past the disc edge to seat the valve. The seal shall be designed to flex in either flow direction. There shall be a small gap on both sides of seal which will allow for pipeline pressurized media to further expand the seal against the metallic seat- the higher the differential pressure or velocity. The elastomeric seal shall be field replaceable and adjustable in line. It shall not require special skills or tools to replace the seat. With access to the seat retaining bolts, the seat removal, replacement and readiness for service must be able to be accomplished in a maximum of 3 hours for all size valves. Seat methods which do not comply or use either irreplaceable vulcanized seals or which use hardened epoxy or grout in a dovetailed groove are not acceptable.
- G. Metallic Seat: The metallic valve seat shall be located in the valve body. It shall be a highly wear resistant stainless steel alloy. There shall be no gap between the valve body and metallic body seat and consequently no potential for corrosion or lifting of the seat. The seat shall be applied through a high alloy weld overlay process. Metallic seats shall not be mechanically retained by fasteners.
- H. Shaft Seals: Shaft seals shall not need periodic manual adjustment. They shall be multi-oring seals protecting both the OD and ID of the shaft bearings. They shall prevent pressurized system water from entering the uncoated valve disc hub and valve body shaft bore. The valve shaft shall remain non-wetted and unpressurized. The non-wetted shaft shall allow the actuator to be removed without dewatering the pipeline. It shall prevent debris and system pressurized water from entering into the uncoated valve body shaft bore. It shall prevent waters or contaminated media, external to the valve, from entering through the valve shaft under vacuum/ negative pressure conditions in the pipeline such as at line break. It shall additionally prevent an ingress breach where external hydrostatic forces exceed pipeline

pressures such as in dewatered pipelines. Neither manual pulldown packing glands nor braided packing are allowed. The outer shaft seals shall be a replaceable cartridge type, bolted to the valve body. Packing shall not be held in place with an adapter plate or by the valve actuator.

- I. Shaft Bearings: Valve shaft bearings shall be corrosion resistant, self-lubricating sleeve type made of bronze, stainless steel or stainless steel backed PTFE. Bearing choice and consequent bearing friction shall be correctly added to valve input torque requirements.
- J. Strength: The proportion and dimensions of all parts of the valve and actuator shall be designed to withstand, without failure, the stresses occurring under the testing and operating conditions. The maximum allowable stress in any material shall not exceed 1/5 of the ultimate tensile strength or 1/3 of the minimum yield strength. Class 150B valves shall be rated to and shall receive a pressure test of 250 psi and Class 250B valves shall be rated to and shall receive a pressure test of 350 psi applied to one side of the disc with zero pressure applied to the other side of the disc while in the closed position, without damage or permanent deformation to any part of the valve, seat, disc or shaft. The valve shall be capable of withstanding such pressures in both directions.
- K. Safety Disc Pinning: Where noted herein, where noted on the plans or in the bid documents, an integrated safety locking device shall be incorporated. The valve shall have an externally lockable disc in the closed position. Calculations shall be provided to verify that the disc cannot rotate even with the full stall output torque of the actuator. The disc shall remain in the zero leak sealed closed position even if the entire actuator is removed for safety or maintenance. With the actuator and or the adapter plate removed, the valve will not leak through the stem. The locking device shall be handwheel operated; stainless steel wetted construction, pad lockable and suitable for lockout/tag out safety procedures.
- L. Manual Actuators: Actuators shall conform to Section 40 05 57 - Valve and Gate Actuators and to ANSI/AWWA C 540, subject to the following requirements. All actuators shall be self-locking and shall hold the valve disc in the closed, open and any intermediate position without creeping or fluttering. All actuators shall incorporate a mechanical stop-limiting device to prevent over travel of the disc. Unless direct buried or otherwise indicated, all manually actuated butterfly valves shall be equipped with a handwheel and external position indicator. The number of turns for direct buried valves shall be a minimum of 1.4 times the nominal valve size with no fewer than 25 turns. The valve manufacturer shall be responsible for mounting and testing the actuator. Screw-type (traveling nut) actuators are not permitted due to their inconsistent output torques through the 90 degree stroke. All manual direct buried service actuators shall be designed for a 300 foot-pound input torque against the closed and open travel stops. The owner reserves the right to field verify.
- M. Worm-Gear Actuators: All valves including submerged and buried valves, shall be equipped with top tier AWWA worm-gear actuators (per Section 40 05 57 – Valve and Gate Actuators), lubricated and sealed to prevent entry of dirt or water into the housing. Buried service valves shall be 90% or greater, grease packed. Submerged service valves in potable water applications shall be 100% grease filled with FDA approved food grade grease. Documentation for the selected grease for submerged service valves shall accompany submittals. The owner reserves the right to field verify grease levels. Non-complying gears shall be remedied by the factory, verified by the customer and signed off by both parties.

Gears are recommended to be Limitorque or Rotork and are required to be of an equal or better quality. No-name or unbranded actuators will not be accepted.

- N. Hardware: All fasteners and hardware shall be Type 316 Stainless Steel.
- O. Paint and coatings: The manufacturer is required to have and follow a system of valve preparation and coating which assures a quality holiday free application and which maximizes the available multi-decade protection the coating offers. Manufacturers that do not properly prepare or coat their valves properly will not be accepted.

The manufacturer must provide their written system of valve preparation and coating. This document shall include the methodologies used (quality compliance) as well as post application review (quality assurance). It will be based on a professional system of coating and grading such as NACE, SSPC, GSK, ISO or DIN and will include both text and color photo-documentation. The manufacturers coating system must be documented as well as implemented with a quality assurance program to prevent unacceptable deviation. This coating system shall be submitted for approval. It shall be titled, signed and dated by the manufacturers Coating Department Head, its' Compliance Officer or an equal ranking staff.

- 1. Valves 90-inch and smaller (open-close): All external and internal surfaces except for the seating surface shall be 400 degree F plus, heat bonded fusion coated. Coating damaged in shipping or installation shall be noted and properly repaired to the satisfaction of the utility or its authorized agent.
 - 2. Valves 90-inch and smaller (modulating): All external surfaces except for the seating surface shall be 400 degree F plus, heat bonded fusion coated. All internal surfaces shall be rubber lined. Coatings and linings damaged in shipping or installation shall be noted and properly repaired to the satisfaction of the utility or its authorized agent
 - 3. Valve coating shall be white or blue. Red Oxide or any near color to rust shall not be acceptable.
- P. Manufacturers, or Equal
 - 1. VAG Armaturen, EKN Double Offset.
 - 2. Tyco Keystone RMI Dubex Triple Offset.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All exposed butterfly valves shall be installed in a manner whereby the complete valve can be removed without dismantling the valve or operator. The installation shall be in accordance with Section 40 05 51- Valves General.
- B. Contractor shall use the provided lifting lugs to move all project valves. The use of chains, lifting straps, rope or any type other strapping through the valve body is strictly prohibited. Correct lifting procedures shall be the Contractor's responsibility. As necessary, consultation with the valve manufacturer is recommended. The contractor shall be responsible for all damage and project delays resulting from improper lifting and moving procedures, these shall include but shall not be limited to: pulling the valve body out of round, gouges, scratches, displacing the gear box etc.

- C. Butterfly valves 54-inch and larger must be inspected and certified by the manufacturer that the final installation meets all the manufacturers requirements, and that the actuator and disk have not changed positions from that as successfully tested at the factory.
- D. Strict care shall be taken to assure valves are not installed under stress. In no instance shall adjacent mating flanges be forced into position. A progressive and proper star cross pattern shall be used to tighten valve flange mating bolts.

END OF SECTION

**SECTION 40 71 13
FLOW-MAGNETIC**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Instruments for instrumentation and control systems that are to be permanently installed.
- B. Related Sections
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

- A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. Instrumentation Systems and Automation Society.
 - 4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Furnish all instruments as identified on the P&IDs, instrument lists, Drawings, and instrument data sheets.
- B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.
- C. Calibration of instruments shall be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

- A. Furnish complete submittals in accordance with Section 01 33 20.
- B. Product Data:
 - 1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
 - 2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.
- C. Shop Drawings:
1. Mechanical connection diagrams.
 2. Sensor transducer mounting requirements with dimensions and elevations.
 3. Electrical connection diagrams.
- D. Test Reports:
1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
- E. Operating Manuals:
1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
 2. Complete installation, calibration, and testing manuals.
- F. Record Drawings:
1. Complete field calibration sheets, including range, span, PLC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

- A. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 ma loop accuracy.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

- A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

- A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

- A. Provide a spare pipe spool for each meter size to be used in the event the meter tube must be removed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As identified on the instrument data sheets and Drawings.
- B. Hardware Commonality:
 - 1. All instruments, which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, shall be furnished by a single Manufacturer.
 - 2. All panel-mounted instruments shall have matching style and general appearance.
 - 3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 MANUFACTURED UNITS

- A. Flow Meters:
 - 1. Magnetic Flow Meters.
 - a. General:
 - 1) Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC pulsed linear signal which is directly proportional to the liquid flow rate.
 - 2) Complete zero stability shall be an inherent characteristic of the flowmeter system.
 - 3) Each magnetic flow metering system shall include:
 - a) A metering tube.
 - b) Signal cable.
 - c) Transmitter.
 - d) Flow meter grounding rings.
 - b. Source quality control.
 - 1) Shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
 - c. Metering tube:
 - 1) Constructed of carbon steel, with ANSI Class 150 carbon steel flanged connections, fusion bonded epoxy coating. Liner shall be polyurethane.
 - 2) Utilize a minimum of 2 bullet-nosed, 316 Ti Stainless Steel, self-cleaning electrodes.
 - 3) Liner in conformance with:
 - a) As identified on the instrument data sheet.
 - b) Manufacturer's recommendations for the intended service.
 - c) Whichever is the more stringent.
 - 4) Electrodes in conformance with:
 - a) As identified on the instrument data sheet.
 - b) Manufacturer's recommendations for the intended service.
 - c) Whichever is the more stringent.
 - 5) Meter housing NEMA 6 (submersible).
 - 6) Meter coating consisting of epoxy painted finish.

- 7) Two grounding rings:
 - a) Which are in conformance with the Manufacturer's bore and material recommendation for the meter's intended service.
 - b) Designed to protect and shield from abrasion the liner's edge interface at the meter's end.
- d. Transmitter.
 - 1) Microprocessor-based signal converter/transmitter.
 - 2) Utilize DC pulse technique to drive flux-producing coils.
 - 3) Contain a 6 digit display for flow rate, percent of span, and totalizer.
 - 4) Operator interface consisting of keypads which respond to English text entry.
 - 5) Integral zero return to provide a consistent zero output signal in response to an external dry contact closure.
 - 6) Integral low flow cut-off zero return.
 - 7) Automatic range change.
 - 8) Programmable parameters including:
 - a) Meter size.
 - b) Full scale flow rate.
 - c) Magnetic field frequency.
 - d) Time constant.
 - 9) Data retention for a minimum of 5 years without auxiliary main or battery power.
 - 10) Self diagnostics and automatic data checking.
 - 11) Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
 - 12) Ambient operating temperature limits of -29 to 60 °C (-20 to 140 °F).
 - 13) Transmitter shall be configured for Modbus TCP/IP communications protocol.
- e. Performance requirements:
 - 1) Time constant:
 - a) 0.5 to 1,000 seconds.
 - 2) Accuracy:
 - a) 0.25 percent of flow rate from 10 to 100 percent of full scale for velocities over 3 ft per second.
 - 3) Repeatability:
 - a) 0.25 percent of full scale.
 - 4) Isolation:
 - a) Galvanic or.
 - b) Optical.
 - 5) Power supply:
 - a) 120 VAC ± 10%.
 - b) 60 Hz.
 - c) 30 Watts Max.
 - 6) Output/Input signal:
 - a) Output signal: Measured range – Current 0/4 to 20 mA;
 - b) Modbus RS485
 - 7) Submersible rating. All meters in vaults and below ground installations shall have IP68 submersion rating.
 - 8) Remote readout.

- f. Factory testing:
 - 1) Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the Nation Institute of Testing Standards.
 - 2) The calibration procedure shall conform to the requirements of MIL-STD-45662A.
 - 3) A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 20%, 40%, 60%, 80% and 100% of the calibrated range shall be submitted to the Engineer at least thirty (30) days prior to shipment of the meters to the project site.
- g. Manufacturer:
 - 1) Endress & Hauser Promag 53W.

2.3 SOURCE QUALITY CONTROL

- A. All instruments and/or representative instruments shall be calibrated in facilities and with instruments traceable to the National Bureau of Standards.
 - 1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, flowrates, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

- A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances. Weldolets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

- A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
 - 1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
 - 2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

- A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

- A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

- A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

- A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.
- B. All instrument calibration shall be witnessed by the Owner's Representative.
- C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC control system and associated registers.

3.8 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
- B. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

- A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.
- B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.05 of this section.
 - 1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

**SECTION 40 71 15
FLOW-ULTRASONIC**

PART 1 - GENERAL

1.1 SUMMARY

- A. General: The Contractor shall furnish all labor, equipment, materials, tools, supplies, and appurtenances required to furnish and install ultrasonic flow meters at each location shown in the drawings, in accordance with these specifications. The flow meter shall measure flow in the aqueduct and shall display and output individual flow rate for the aqueduct. The method used for velocity measurement shall be the acoustic transit-time method, which measures velocity by transmitting acoustic pulses between pairs of transducers mounted in the aqueduct walls. Flowmeters with limited upstream and downstream conditions (10 diameters straight run upstream and 2 diameters straight run downstream of meter centerline) shall be of the 8-path ultrasonic transit-time type with wetted transducers and parallel path placement.
- B. The flow meter manufacturer shall have a minimum of ten years experience manufacturing and installing flow meters of the multiple-parallel-path type specified. The flow meter manufacturer shall have conducted tests at an independent laboratory, using a multiple-parallel-path flow meter, which verifies the accuracy of the proposed flow meter. The report shall bear the signature of an authorized representative of the laboratory.
- C. The manufacturer shall also, upon request, provide a list of users which satisfactorily demonstrates the manufacturer's experience with the type of flow meter specified.
- D. All correspondence referring to this equipment shall include the tag number and name.

<u>Tag No.</u>	<u>Equipment Name</u>
FWR-FE/FIT-130	90" Ultrasonic Flow Meter

- E. Each ultrasonic flow meter will be installed in new welded steel pipe. Each meter will be located within new vaults to be constructed as part of the Terminal Reservoir Replacement Project. The ultrasonic flow meters shall be in general accordance with the following drawings:

<u>Drawing No.</u>	<u>Description</u>
M-02	FWR Inlet Valve Vault Plan
M-03	FWR Inlet Valve Vault Section

1.2 SUPPLIER SUBMITTALS

- A. Supplier submittals shall be furnished in accordance with specification Section 01 33 20 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

- A. Equipment to be Furnished: At each location flowmeter equipment to be furnished shall include the following:
1. 4- or 8-path flow meter console in NEMA 4 wall-mount enclosure to measure flow in one aqueduct and display all variables and parameters for all paths plus flow and temperature. The flow meter console shall be connected to a SUPPLIER provided uninterruptible power supply (UPS) that will power the meter for a minimum of one (1) hour.
 2. Sixteen (16) ultrasonic transducer assemblies and cables for measurement on 8 acoustic paths where flow conditions are less than 10 diameters of straight run upstream and 2 diameters straight run downstream of the meter centerline.
 3. Eight (8) ultrasonic transducer assemblies and cables for measurement on 4 acoustic paths where there are more than 10 diameters of straight run upstream and 2 diameters straight run downstream of the meter centerline.
- B. In addition to the above equipment one (1) insertion removal tool shall be provided that will be used commonly at all sites.
- C. Equipment Functions Required: The ultrasonic flow meter will be required to perform the following:
1. Calculate and display flow rate and total flow through the aqueduct in units of cfs, MGD, etc.
 2. Calculate and display volumes and total volume through the aqueduct in units of acre-feet, cubic-feet, gal, MG, etc.
 3. Calculate and display temperature of finish water in the aqueduct in units of oF or oC.
 4. Provide 2 analog 4-20 mA outputs for the aqueduct including flow rate and temperature, and the capability of adding up to 5 additional analog 4-20mA outputs for future expansion of the meter.
 5. Provide digital RS-422/RS-485 output of user-selected variables
 6. Provide capability for output of user-selected variables to a laptop via the widows based program at pre-selected intervals.
 7. Provide capability for logging user-selected variables to a USB memory stick or via the windows based program.
 8. Configured for Modbus TCP/IP communications protocol.
- D. Operating Conditions: The equipment of this section shall be suitable for long term operation under the following conditions:
1. Fluid Service - Finished water
 2. Temperature - Ranging from 0 to 50 degrees Celsius
 3. Relative Humidity - Ranging from 0% to 95% (non-condensing)
 4. Flow Range - 0 - 180 mgd (90" FWR-FE/FIT-130)
 5. Pipe Material - Steel
 6. Pipe Wall Thickness (in) - 0.375 (90")
 7. Pipe I.D. (in) - 90"
 8. Pressure Range (psi) - 0 - 50

- E. Performance Requirements:
1. The flow meter shall measure flow to within $\pm 0.5\%$ of actual flow rate for all flows where the velocity is above 1 foot per second. Manufacturer shall submit to the ENGINEER a statement of estimated meter accuracies when flow velocities are below 1 foot per second.
- F. Materials: All of the equipment described below shall be furnished by one supplier. Component devices which perform similar functions in each system shall be purchased from the same manufacturer.

2.2 COMPONENT REQUIREMENTS

- A. Transducer Assemblies:
1. Each transducer assembly shall be watertight and shall consist of a wettable transducer mounted through to the inside of the aqueduct pipe. A ball-type valve shall be provided to allow removal/replacement of the transducer without dewatering the pipeline.
 2. The operating frequency of the transducers shall be 1 MHz.
 3. The transducers shall be connected to cables via underwater-pluggable electrical connectors or with standard electrical connections with sealed mounting.
 4. Transducers shall be suitable for mounting through round pipe walls and be safely removable under design pressure range. The entire transducer assembly, including the face in contact with the water, shall be removable under pressure, for leaning or replacement. Fixed-window type transducers will not be accepted.
 5. Transducer elements shall have a proven mechanical securing mechanism preventing movement of the transducer when removing under pressure and allows for reinserting new transducers at the same path angle for alignment.
- B. Flow Meter Console:
1. The flow meter console shall be a PC- or micro processor-based, multi-path acoustic transit-time type system. The flow meter console shall measure discrete acoustic travel times to arrive at an average velocity for each of the acoustic paths. These velocity data points shall be integrated to determine the flow rate through the aqueduct. The method of measuring and computing water velocity shall be independent of the speed of sound in water.
 2. The console shall evaluate each acoustic signal received and shall reject those which are distorted by reflections or reverberations or whose amplitude is below a minimum value. Flow rate and rate-of-change-of-flow limits shall be user selectable and adjustable on-site.
 3. The flow meter console shall be equipped with an Automatic Gain Control (AGC) to ensure that all received acoustic signals are continuously amplified to useable levels without noise interference.
 4. The system shall also be capable of communication via a laptop PC through a Windows-based user interface. Site-specific parameters shall be loaded into the flowmeter utilizing a secure file format. Operational parameters shall be set utilizing a file download setting on a Windows-based interface program.
 5. The console shall be installed in a stainless steel NEMA 4 enclosure suitable for wall mounting. The display shall be mounted on the front door of the enclosure and shall

- be accessible without opening the front door of the enclosure. The exposed display shall conform to NEMA 4 requirements.
6. The console shall be equipped with an EL or LCD-type display. The system shall have the capability to display individual pipe flow rates and totalized flow. The system shall display a message that indicates the type and path location of a signal interruption or transducer failure.
 7. Two Analog Outputs of 4-20 mA current loops representing flow rate and temperature in the aqueduct shall be provided. The analog output shall be designed to output 4 mA if the flow meter is in error mode.
 8. One Modbus TCP/IP port as approved by owner, shall be provided for transmission of data.
 9. The flow meter console shall have a self-test routine that periodically checks for proper operation of the flow meter transceiver, processor, and timing functions. The system shall alert the user to any self-test or acoustic path failure by displaying an error message on the flow meter display. The flow meter shall also provide a message indicating the type and location of any acoustic path problems.
 10. The flow meter shall be designed to return to full operation following a short-term power interruption, with all stored values retained. The flow meter shall also provide storage in the instrument of up to 1 year of hourly, daily, and monthly summaries. All stored data shall be removable.
- C. Transducer Cable: The Supplier shall furnish all cable between the transducers and the electronic console. The cable shall be of the type specified by the flow meter manufacturer. Any connectors to the transducers that may be required shall be supplied by the flow meter manufacturer. See the Project drawings for location of the Chemical and Control Building relative to each flowmeter.
- 2.3 MANUFACTURERS
- A. Caldon LEFM 880 as manufactured by Cameron Measurement Systems, 1000 McClaren Woods Drive, Coraopolis, PA 15108. Information available from Flowmeter Services (508) 274-0328. info@flowmeterservices.com.
 - B. Risonic 2000 with Transducers: Type C, Model MFATC14.60 as manufactured by Rittmeyer Ltd, 13222 East Aspen Bluff Lane, Spokane, WA 99217, Phone (509) 926-6873, FAX (866) 401-8306.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The flow meter shall be handled, installed, calibrated, tested, precommissioned, and Manufacturer's service and training shall be furnished as per specification Section 15075 - Meters, General.

3.2 WARRANTY

- A. For a period of 1-year following acceptance of the flow meter system, the manufacturer shall repair or replace any part which fails due to defects in materials or workmanship. Warranty

shall include all costs associated with the service of the meter within this time period, including but not limited to service costs for a factory trained technician to repair or replace any part of the meter in the field including transportation to the site, per diem, etc.

END OF SECTION

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SECTION 40 71 43 ROTAMETERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish and install rotameters and appurtenances, complete and operable in accordance with the Contract Documents

1.2 SUBMITTALS

- A. Submit in accordance with Section 01 33 20 – Submittal Procedures.
- A. Product Data
 - 1. Submit manufacturer's product data for rotameters. Include operation and maintenance information suitable for inclusion in facility operation and maintenance manual.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.
- B. Deliver meters in their original undamaged packaging and store in protected area. Schedule delivery of meters to coincide with installation.
- C. Protect stored meters from direct sunlight.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers and products are acceptable:
 - 1. Rotameters:
 - a. Blue-White Industries, Ltd.
 - b. Engineer approved equal.

2.2 PERFORMANCE / DESIGN CRITERIA

- A. Provide only meters that are suitable for the service and chemicals conveyed and at process temperatures specified.
- B. Unless otherwise indicated, provide rotameters in chemical solution lines and where otherwise indicated, with vertical bottom inlets and top outlets with ANSI 150-lb flanged ends, for vertical mounting.
- C. In gas, air, and pump seal flushing lines, provide meters of the modified rotameter design with screwed ends, spring-loaded pistons, and union bodies for mounting in any position.

- D. Minimum working pressure: 150 psi.

2.3 MATERIALS

A. Flanged Meters for Chemical Solutions:

1. Calibrate flanged rotameters for chemical solutions and other service where indicated, in gallons per minute.
2. Provide meters with 10-inch long scales (unless otherwise noted), and a range of 10:1 with an accuracy of plus and minus 2 percent.
3. Scales suitable for a capacity range of 0-50 gpm, unless otherwise indicated.
4. Use the following body materials:
 - a. Chlorine Service: Cast iron ends, Teflon-lined, or PVC ends, with heavy borosilicate glass tubes and packing glands.
 - b. Other chemicals: Type 316 stainless steel ends with heavy borosilicate glass tubes and packing glands, or other best suitable material.
 - c. All materials including wetted parts and floats to be suitable for designated service.

B. Screwed Meters for Water, Air, and Fuel Gas:

1. Calibrate rotameters with NPT screwed ends for water, air, and fuel gas service in gallons per minute or cubic feet per minute.
2. Provide meter bodies with union ends for ease of maintenance, polysulphone tubes, aluminum or brass end fittings, Type 316 stainless steel internal parts, and scales suitable for the given capacity range.
3. Meter accuracy: Plus and minus 5 percent over the given capacity range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install rotameters in accordance with the manufacturer's printed instructions in the following locations:

1. Chemical solution lines.
2. Dilution water lines.
3. Pump seal flushing lines.
4. Gas and air lines.
5. Sample lines.

END OF SECTION

SECTION 40 71 79 FLOW-SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Instruments for instrumentation and control systems that are to be permanently installed.
- B. Related Sections
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

- A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. Instrumentation Systems and Automation Society.
 - 4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.
- B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.
- C. Calibration of instruments shall be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20.
- B. Product Data
 - 1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
 - 2. Completed instrument data sheets including catalog number and source for determining catalog number.

- 3. Manufacturer's installation instructions.
- C. Shop Drawings
 - 1. Mechanical connection diagrams.
 - 2. Sensor transducer mounting requirements with dimensions and elevations.
 - 3. Electrical connection diagrams.
- D. Test Reports
 - 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
- E. Operating Manuals
 - 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
 - 2. Complete installation, calibration, and testing manuals.
- F. Record Drawings
 - 1. Complete field calibration sheets, including range, span, PLC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

- A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
 - 1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

- A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

- A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

- A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As identified on the instrument list in Section 40 75 01.

2.2 MANUFACTURED UNITS

- A. As identified on the instrument list in Section 40 75 01.

2.3 SOURCE QUALITY CONTROL

- A. All instruments and/or representative instruments shall be calibrated in facilities and with instruments traceable to the National Bureau of Standards.
 - 1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

- A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

- A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
 - 1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
 - 2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

- A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

- A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

- A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

- A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.
- B. All instrument calibration shall be witnessed by the Owner's Representative.
- C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC control system and associated registers.

3.8 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
- B. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

- A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.
- B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.05 of this section.
 - 1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 72 76 LEVEL-SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Instruments for instrumentation and control systems that are to be permanently installed.
 - 2. Level switches and floats used for level measurement.
 - a. Mechanical.
 - b. Tipping Float.
 - c. Reed.
- B. Related Sections:
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

- A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. Instrumentation Systems and Automation Society.
 - 4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.
- B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.
- C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor.

1.5 CONTRACTOR SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20.
- B. Product Data:

1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
 2. Completed instrument data sheets including catalog number and source for determining catalog number.
 3. Manufacturer's installation instructions.
- C. Shop Drawings:
1. Mechanical connection diagrams.
 2. Sensor transducer mounting requirements with dimensions and elevations.
 3. Electrical connection diagrams.
- D. Record Drawings:
1. Complete field calibration sheets, including range, span, PLC I/O address, register, and scaling coefficients.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.
- 1.7 PROJECT/SITE CONDITIONS
- A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.
- 1.8 WARRANTY
- A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As identified on the instrument list in Section 40 75 01.
- B. Hardware Commonality:
1. All instruments which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters which monitor hydrostatic head, shall be furnished by a single Manufacturer.
 2. All panel mounted instruments shall have matching style and general appearance.
 3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 EQUIPMENT

- A. As identified on the instrument list in Section 40 75 01.

2.3 SOURCE QUALITY CONTROL

- A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
 - 1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

- A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, including weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

- A. All instruments shall be installed in strict conformance with the manufacturer's recommendations.
 - 1. It is the Instrumentation and Control Systems Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
 - 2. It is the Instrumentation and Control Systems Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

- A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

- A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

- A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

- A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

- B. All instrument calibration shall be witnessed by the Owner's Representative.
- C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC control system and associated registers.

3.8 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
 - 1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

- A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Instrumentation and Control Systems Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review at no additional costs to the Owner.
- B. The Instrumentation and Control System Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with Paragraph 1.05 of this section.
 - 1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

**SECTION 40 73 13
PRESSURE GAUGES**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Instruments for instrumentation and control systems that are to be permanently installed.
- B. Related Sections:
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

- A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society..

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. Instrumentation Systems and Automation Society..
 - 4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.
- B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.
- C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20.
- B. Product Data:
 - 1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
 - 2. Completed instrument data sheets including catalog number and source for determining catalog number.

- 3. Manufacturer's installation instructions.
- C. Shop Drawings:
 - 1. Mechanical connection diagrams.
 - 2. Sensor mounting requirements with dimensions and elevations.
 - 3. Electrical connection diagrams.
- D. Test Reports:
 - 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
- E. Operating Manuals:
 - 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
 - 2. Complete installation, calibration, and testing manuals.
- F. Record Drawings:
 - 1. Complete field calibration sheets, including range, span.

1.6 QUALITY ASSURANCE

- A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
 - 1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

- A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

- A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

- A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ashcroft 1279 with Performance Plus.
- B. No equals.

2.2 MANUFACTURED UNITS

A. Pressure, Vacuum, Compound Gauges.

1. General.

- a. Furnish and install pressure and vacuum gauges as specified, complete, including all fittings, snubbers, connections, gaskets, supports, and accessories in the locations shown or specified, in accordance with the Contract Documents.
- b. Pressure gauges shall be provided whether or not shown on the plans:
 - 1) On suction and discharge connection to all pumps.
 - 2) On discharge connection from blowers and compressors.
 - 3) On each side of pressure reducing valves.
 - 4) In other locations as shown on the P&IDs and/or mechanical plans.
- c. Vacuum gauges shall be provided whether or not shown on the plans:
 - 1) On all supply side eductor type chemical feeders.
 - 2) In other locations as shown on the P&IDs and/or mechanical plans.
- d. Sleeve pressure gauges.
 - 1) Shall be provided where shown on the plans.
 - 2) Pressure shall be sensed by a flexible sleeve contained in a flanged cast iron or steel spool or wafer body, and transmitted to the gauge through a captive fluid.
 - 3) Sleeve shall be of BUNA A and fabricated so as to isolate the body from the process liquid.
 - 4) Gauges shall be calibrated to read in applicable units.
 - 5) Accuracy of $\pm 1\%$ to 150% of the working pressure of the system to which they are connected

2. Construction:

- a. Gauges shall be industrial quality type with Type 316 stainless steel movement.
- b. Phenolic case.
- c. Liquid filled.
- d. Unless otherwise shown or specified, gauges shall have:
 - 1) A 4-1/2-inch dial.
 - 2) 1/2-inch threaded connection.
 - 3) Type pulsation dampener adapter.
 - a) Pulsation Dampener as manufactured by:
 - b) Cajon Co.
 - c) Weksler Instruments, Corp.
 - d) Ashcroft.
 - e) No equals.

- 4) A block and bleed valve - 1/2 inch national pipe thread process connection and bleed/calibrate valve between block valve and outlet port.
 - e. Gages shall be calibrated to read in applicable engineering units.
 - f. Accuracy of $\pm 0.5\%$ to 150 % of the working pressure or vacuum of the pipe or vessel to which they are connected.
 - g. All gauges shall be vibration and shock resistant.
- 3. Diaphragm seals:
 - a. Gauges attached to system involving chemical solutions, corrosive fluids, sludge, sewage, or other liquids containing solids shall be equipped with diaphragm seals.
 - b. In addition diaphragm seals shall be provided and included at the locations shown.
 - c. Seals shall have clamped housings.
 - d. All seals shall have 1/2" NPT flushing connection and fluid fill connection.
 - e. Diaphragm Seals as manufactured by:
 - 1) Dresser Industrial Valve and Instrument, Ashcroft Type 101.
 - 2) Ametek, Inc., Mansfield and Green Division, Type Series RAG.
- 4. Gauges general as manufactured by:
 - a. Ashcroft Industrial Instruments (Dresser). With Plus Performance.
 - b. Foxboro/Jordan, Inc. Equivalent model
- 5. Gauges sleeve pressure as manufactured by:
 - a. Red Valve Co., Inc.
 - b. Ronningen-Petter.
 - c. Onyx.
 - d. No Equal
- 6. Snubbers as manufactured by:
 - a. Cajon Co.
 - b. Weksler Instruments, Corp.
 - c. Ashcroft.
 - d. No Equal
- 7. Pulsation dampeners as manufactured by:
 - a. Cajon Co.
 - b. Weksler Instruments, Corp.
 - c. Ashcroft.
 - d. No Equal

2.3 ACCESSORIES

- A. Gauges shall be liquid filled or have some equivalent technology.

2.4 SOURCE QUALITY CONTROL

- A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
 - 1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

- A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances. weldolets, valves, orientation, etc. for proper installation of the instruments.

3.3 INSTALLATION

- A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
 - 1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
 - 2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations
 - 3. Install two 2-valve instrument manifolds for each gauge pressure transmitter.
 - 4. Bolt 3 valve manifolds at non-flange diaphragm type differential pressure transmitters in place of standard flange adapters.
 - 5. Install root valves at process taps except insertion elements.
 - 6. Install gauge valves on process connections to instruments where multiple instruments are connected to one tap or where root valves are not readily accessible.
 - 7. All gauges shall be installed with the face in the vertical position.
 - 8. In strict accordance with the manufacturers printed instructions.
 - 9. At the locations shown on the drawings, when so shown.
 - 10. Care shall be taken to minimize the effect of water hammer or vibrations on the gauges.
 - 11. In extreme cases, and with the approval of the Engineer, gauges may be mounted independently, with flexible connectors.

3.4 FIELD QUALITY CONTROL

- A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

- A. All instruments shall be field verified.

3.6 DEMONSTRATION

- A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

3.7 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
 - 1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.8 SCHEDULES

- A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.
- B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with Paragraph 1.05 of this section.
 - 1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 73 26
PRESSURE-TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Instruments for instrumentation and control systems that are to be permanently installed.
- B. Related Sections
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

- A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. Instrumentation Systems and Automation Society.
 - 4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.
- B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.
- C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20.
- B. Product Data:
 - 1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
 - 2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.
- C. Shop Drawings:
 1. Mechanical connection diagrams.
 2. Sensor transducer mounting requirements with dimensions and elevations.
 3. Electrical connection diagrams.
- D. Test Reports:
 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
- E. Operating Manuals:
 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
 2. Complete installation, calibration, and testing manuals.
- F. Record Drawings:
 1. Complete field calibration sheets, including range, span, PLC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

- A. All instruments of similar nature must be furnished by the same manufacturer.
- B. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 ma loop accuracy.
- C. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
 1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

- A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

- A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

- A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As identified on the instrument data sheets.
- B. Hardware Commonality:
 - 1. All instruments, which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, shall be furnished by a single Manufacturer.
 - 2. All panel-mounted instruments shall have matching style and general appearance.
 - 3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 EQUIPMENT

- A. Pressure Transmitters Direct
 - 1. General
 - a. Pressure transmitters shall be 2 wire devices.
 - b. Continuously adjustable span, zero and damping adjustments.
 - c. Integral LCD meter scaled in engineering units.
 - d. Solid state circuitry.
 - e. Accuracy shall be ± 0.20 percent of span.
 - f. Process wetted materials as identified on Instrument Data Sheets.
 - g. Body material as identified on Instrument Data Sheets.
 - h. Process connections shall be 1/2-inch NPT.
 - i. Diaphragm seals shall be provided and included at the locations shown.
 - j. Rangeability: 20:1.
 - k. Integral transient protection.
 - l. Factory calibrated for span and range.
 - 2. Ranges:
 - a. As noted on the Instrument Data Sheets
 - 3. As manufactured by:
 - a. Rosemount Model 3051.
 - b. Endress+Hauser PMC71.
 - c. No equals.
- B. Pressure Transmitters - Differential
 - 1. General
 - a. Continuously adjustable span, zero and damping adjustments.
 - b. Integral LCD meter scaled in engineering units.
 - c. Solid state circuitry.
 - d. Accuracy shall be ± 0.20 percent of span.
 - e. Process wetted materials as identified on Instrument Data Sheets.
 - f. Body material as identified on Instrument Data Sheets.

- g. Process connections shall be 1/2-inch NPT.
- h. Diaphragm seals shall be provided and included at the locations shown.
- i. Rangeability: 20:1.
- j. Integral transient protection.
- k. Factory calibrated for span and range.
- 2. Ranges:
 - a. As noted on the Instrument Data Sheets
- 3. As manufactured by:
 - a. Rosemount Model 3051.
 - b. Endress+Hauser PMC71
 - c. No equals.

2.3 SOURCE QUALITY CONTROL

- A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
 - 1. Provide complete documentation covering the traceability of all calibration instruments.
 - 2. Provide 3 copies of calibration curve – One with the instrument, one to the engineer and a third copy in the O&M located with its corresponding ISA data sheet. Calibration curve shall be matched by instrument tag.
- B. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 ma loop accuracy.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

- A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

- A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
 - 1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
 - 2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

- A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

- A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

- A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

- A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.
- B. All instrument calibration shall be witnessed by the Owner's Representative.
- C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC control system and associated registers.

3.8 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
 - 1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

- A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.
- B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.05 of this section.
 - 1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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**SECTION 40 73 36
LEVEL-PRESSURE**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Instruments for instrumentation and control systems that are to be permanently installed.
 - 2. Instruments that measure level by using pressure.
- B. Related Sections:
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

- A. Instruments shall comply with the latest edition and standards of the Instrument Society of America.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. Instrument Society of America.
 - 4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.
- B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.
- C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20.
- B. Product Data:
 - 1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.

2. Completed instrument data sheets including catalog number and source for determining catalog number.
 3. Manufacturer's installation instructions.
- C. Shop Drawings:
1. Mechanical connection diagrams.
 2. Sensor transducer mounting requirements with dimensions and elevations.
 3. Electrical connection diagrams.
- D. Test Reports:
1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
- E. Operating Manuals:
1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
 2. Complete installation, calibration, and testing manuals.
- F. Record Drawings:
1. Complete field calibration sheets, including range, span, PLC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

- A. All instruments and any associated software shall be Year 2000 compliant.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

- A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

- A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

- A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As identified on the instrument list in Section 40 75 01.
- B. Hardware Commonality:
 - 1. All instruments which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters which monitor hydrostatic head, shall be furnished by a single Manufacturer.
 - 2. All panel mounted instruments shall have matching style and general appearance.
 - 3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 EQUIPMENT

- A. As identified on the instrument list in Section 40 75 01.

2.3 ACCESSORIES

- A. All instruments furnished shall be HART compatible and furnished with the following:
 - 1. HART interfaces.
 - 2. Diaphragm Seals.
 - 3. Annular Diaphragm Seals.
 - 4. Block and bleed valves.

2.4 QUALITY CONTROL

- A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
 - 1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

- A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, such as weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

- A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
 - 1. It is the Instrumentation and Control Systems Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
 - 2. It is the Instrumentation and Control Systems Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

- A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

- A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

- A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

- A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.
- B. All instrument calibration shall be witnessed by the Owner's Representative.
- C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC control system and associated registers.

3.8 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
 - 1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

- A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Instrumentation and Control Systems Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review at no additional costs to the Owner.

- B. The Instrumentation and Control System Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.05 of this section.
1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 74 63
TEMPERATURE-TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Instruments for instrumentation and control systems that are to be permanently installed.
- B. Related Sections
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

- A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

- A. Definitions of terms and other electrical considerations as set forth in the:
 - 1. National Electrical Code.
 - 2. Institute of Electrical and Electronic Engineers.
 - 3. Instrumentation Systems and Automation Society.
 - 4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.
- B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.
- C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

- A. Furnish complete submittals in accordance with Sections 01 33 20.
- B. Product Data:
 - 1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
 - 2. Completed instrument data sheets including catalog number and source for determining catalog number.

- 3. Manufacturer's installation instructions.
- C. Shop Drawings:
 - 1. Mechanical connection diagrams.
 - 2. Sensor transducer mounting requirements with dimensions and elevations.
 - 3. Electrical connection diagrams.
- D. Test Reports:
 - 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - a. Including factory calibration for each instrument with stated accuracy.
- E. Operating Manuals:
 - 1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
 - 2. Including factory calibration for each instrument with stated accuracy.
 - 3. Complete installation, calibration, and testing manuals.
- F. Record Drawings:
 - 1. Complete field calibration sheets, including range, span, PLC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

- A. All instruments of similar nature must be furnished by the same manufacturer.
- B. Manufacturer's representative shall be responsible for proving all 4-20ma loops.
- C. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
 - 1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the OWNER.

1.8 PROJECT/SITE CONDITIONS

- A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 SEQUENCING AND SCHEDULING

1.10 WARRANTY

- A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.11 MAINTENANCE

- A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - - PRODUCTS

2.1 MANUFACTURERS

- A. As identified on the instrument list in Section 40 75 01.

2.2 SOURCE QUALITY CONTROL

- A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
 - 1. Provide complete documentation covering the traceability of all calibration instruments.
 - 2. Provide 3 copies of calibration curve – One with the instrument, one to the engineer and a third copy in the O&M located with its corresponding ISA data sheet. Calibration curve shall be matched by instrument tag.

PART 3 - - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

- A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

- A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
 - 1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.
 - 2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

- A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

- A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

- A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

- A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.
- B. All instrument calibration shall be witnessed by the OWNER's Representative.
- C. Each and every instrument shall be tested during the Loop Validation Tests and the OWNER's Representative shall witness the response in the PLC control system and associated registers.

3.8 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged prior to commissioning.
 - 1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

- A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the CONTRACTOR's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The CONTRACTOR shall provide documented evidence for a differential plus or minus that results from these changes.
- B. The CONTRACTOR shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.05 of this section.
 - 1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

**SECTION 40 75 01
INSTRUMENT LIST**

PART 1 - GENERAL

1.1 INSTRUMENT LIST

- A. Instrument list is shown in the attached table following this section.

PART 2 - PRODUCTS

2.1 COMMUNICATIONS PROTOCOL

- A. All instruments shall be configured for Modbus TCP/IP communications protocol.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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Instrument List			
Tag	Location	Device	Description (See notes at bottom of document)
AIT-102	Inlet Valve Vault Sample Water	Turbidity Monitor	Hach (Series 660 SC) FilterTrak Laser Turbidity Sensor with Hach (Series SC 200) controller
AIT-152	Interconnect Vault Sample Water		
AIT-100	Inlet Valve Vault Sample Water	pH Monitor	Hach (Series PD1P1) pH Sensor, Hach (Series SC 200) controller
AIT-150	Interconnect Vault Sample Water		
AIT-101	Inlet Valve Vault Sample Water	CL2 Monitor	Hach (Series CL10) Amperometric Chlorine Sensor or ATI Q46H
AIT-151	Interconnect Vault Sample Water		
AIT-103	Inlet Valve Vault Sample Water	Fluoride Monitor	ATI Q46F
FE/FIT-101	Inlet Valve Vault	Flow	Rittmeyer Risonic 200 Type C or Cameron Caldon LEFM 880
FE/FIT-501	Bluffdale Meter Vault	Flow	Endress+Hauser Promag 53W
FE/FIT-2	SWA (Existing)	Flow	Existing E+H Magnetic Flow Meters
FE/FIT-1	JA-2 (Existing)		
FSH-100	Inlet Valve Vault Sample Water	Flow Switch	McDonnell & Miller, Series FS6 Water Flow Switch, 1" NPT
FSH-150	Interconnect Vault Sample Water		
LE/LIT-xxx	Existing 8 MG FWR	Level	Existing Pressure Transducer
LE/LIT-202	12.5 MG FWR	Level (Primary)	Endress+Hauser Waterpilot FMX21
LE/LIT-201	Overflow/Bypass Channel - 1		
LE/LIT-203	Overflow/Bypass Channel - 2		
LE/LIT-102	12.5 MG FWR @ Inlet Valve Vault	Level (Secondary)	Rosemount 3051 or Endress+Hauser PMC71
LE/LIT-103	12.5 MG FWR @ Inlet VV (Future)		
LSH-101	Inlet Valve Vault	Flood Alarm	Gem Sensor (series LS270) Single Point Level Switch
LSH-301	Drain Vault		
LSH-402	Underdrain Vault		
LSH-501	Bluffdale Meter Vault		
LSH/HH-205	12.5 MG FWR	Overflow Alarm	B/W (Series 6012/6013) or Warrick (Series 16) Conductivity Probes and Relay System(s). Common Probe must extend to EL 4723.3, the High Level Probe must extend to EL 4723.3 and the High High Level Probe must extend to EL 4723.8. The probes are to be wired to the LSH/LSHH controller(s) Mounted in a NEMA 4X enclosure. Relay(s) to operate on 24VDC power source and provide two dry contacts to provide a High and High High alarm that is automatically reset as alarms level drops.
LE-201	Overflow/Bypass Channel - 1 (pressure transducer only, no separate overflow probe)		
LSH/HH-204	Overflow/Bypass Channel - 2		
TIT-100	Inlet Valve Vault Sample Water	Temperature Transmitter	Output from AIT-102 and AIT-152 above (no separate temperature probe)
TIT-150	Interconnect Vault Sample Water		

Instrument List			
Tag	Location	Device	Description (See notes at bottom of document)
TIT-110	Inlet Valve Vault	Temperature Transmitter	Devar inc. Model RTTI-0024. RTD Sensor, LED Temperature Indicated, 4-20 loop powered, no batteries, 0-150 degree F range
TIT-111	IVV Electrical Room		
ZSC-101	Inlet Valve Vault	Entry Switch (Door Closed)	Magnetic Entry Switch, Ademco, 7939WG-GY
ZSC-102	Inlet Valve Vault		
ZSC-150	Interconnect Vault		
ZSC-201	12.5 MG FWR	Entry Switch (Hatch Closed)	Limit Switch with Roller Lever, side mount with at least 1 normally open contact. Contact to close when level is 'pressed'. Allen Bradley (Series 802B) or Square D (class 9007)
ZSC-204	12.5 MG FWR		
ZSC-205	12.5 MG FWR		
ZSC-203	Overflow/Bypass Channel - 1		
ZSC-202	Overflow/Bypass Channel - 2		
ZSC-301	Drain Vault		
ZSC-401	Underdrain Vault		
ZSC-501	Bluffdale Meter Vault		

Notes: All instruments to be configured for Modbus TCP/IP communications protocol (where available).

Items listed as Existing or Future are for information and are not included in contract.

Substitutions allowed with written approval of Owner and Engineer only.

DIVISION 43
GAS, LIQUID AND STORAGE

**SECTION 43 20 10
PUMPS, GENERAL**

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.
- C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.
- D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01 33 20 - Contractor Submittals.
- B. Shop Drawings: 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 equipment 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 frequency drive.
 - 3. The Contractor shall require the Manufacturer to indicate on the performance curves the limits recommended for stable operation without surge, without cavitation, and without vibration (except vibration within specified allowable limits). The stable operating range shall be as wide as possible based on actual hydraulic and mechanical measurements taken during the factory performance tests of the pumps.
 - 4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
 - 5. Data, in accordance with Section 26 19 00 - Medium-Voltage Induction Motors, for the electric motor proposed for each pump.
 - 6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel,

- and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.
- 7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
- 8. Complete electrical schematic diagram.
- C. Operation and Maintenance Manual: The Manual shall contain the required information for each pump Section.
- D. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.
- E. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.
- F. Certifications
 - 1. Manufacturer's certification of proper installation.
 - 2. Contractor's certification of satisfactory field testing.
- 1.3 QUALITY ASSURANCE
 - A. Warranty: Unless otherwise specified, each pump shall be supplied with manufacturer's standard warranty of one (1) year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.
- B. Performance Curves: All centrifugal pumps shall have a continuously rising 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.
- C. No cavitation shall be allowed in pumps operating within the stable operating range for the specified operating conditions. For the purposes of this provision, cavitation shall be recognized and accepted as being present in a pumping unit if cavitation noise can be perceived either by the human ear or by acoustic instruments or devices. The presence or absence of cavitation noise shall be verified by the Owner during both the factory performance tests of the pumps and during operation of the pumps up to the end of the warranty period. To assist in revealing potential cavitation during the factory performance tests, in addition to all other required tests, the Manufacturer shall force the pumps to operate at the specified minimum net positive suction head available for each of the following conditions: minimum flow rate, design flow rate and head, and maximum flow rate.
- 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, variable frequency controls if required, necessary mountings, and appurtenances.

2.2 MATERIALS OF CONSTRUCTION

- 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 austenitic ductile iron, conforming to ASTM A 439 - Specification for Austenitic Ductile Iron Castings, or equal.
 2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
 3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
 4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 05 50 00 – Metal Fabrications.

2.3 PUMP COMPONENTS

- A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings Dimensions.
- B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for other process fluids shall be lubricated as indicated.
- C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.
- D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.
- E. Drains: All gland seals, air valves, cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.
- F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.
- G. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For drainage and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.

1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
 - a. Shaft speeds - up to 2500 rpm
 - b. Temperature - up to 500 degrees F
 - c. pH range - 0 to 14.
2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Type	Manufacturer
Water Pumps Hot and Cold	Single seals: John Crane, Type I, 21; Borg-Warner Type L; Chesterton

- I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.
- J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

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. Dimension and flow information shall be in metric units, followed by English units in parentheses.
- B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.
- C. Gauges: all pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. 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.
 1. 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. Pressure and compound gauges shall be provided in accordance with Section 17205 – Pressure Gauges.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

- A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections 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 the specified requirements.
- B. Instruction of the Owner's Personnel
 - 1. Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections 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 years' experience in training. A resume for the representative shall be submitted.
 - 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 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 PROTECTIVE COATING

- A. Materials and equipment shall be coated as required in Section 09 90 00 – Painting and Coating.

3.4 FIELD TESTS

- A. Where required by the individual pump Sections, each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.
- B. The following field testing shall be conducted:
 - 1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits 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 Sections under which that equipment is indicated.
- C. Field testing will be witnessed by the Engineer. The Contractor shall furnish 5 days advance notice of field testing.
- D. 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.
- E. 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.
- F. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the Owner will bear. If available, the Owner's operating personnel will provide assistance in field testing.

END OF SECTION

**SECTION 43 23 10
REGENERATIVE TURBINE PUMPS**

PART 1 - GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide regenerative turbine pumps, with horizontal electric motors and all appurtenant work, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 20 10 – Pumps, General apply to this Section.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 WARRANTY

- A. Pumps shall be provided with manufacturer standard warranty for minimum of one year from date of project substantial completion to cover parts, labor, shipping, and travel.

PART 2 - PRODUCTS

2.1 SAMPLE PUMPS

- A. Identification
 - 1. Equipment Number - FWR-P-112, FWR-P-113
 - 2. Quantity - 2
 - 3. Location - Inlet Valve Vault
- B. Operating Conditions: The Work of this Section shall be suitable for long-term operation under the following conditions:
 - 1. Duty - Continuous
 - 2. Drive - Constant speed
 - 3. Ambient environment - Indoors
 - 4. Ambient temperature, (degrees F) - 40 to 80
 - 5. Ambient relative humidity (percent) - 20 to 90
 - 6. Fluid service - Treated Water
 - 7. Fluid temperature, (degrees F) - 50 to 80
 - 8. Fluid pH range - 7 to 8.3
 - 9. Fluid specific gravity - 1.0
 - 10. Project site elevation (ft. a.s.l) - 4,730
 - 11. Minimum available NPSH (ft) - 10
- C. Performance Requirements
 - 1. Maximum shutoff head (ft) - 150
 - 2. Design flow capacity (gpm) - 4.0
 - 3. Design flow pump head (TDH ft) - 60

- | | | | |
|----|---|---|-------|
| 4. | Design flow minimum pump efficiency (percent) | - | 40 |
| 5. | Maximum pump speed (rpm) | - | 1,800 |
| 6. | Maximum motor speed (rpm) | - | 1,800 |
| 7. | Minimum motor size (hp) | - | 1/3 |
- D. Pump Dimensions
- | | | | |
|----|--------------------------------|---|-----|
| 1. | Minimum impeller diameter (in) | - | NA |
| 2. | Minimum size of suction (in) | - | 1 |
| 3. | Minimum size of discharge (in) | - | 1 |
| 4. | Flange rating, ANSI (psi) | - | 150 |
- 2.2 PUMP REQUIREMENTS
- A. Construction: Construction of regenerative turbine pumps shall conform to the following requirements:
- | | | | |
|-----|-----------------|---|--|
| 1. | Casing | - | Cast iron |
| 2. | Impeller | - | Bronze |
| 3. | Shaft | - | Stainless steel |
| 4. | Configuration | - | Frame-mounted |
| 5. | Bearings | - | 2 sets of ball bearings with min L-10 life of 50,000 hours |
| 6. | Coupling | - | Flexible heavy-duty shaft coupling with guard |
| 7. | Seal | - | Mechanical seal |
| 8. | Pump base | - | Cast iron or fabricated steel with drain |
| 9. | Mounting method | - | Base-mounted |
| 10. | Lubrication | - | Grease-lubricated |
| 11. | Accessories | - | Bypass with relief valve discharging to pump suction |
- B. Drive: Direct drive with horizontal, ODP electric motor suitable for 120-volt, single-phase, 60-Hz ac power supply.

2.3 PROTECTIVE COATING

- A. Pumps shall be coated in accordance with Section 09 90 00 - Coatings and Painting.

2.4 SPARE PARTS

- A. The Contractor shall furnish a complete set of manufacturer's recommended spare parts for EACH pump. Parts subject to wear, such as seals, packing, gaskets, and bearings and any special tools shall be included.

2.5 MANUFACTURERS, OR EQUAL

- A. Aurora Pumps.
- B. Burk Pumps.
- C. Colt Industries (Fairbanks Morse).

D. Roth Pump Company.

E. Paco Pumps.

PART 3 - PART 3 - EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with procedures submitted with the shop drawings.

B. General installation requirements shall be as indicated in Section 43 20 10 - Pumps, General.

END OF SECTION

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**SECTION 43 25 15
SUBMERSIBLE PUMPS**

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide submersible pumps and appurtenant work, complete and operable, in accordance with the Contract Documents.
- B. The requirements of 43 20 10 – Pumps, General apply to the work of this Section.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will satisfy the indicated requirements.

1.2 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Submittals shall be made in accordance with Section 01 33 20 – Contractor Submittals and Section 43 20 10 – Pumps, General.
- B. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.
- C. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 – Submittal Procedures.

1.3 QUALITY ASSURANCE

- A. Provide pump manufacturer's standard one-year warranty which starts upon substantial completion of the project.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION:

A. Identification

Pump Name	Submersible drain pump and sump pumps
Equipment Number	P-101, P-111, P-114, 115, and P-116
Quantity	A total of 5
Location	Inlet Valve Vault (P-101, P-111), Drain Vault (P-115, P-116), Underdrain Vault (P-114)

- B. Operating Conditions: The work of this Section shall be suitable for long term operation under the following conditions:

Duty	Continuous
Drive	Constant speed
Ambient environment	Inside concrete vault
Ambient temperature, degrees F	40 to 80
Ambient relative humidity, percent	100
Fluid service	Structural underdrain water, wash-down water from vault, drain water from reservoir
Fluid temperature, degrees F	40 to 70
Fluid pH range	7.5 to 8.5
Fluid specific gravity	1.0
Fluid viscosity (absolute), centipoises at 50 deg. F	1.31
Project site elevation, ft. a.s.l	4,730
Minimum available NPSH, ft absolute	20
Maximum size of spheres to pass, in. dia	0.5

C. Performance Requirements (P-101, P-111, P-114, and P-115)

Maximum shutoff head, ft	45
Design flow capacity, gpm	50
Design flow pump head, TDH ft	40
Design flow minimum pump efficiency, percent	50
Maximum flow NPSH required at Design Flow, ft absolute	< 20
Minimum flow capacity at maximum speed, gpm	20
Minimum flow pump head, TDH, at maximum speed, ft	40
Minimum flow pump efficiency, percent	50
Maximum pump speed, rpm	1750 or 3550
Maximum motor speed, rpm	3600
Minimum motor size, hp	1.0

D. Performance Requirements (P-116)

Maximum shutoff head, ft	50
Design flow capacity, gpm	1,500
Design flow pump head, TDH ft	29
Design flow minimum pump efficiency, percent	60
Maximum flow NPSH required at Design Flow, ft absolute	< 20
Minimum flow capacity at maximum speed, gpm	2,000
Minimum flow pump head, TDH, at maximum speed, ft	10
Minimum flow pump efficiency, percent	50
Maximum pump speed, rpm	1750 or 3550
Maximum motor speed, rpm	3600
Minimum motor size, hp	30

E. Pump Dimensions (P-101, P-111, P-114, and P-115)

Sump dimensions, ft x ft	2.0 x 2.0
Sump depth, ft	2.5
Sump top	FRP grating with frame open
Pump discharge size, inches	2" minimum. Transition to 4" pipe outside vaults.
Discharge flange rating minimum, psig	75

F. Pump Dimensions (P-116)

Vault dimensions, ft x ft	8.0 x 8.0
Sump depth, ft	See drawings
Manhole for pump removal	3' x 8'
Pump discharge size, inches	12"
Discharge flange rating minimum, psig	125

2.2 PUMP REQUIREMENTS

A. Construction: Construction of submersible sump pump shall conform to the following requirements:

Pump casing	Stainless Steel (P-101, P-111, P-114, and P-115) Cast Iron (P-116)
Impeller	Semi-open, non-clog cast iron
Bearings	Permanently lubricated ball and sleeve type
Shaft	Stainless steel, series 400
Seal	Mechanical seal
Mounting Method	Flexible hose, stainless steel lifting chain with hook.
Pump Connection	Flange

B. Drive: Enclosed, submerged, electric 1800 or 3600 rpm motor, suitable for:

1. 230-volt, single phase (P-101, P-111, P-114, and P-115)
2. 480-volt, three phase (P-116)

- 3. 60 Hz ac power supply, with armored cable, in accordance with Section 26 20 00 - Electric Motors.
- C. Automatic Control: Sump pumps (P-101, P-111, P-114, and P-115) shall be supplied by Manufacturer with automatic control based on low and high level floats supplied with the pump by the Manufacturer. Drain pump (P-116) shall be controlled by floats as shown in drawings.
- 2.3 PROTECTIVE COATING
 - A. Pumps shall be coated in accordance with Section 09 90 00 – Coatings and Painting.
- 2.4 MANUFACTURERS, OR EQUAL
 - A. Grundfos Pumps or Tsurumi Pumps (P-101, P-111, P-114, and P-115)
 - B. Flygt Pumps or Sulzer Pumps (P-116)

PART 3 - EXECUTION

- A. INSTALLATION
- B. Pumping equipment shall be installed in accordance with the approved Shop Drawings and as indicated.
- C. General installation requirements shall be in accordance with Section 43 20 10 - Pumps, General.

END OF SECTION

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