Four Rivers Sanitation Authority Rockford, Illinois

Bidding Requirements and Contract Forms

for

Aerobic Granular Sludge-Phase I

Capital Project No. 2207 IEPA Project No. L17-6127

DECEMBER 20, 2022 - BID SET

Volume 2 of 2



B & V DESIGN, LLC ILLINOIS PROFESSIONAL DESIGN FIRM (ARCHITECTURAL) - 184-007283

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Four Rivers Sanitation Authority Rockford, Illinois

Bidding Requirements and Contract Forms and General Provisions and Technical Specifications

for

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Aerobic Granular Sludge-Phase I

Capital Project No. 2207 IEPA Project No. L17-6127

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PROJECT MANUAL



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PROJECT MANUAL

FOUR RIVERS SANITATION AUTHORITY WASTEWATER TREATMENT PLANT

AEROBIC GRANLAR SLUDGE-PHASE I CAPITAL PROJECT NO. 2207 IEPA PROJECT NO. L17-6127

ROCKFORD, ILLINOIS

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FOUR RIVERS SANITATION AUTHORITY WASTEWATER TREATMENT PLANT

AEROBIC GRANLAR SLUDGE-PHASE I CAPITAL PROJECT NO. 2207 IEPA PROJECT NO. L17-6127

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SECTION 22 00 00 - PLUMBING

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of materials, appliances, fixtures, equipment, and appurtenances associated with the plumbing systems as specified herein and as indicated on the Drawings. Additional requirements for plumbing systems shall be as indicated in the schedules on the Drawings. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.
- B. Pipe materials, valves, thermal insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1.2 GENERAL

- A. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.
- B. Coordination
 - 1. Contractor shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.
 - 2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
 - 3. Each manufacturer of shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.
 - Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

- D. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- E. Governing Standards
 - 1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.
 - 2. All work shall conform to the requirements of AGA, ASTM, NFPA, and UL safety requirements.
- F. Power Supply
 - 1. Unless otherwise specified, power supply to equipment with motors shall be as indicated on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.
- G. Metal Thickness
 - 1. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.
- H. Mechanical Identification
 - 1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Equipment, Piping Accessories, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Capacities.

Pressure and temperature ratings.

Overall dimensions.

Piping connection sizes and locations.

Net weight.

Rated size of motor, HP, kW.

Power requirements.

Wiring diagrams.

Plumbing Fixtures

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Water consumption data.

Overall dimensions.

Rough-in dimensions.

Piping connection sizes and locations.

Net weight.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

- B. Operations and Maintenance Data and Manuals
 - 1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section.
 - 2. Operation and maintenance manuals are required for electronic trap priming panels, hose reels,

1.4 QUALITY ASSURANCE

A. Welding Qualifications

All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

- B. Qualification
 - 1. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

- C. Manufacturer's Experience
 - 1. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

- А.
- A. Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.
 - 1. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All plumbing fixtures and equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the Drawings.

B. Dimensional Restrictions

Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION

- A. Anchor Bolts and Expansion Anchors
 - 1. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage in Concrete and Masonry section unless otherwise indicated on the Drawings.
- B. Surface Preparation
 - 1. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.
- C. Shop Painting
 - 1. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.
 - 2. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.
 - 3. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the Protective Coatings section.
- D. Equipment Bases
 - 1. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.
 - Special Tools and Accessories
 - Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
- F. Piping Systems
 - 1. Unless otherwise specified herein, piping system materials shall be as specified in other sections.

- G. Valves
 - 1. Unless otherwise specified herein, valves indicated to be a part of the plumbing systems shall be as specified in other sections.

2.5 WATER SUPPLY PIPING ACCESSORIES

- A. Water Hammer Arresters
 - 1. Water hammer arresters shall be either bellows or piston type. Bellows type arresters shall consist of a stainless steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arresters shall consist of a seamless Type L copper shell, a seamlessly spun and factory charged air chamber, a factory lubricated double or triple O-ring sealed piston, and a threaded copper adapter. Water hammer arresters shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1010. Arresters shall be rated for a maximum working pressure of 350 psig gauge and a temperature range of 33° F to 250° F. Water hammer arresters shall be Smith "Hydrotrol," Josam "75000 Series Absorbotron," Wade "Shokstop," or Sioux Chief "Hydra-Rester."
 - 2. Electronic Trap Priming Panel
 - a. Electronic trap priming panels shall be provided as indicated by the plumbing drawings denoted by a symbol "TPP" and an identifying number. One half-inch copper tubes shall run from the electronic trap priming panel to the traps. Trap primers shall be mounted in accessible locations. Electronic trap priming panels shall consist of a panel, timer, 120 V solenoid, calibrated manifold system and shall be manufactured by Precision Plumbing Products Inc. "PTS Series," Zurn, MIFAB, or equal, Reference the plumbing drawings for the number of priming tubes required per trap priming panel.
- B. Strainers
 - 1. Strainers shall be provided where indicated on the Drawings. Strainer screen size shall be 20 mesh unless otherwise indicated. The blowoff from each strainer shall be equipped with a shutoff valve.
 - 2. Strainers located in copper piping systems shall be Y-pattern type with bronze body, threaded ends, and monel or stainless steel screens. Strainers shall be Watts "Series LF777SI," Apollo Valves "Model YB-LF" or Wilkins "Model YBXL."
 - 3. Strainers located in ductile iron piping systems shall be Y-pattern type with iron body, flanged ends, and monel or stainless steel screens. Strainers shall be Hoffman Specialty "Series 400" or Metraflex "Model TF."
- C. Hose Faucets
 - 1. Hose faucets are part of the hose connection detail which also includes hose valves (see paragraph D below). Refer to Plumbing Standard Details, 99-P-501. Hose faucets shall be

constructed from Stainless Steel. The 3/4 inch Stainless Steel, threaded water service ball valve to be located upstream the 45 deg. Stainless Steel elbow. 3/4 inch x 2 inch SS pipe nipple with 3/4 inch hose thread termination shall finish the assembly. Stainless Steel hose rack shall be Super Klean Model 12-SS and shall fasten to wall with SST anchors. 3/4 inch hose with 40 ft length shall be provided. Non-Potable water sign as per FRSA standard shall be provided at each hose faucet. Install hose faucet at 3 ft above finished floor or grating.

- 2. Each in-line ball valve shall be full port Apollo "76F Series", Boshart "SSBV", or US Valve "WOG" all rated to 1000 CWP.
- 3. Where indicated on the Drawings, hose faucets shall be equipped with hose connection vacuum breakers. Hose connection vacuum breakers shall be provided with 3/4 inch hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be equipped with manual drain. Hose connection vacuum breakers shall be Febco "Series 731," Watts Regulator Company "Series 8" or Wilkins "Model BFP 8."
- D. Hose Valves
 - 1. Hose valves are part of the hose connection detail which also includes hose faucets (see paragraph C above). Refer to Plumbing Standard Details, 99-P-501. Hose valves shall be constructed from Stainless Steel. The 1-1/2 inch SS, threaded water service ball valve shall be installed upstream the 45 deg. SS elbow. 1-1/2 inch x 2 inch SS pipe nipple with 1-1/2 inch hose thread termination shall finish the assembly.
 - 2. Each in-line ball valve shall be full port Apollo "76F Series", Boshart "SSBV", or US Valve "WOG" all rated to 1000 CWP.
 - 3. All hose valves shall be 1-1/2 inch size unless otherwise indicated on the Drawings.
- E. Wall Hydrants
 - 1. Wall hydrants shall be freezeproof type with bronze body, polished bronze or chrome plated face, integral vacuum breaker, and removable handle key. Wall hydrants shall be provided with 3/4 inch pipe thread inlet and 3/4 inch male hose thread outlet. Wall hydrants shall be ASSE 1019-B approved. Wall hydrants shall be Smith "Model 5619,"Woodford Model 65, or Prier "Model C-634."
- F. Pressure Gauges
 - Pressure gauges shall be Ashcroft "Duragauge 1279," Weksler, or Weiss Instruments, Inc.
 - 2. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade A or better. Gauges shall be indicating dial type with C-type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.

- 3. The dial shall be 4-1/2 inch in diameter with black markings on a white background. The units of measurement shall be psi and shall be indicated on the dial face. The pointer shall span not less than 200 degrees nor more than 270 degrees. The range shall be selected so that the normal operating reading is near the midpoint of the scale.
- 4. Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Ball Valves section.
- 5. All stem-mounted gauges shall be provided with 1/2 inch NPT connections.
- 6. Diaphragm Seals
 - a. Pipe-mounted diaphragm seals shall be provided where indicated on the Drawings. Diaphragm seals shall be thread-attached type with cleanout ANSI Type 316 stainless steel diaphragm, plated carbon steel upper housing, and stainless steel lower housing. The diaphragm seal shall be of "continuous" design to safely contain the process fluid in the event of gauge failure or removal from the system under pressure. The lower housing shall be provided with a tapped 1/4 inch NPT flushing connection and an MxF stainless steel needle valve. Each gauge isolator and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.
 - b. Gauge isolators shall be as manufactured by Ashcroft "Type 101," Weksler, or Weiss Instruments, Inc.

2.6 DRAINAGE AND VENT PIPING ACCESSORIES

- A. Cleanouts
 - 1. Cleanouts shall be provided where indicated on the Drawings and required by the referenced codes and shall be of the required type.
 - 2. Floor cleanouts shall consist of a two-piece body, a threaded plug, an adjustable head, and a cover. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanout covers shall be stainless steel. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T-pattern, 90 degree drainage fitting.



Cast iron cleanouts shall be manufactured by Smith, Josam, or Wade. Polypropylene cleanouts shall be manufactured by Orion, Enfield, or Zurn. PVC cleanouts shall be manufactured by Sioux Chief, Plastic Oddities, or Zurn.

- B. Bell-Up Drains
 - 1. Unless otherwise indicated, bell-up drains shall consist of a drainage pipe hub extended to 1 inch above the finished floor. For chemical-resistant waste systems, bell-up drains shall consist of a plain end section of pipe, with a coupling extended 1 inch above the finished floor.

- C. Funnel Receptors
 - 1. Funnel receptors shall consist of cast iron funnels with cast iron dome type bottom strainers. Funnel receptors shall be provided with waterstop flange and threaded or no-hub outlet connections suitable for connection to the waste piping. Funnel receptors connected to chemical resistant waste systems shall be furnished with a factory applied chemical resistant interior coating. Unless otherwise indicated, funnel receptors shall be installed 1 inch above the finished floor.
 - 2. Funnel receptors shall be Smith "Series 3800 Figure SQ-3-1793-DBS," Josam, or Wade.
- D. Floor Drains
 - 1. Floor drains shall be of the types specified herein and indicated on the Drawings. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the Drawings. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.
 - 2. Cast iron floor drains shall be manufactured by Smith, Josam, or Wade. Polypropylene floor drains shall be manufactured by Orion, Enfield, Zurn. PVC floor drains shall be manufactured by Sioux Chief, Plastic Oddities, or Zurn.
- E. Roof Drains and Overflow Roof Drains
 - 1. Roof drains and overflow roof drains shall be of the types specified herein and indicated on the Drawings. Roof drains shall consist of a cast iron dome, a cast iron body, a sump receiver, an integral flange, and an extension for insulation thickness, where applicable. Drains for aggregate-surfaced roofing shall be provided with gravel stops. For other than cast-in-place locations, roof drains shall be provided with angle type underdeck clamps. When indicated on the Drawings, overflow roof drains shall be provided with interior extension rings. Roof drains and overflow roof drains shall be manufactured by Smith, Josam, or Wade.
- F. Vent Flashings

General

1. Plumbing vent flashings shall be furnished and installed as indicated on the Drawings.

2.7 PLUMBING FIXTURES AND ACCESSORIES

- 1. Plumbing fixtures shall be provided with all required supports, fasteners, supply and drain fittings, gaskets, and escutcheons required for a complete installation.
- B. Stainless Steel Sinks
 - 1. Sink types, dimensions, hole punching, metal gage, and water use shall be as indicated on the Drawings.

- 2. Stainless steel sinks shall be seamless Type 304 stainless steel, with smooth radius interior corners. All exposed surfaces of sinks shall be machine polished to a bright finish and the underside shall be fully undercoated. Wall mounted sinks shall have integral stainless steel support brackets and shall be furnished with a wall hanger. Sinks shall be provided with mounting clips, support legs, and all other hardware as indicated in the schedules. Stainless steel sinks shall be manufactured by American Standard, Elkay, Just, or Advance Tabco.
- 3. Faucets
 - a. Sink faucets shall be polished chrome, with a vandal-resistant single-lever handle. All waterways shall be constructed of brass or copper. Faucets shall be provided with a brass spout, an aerator, and a flow restrictor. Supply sets consisting of 1/2 inch NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be provided. All supply components shall be polished chrome. Sink faucets and supply sets shall be manufactured by Chicago Faucet, American Standard, Kohler, Eljer, or Advance Tabco
- 4. Drain Assembly
 - a. All required drainage accessories, including strainers, tailpieces, and traps, shall be provided. Basket strainers shall be heavy gage stainless steel, with a removable conical strainer plate and a neoprene stopper. Tailpieces shall be chrome plated brass. Sink traps shall be at least 1-1/2 inches in diameter, cast brass, with polished chrome finish, an escutcheon flange, and a cleanout plug.

2.8 PLUMBING EQUIPMENT

- A. General
 - 1. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

B. Hoses

- 1. Hose type, diameter, length, manufacturer, and model shall be as indicated below.
- 2. Type 1 Hoses
- a. Type 1 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig gauge working pressure. The hose shall consist of 1-1/2 inch ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 1 hoses shall be Gates Rubber Company "Water Master" or Potter-Roemer "Model 2853."
- 3. Type 2 Hoses
 - a. Type 2 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig gauge working pressure. The hose shall consist of 3/4 inch ID heavyduty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile

textile cord reinforcement and an EPDM cover. Type 2 hoses shall be Gates Rubber Company "Adapta Flex" or Potter-Roemer "Model 2851."

2.9 COLOR

- A. Plumbing equipment shall have the manufacturer's standard color and finish unless otherwise indicated in the schedules.
- 2.10 ELECTRICAL
 - A. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION

A. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

3.3 INSTALLATION

- A. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Unless otherwise indicated, sleeves shall be provided for all pipe penetrations through concrete and masonry walls. Sleeves and sealing requirements shall be as indicated in the Miscellaneous Piping and Accessories Installation section and as indicated on the Drawings.

- C. Not all required reducing fittings and unions are indicated. Additional fittings and unions shall be provided as needed to connect all equipment and appurtenances.
- D. Insulating fittings shall be provided to prevent the contact of dissimilar metals in piping systems.
- E. When located indoors, fuel gas pressure regulator vents and fuel train vent valves shall be piped to the exterior of the building in accordance with the applicable codes and standards.
- F. Piping shall not be routed over or in front of electrical switchboards or panels unless acceptable to Engineer.
- G. Water Supply Piping and Accessories
 - 1. Water hammer arresters shall be provided in the cold water supply piping at all quick closing valves, at solenoid valves, and at plumbing fixtures. When not indicated on the Drawings, arresters shall be located and sized by Contractor in accordance with PDI Standard No. WH201. Contractor shall submit arrester location and sizing plans to Engineer for approval prior to installation. Where possible, water hammer arresters shall be installed in an accessible location.
 - 2. Water supply piping to hose faucets and hose valves shall be secured with a pipe support within 6 inches of the fixture.
- H. Drainage and Vent Piping and Accessories
 - 1. Unless otherwise indicated or required by code, horizontal sanitary drainage piping 3 inches in diameter or smaller shall be installed at a uniform slope of 1/4 inch per foot 2 percent; horizontal sanitary drainage piping larger than 3 inches in diameter shall be installed at a uniform slope of 1/8 inch per foot; horizontal storm drainage piping shall be installed at a uniform slope of 1/8 inch per foot.
 - 2. All cast iron drainage piping which is buried beneath floors shall be encased in at least 6 inches of concrete. A joint shall be provided in the piping within 12 inches of each end of the encasement. For buildings supported by piers or piles, the concrete encasement shall be reinforced and connected to the floor slab.
 - 3. Plastic drainage pipe buried beneath floors shall not be encased. For buildings supported by piers or piles plastic drainage piping which is buried beneath floors shall be supported with stainless steel pipe supports per ASTM F2536.

Drainage fittings shall be installed to convey flow in the piping in the intended direction. To the extent possible, changes in direction shall be made by sweep type fittings. Quarter-bends and sanitary tee fittings shall not be installed for vertical to horizontal or horizontal to horizontal changes of direction.

5. Plumbing vents through roofs shall be located at least 12 inches from a parapet or from the intersection of a cant with the roof deck, and shall be installed with watertight flashings. Plumbing vents shall be located no closer to operable windows or air intakes than is allowed by the applicable code.

- 6. Vents connecting to horizontal sanitary piping shall connect above the centerline of the piping and shall rise at an angle of not less than 45 degrees from the horizontal to a point at least 6 inches above the flood level rim of the fixture served before offsetting horizontally.
- 7. Floor drains shall be adjusted to the correct elevation for proper drainage. Heads of fastening screws shall be flush with the grate surface.
- 8. Cleanouts on drainage piping inside structures shall be located where indicated on the Drawings. Additional cleanouts shall be provided where required by the applicable code or authority having jurisdiction. Cleanouts located in drainage risers shall be located 12 inches above the finished floor.
- 9. Unless otherwise indicated or required by the applicable code, cleanout size shall equal the line size for 4 inch and smaller drainage piping, and 4 inch in diameter for drains larger than 4 inch. Proper clearance shall be provided for access to cleanouts. Floor cleanouts shall be installed flush with the finished floor.
- 10. Floor drains, trench drains, floor sinks, funnel receptors, and bell-up drains indicated to be equipped with traps shall be provided with deep seal "P" traps located as close to the drain as possible.
- 11. Roof drains shall be set at the proper level for flashing and drainage and shall be securely attached to the roof decks to prevent movement, unless otherwise indicated. Overflow roof drain dams or standpipes shall be set at an elevation 2 inches above the low point of the roof.

3.4 FIELD QUALITY CONTROL

- A. Installation Check
 - 1. An installation check by an authorized representative of the manufacturer of equipment specified herein is not required.
- B. Startup and Testing
 - 1. Field performance tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer.



If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3.5 ADJUSTING

A. All devices shall be adjusted for proper flow and quiet operation. Faucet and supply assemblies shall be adjusted or repaired to eliminate leaks. All drains shall be checked for proper operation.

3.6 **PROTECTION**

A. Plumbing fixtures, equipment and appurtenances shall be protected from damage immediately after installation. Plumbing fixtures shall not be used during the construction.

3.7 CLEANING

- A. After completion of testing and immediately before the final inspection, plumbing fixtures, equipment, piping, and appurtenances shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer. All faucet aerators shall be removed, cleaned, and reinserted.
- B. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3.8 DISINFECTION

- A. Before the non-potable water system is placed in operation, it shall be disinfected in accordance with the requirements of the local authority having jurisdiction. In the absence of local requirements, the following disinfection method shall be used:
 - 1. The system shall be purged with clean W4 plant well water until all dirt and other substances are flushed from the system.
 - 2. The system shall be filled with a water/chlorine solution containing at least 50 parts per million of available chlorine and allowed to stand for 24 hours; or the system shall be filled with a water/chlorine solution containing at least 200 parts per million of available chlorine and allowed to stand for 3 hours.
 - 3. The system shall be flushed clean W4 well water until the chlorine is removed from the system.
 - 4. The procedure shall be repeated if a bacterial examination indicates that contamination remains present in the system.

3.9 OPERATOR INSTRUCTION AND TRAINING

After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

- 1. Documentation in the final Operation and Maintenance Manuals.
- 2. Use the Operation and Maintenance Manuals.
- 3. Equipment and system startup and shutdown.
- 4. System operation procedures for all modes of operation.

- 5. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.
- B. The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be.
- C. At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is



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SECTION 22 05 11 - BASIC MECHANICAL BUILDING SYSTEMS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers general mechanical building system requirements for the plumbing and heating, ventilating, and air conditioning systems as referenced from other sections and furnishing and installation of:
 - 1. Mechanical identification
 - 2. Seismic restraints
 - 3. Special coatings
- B. Protective coatings for ductwork and equipment without special coatings shall be as specified in the Protective Coatings and Architectural Painting sections.

1.2 GENERAL

- A. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by the Engineer.
- B. Coordination
 - 1. Where two or more units of the same class of materials are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

- E. Metal Thickness
 - 1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Complete information, detailed specifications, and data covering materials, parts, devices, and accessories forming a part of the materials furnished, shall be submitted in accordance with the Submittal Procedures section.

Number Plates

Product data on number plates.

A listing of equipment to receive number plates shall be submitted.

Special Coatings

Name of manufacturer.

Coating type.

Color.

Chemical resistance data.

Temperature range data.

Surface preparation

Application data.

Film thickness per coat.

Drying and curing time information.

Equipment Motors

Name of Manufacturer.

Type and Model.

Full load rotative speed.

Type of bearings and method of lubrication.

Horsepower (HP) rating and service factor.

Temperature rise and insulation rating.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.
- B. Samples
 - 1. Samples shall be submitted in accordance with the Submittal Procedures section.
 - 2. Samples of color, lettering style, and other graphic representation required for each type of identification material and device shall be submitted.

1.4 QUALITY ASSURANCE

A. Welding Qualifications

- an independen
- 1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.
- B. Manufacturer's Experience
 - 1. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5 EXTRA MATERIALS

A. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

All equipment shall be designed and selected to meet the specified conditions. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- 1. Dimensional Restrictions
 - a. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout

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drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

- 2. Elevation
 - a. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.
- 3. Equipment Efficiencies
 - a. Unless otherwise indicated in the respective equipment paragraph, the equipment efficiency shall be in accordance with the requirements of ASHRAE Energy Standard 90.1.
- 4. Drive Units
 - a. Drive units shall be designed for 24 hour continuous service.
 - 1) V-Belt Drives
 - a) Each V-belt drive shall include a sliding base or other suitable belt tension adjustment. V-belt drives shall have a service factor of at least 1.5 at maximum speed based on the nameplate horsepower kW of the drive motor unless otherwise indicated in the specific equipment paragraph. Multiple belts shall be provided in matched sets and shall be oil resistant, non-static type. External belts and drive assemblies shall be protected by a belt safety guard constructed in accordance with OSHA requirements. The guard shall be provided with a tachometer opening.
 - b) Unless otherwise indicated in the specific equipment paragraph, equipment with smaller than 10 horsepower 7.5 kW motors shall have adjustable pitch sheaves and equipment with 10 horsepower 7.5 kW and larger motors shall have fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required speed for the specified airflow.

Electric Motors

- a) Motor horsepower scheduled on the Drawings are minimum motor horsepower. Larger motors shall be provided if required to meet the specified capacities for the equipment furnished. Motors furnished with equipment shall meet the following requirements.
 - 1. Premium efficient motors with a minimum efficiency of at least that specified in the Common Motor Requirements for Process Equipment section shall be provided where available as a standard option. All other motors shall meet the minimum efficiency standards required by the 2007 Energy Independence and Security Act.
 - 2. Designed and applied in accordance with NEMA, ANSI, IEEE,

AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

- 3. Rated for continuous duty at 104 °F ambient.
- 4. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 104° F ambient, altitude exceeding 3,300 feet, explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.
- 5. To ensure long life, motors shall have nameplate horsepower kW equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp kW	Open	1.15
	Other Than Open	1.0
Integral hp kW	Open	1.15
	Other Than Open	1.0

Motors used with adjustable frequency drives shall have a 1.15 service factor on sine wave power and a 1.0 service factor on drive power.

6. Designed for full voltage starting.

7.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

- 9. Bearings shall be either oil or grease lubricated.
- 10. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.
- 11. Drip-proof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.
- 12. Totally enclosed motors shall be furnished on:
 - (A) Outdoor equipment.
 - (B) Equipment for installation below grade.
 - (C) Equipment operating in chemical feed and chemical handling locations.
 - (D) Equipment operating in wet or dust-laden locations.

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- 13. Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.
- 14. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, the motor types indicated are preferred and shall be furnished if offered by the manufacturer as a standard option.
- 15. Motors used with adjustable frequency drives shall have insulation system meeting the requirements of NEMA MG 1, Part 31.
- B. Adjustable Frequency Drives
 - 1. Adjustable frequency drives shall be provided as indicated on the Drawings and shall be coordinated with the requirements of the associated equipment. The equipment manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.
 - 2. Adjustable frequency drives shall be as covered in the Adjustable Frequency Drives section.

2.3 MANUFACTURE AND FABRICATION

- A. Welding
 - 1. All welds shall be continuous (seal type) on submerged or partially submerged components.
- B. Anchor Bolts and Expansion Anchors
 - 1. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage in Concrete and Masonry section unless otherwise indicated on the Drawings.
- C. Edge Grinding

Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

D. Surface Preparation

1. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4 MATERIALS

- A. Mechanical Identification
 - 1. Mechanical identification consisting of equipment number plates, equipment information plates, valve tags, and ductwork identification shall conform to the requirements of the Equipment and Valve Identification section and as indicated herein.
 - 2. Number Plates
 - a. Hand-lettered or tape labels will not be acceptable.
 - b. Number plates for control equipment such as but not limited to thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the specific device identification list the controlled equipment in parenthesis below the device number.
 - 3. Piping
 - a. Piping identification shall be as specified in the Protective Coatings section. The lettering size, length of color field, colors, and viewing angles of identification devices shall be in accordance with ASME A13.1.
 - 4. Valves
 - a. Valve tags shall indicate if the valve is normally open or normally closed.
 - 5. Ductwork
 - a. Ductwork shall be identified with nameplates as specified herein, or stenciled painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.
- B. Seismic Design
 - 1. Equipment and associated attachments and restraints shall be in accordance with the Meteorological and Seismic Design Criteria section 01 67 00.2.
 - 2. If required by Section 01 67 00.2, all ductwork and piping associated with the plumbing and HVAC systems shall be provided with seismic restraints in accordance with Seismic Hazard Level (SHL) of the latest edition of the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems as specified and in accordance with the applicable building code. The seismic hazard level used to design the restraints shall be level D.
- C. Special Coatings
 - 1. Where indicated on the Drawings, sheet metal ductwork, dampers, registers, grilles, coils, and equipment shall be given a special coating suitable for the corrosive atmosphere indicated. Sheet metal ductwork, dampers, registers, grilles, coils, and equipment

construction shall be suitable to allow proper application of the special coating system in accordance with the manufacturer's recommendation.

PART 3 - EXECUTION

3.1 **INSTALLATION**

- Materials furnished under this section shall be installed in proper operating condition in full. A. conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by the Engineer
- The installation of identifying devices shall be coordinated with the application of covering B. materials and painting where devices are applied to surfaces. All surfaces to receive adhesive number plates shall be cleaned before installation of the identification device.

SECTION 22 13 17 - CAST IRON SOIL PIPE AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of cast iron soil pipe and accessories for the service conditions as specified herein. Cast iron soil pipe shall be furnished complete with all fittings and other accessories.

1.2 SUBMITTALS

- A. Drawings and Data
 - 1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Items requiring submittals shall include, but shall not be limited to, the following:

Pipe, Gaskets, and Couplings

Name of Manufacturer.

Type and Model.

Construction materials, thickness, and finishes.

Coating product data sheets.

Certification by manufacturer that the pipe and fittings furnished are in accordance with referenced standards. Certification shall include legal name and address of the manufacturer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Product Marking
 - 1. Pipe and fittings shall bear manufacturer's product marking as required by the referenced standards. Markings shall be plainly marked including but not limited to country of origin, manufacturer's name, and date of manufacturer.

B.	Material Classification CI-1		
	CI-1 – Bell and Spigot	Pipe and Fittings	ASTM A74
	Building sanitary drain, waste and vent piping, building storm drain piping all locations.	Jointing Material	Rubber gaskets, ASTM C564.
C.	Material Classification CI-2		Ś
	CI-2 – Hubless	Pipe and Fittings	CISPI 301.
	Building sanitary drain, waste and vent piping, building storm drain piping, all locations except where buried.	Jointing Material	Heavy duty coupling, with neoprene rubber sleeve, 304 stainless steel shield, and stainless steel clamping bands, or bolted cast iron coupling with stainless steel bolts and neoprene gasket. Couplings shall be Clamp-All Products "HI- TORQ 125," Husky "SD 4000," Mission Rubber Company LLC "HeavyWeight Coupling," or MG Piping Products "MG Coupling," without exception.

PART 3 - EXECUTION

3.1 INSTALLATION

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A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

SECTION 22 13 29.16 - SUBMERSIBLE SUMP AND SEWAGE PUMPS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of medium and heavy duty single-stage, submersible, end suction centrifugal pumping units and controls for sewage service as specified and as indicated in the Sump and Sewage Pump Schedule on the Drawings. Each pump shall be pedestal-mounted as indicated in the schedule.
- B. Piping, pipe supports, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.
- C. Each pumping unit shall be complete with a close-coupled, submersible electric motor; controls; and all other appurtenances specified or otherwise required for proper operation.

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.
- B. Coordination
 - 1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, materials, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
 - 2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.



Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

4. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- D. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- E. Power Supply
 - 1. Power supply to equipment will be as indicated in the Sump and Sewage Pump Schedule.
- F. Mechanical Identification
 - 1. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:
 - Pumps

Name of manufacturer.

Type and model.

Rotative speed.

Size and type of pump discharge connection.

Net weight of pump and motor only.

Complete performance curves showing capacity versus head, bhp, NPSH required, and efficiency.

Seal type and manufacturer.

Data on shop painting.

Motors

Name of manufacturer.

Type and model.

Type of bearings and method of lubrication.

- Rated size of motor, hp kW.
- Full load current.
- Locked rotor current.

Control Panel and Components

Name of manufacturer.

Type and model.

Dimensions and net weight of complete panel.

Pump control sequence.

Liquid level sensors with mounting details and cable lengths, and sump controls.

Wiring diagrams.

Power and control cable type and size.

Accessories

Sump Cover

Material, thickness, and finish.

Overall dimensions.

Opening locations and dimensions.

Guiderail System

Materials.

Dimensions.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

- B. Operations and Maintenance Data and Manuals
 - 1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.
- 1.5 EXTRA MATERIALS

A. Not used.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Unless otherwise indicated in the schedules, sump pumps shall be suitable for pumping clear water with minimal solids of 3/16 inch 5 mm diameter or less, and sewage pumps shall be

PUTPOSES

suitable for pumping sanitary waste and sludge and shall pass a 2 inch sphere. The maximum pumped liquid temperature shall be 85°F.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- Pumping units shall be designed for the operating conditions and requirements indicated in the Α. Sump and Sewage Pumps Schedule.
- B. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. Minimum pump hydrostatic test pressure shall be 1.5 times the pump shutoff head. Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.
- Where indicated on the Sump and Sewage Pump Schedule to be explosionproof, pumping units C. shall be rated and labeled for use in a Class I, Division 1 or 2, Group D area, as defined by the National Electric Code. The division shall be as indicated in the schedule.

2.3 MATERIALS

MATERIALS	
Stator Housing and Pump Casing	Cast iron, ASTM A48.
Impeller	204

Impeller

Heavy	Duty	Sump	Pumps	
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Sewage Pumps

Shaft

All Wetted Assembly Fasteners

Mechanical Seals

Heavy Duty Pumps

Cast Iror

Cast Iron

Stainless steel, AISI Type 316.

Stainless steel.

Double mechanical opposed type, or Tandem mechanical type, oil lubricated with carbon/ceramic upper seal and silicon carbide lower seal.

Cast iron.

Pedestal Base **Epoxy Coating**

Primer & Finish Coat

Carboline "Carboguard 891" or Tnemec "Series N140 Pota-Pox Plus."

PUMP CONSTRUCTION 2.4

Impeller Casing

1. The impeller casing shall have well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities. Guiderail mounted pumps shall be provided with a flanged discharge nozzle sufficiently rigid to support the pumping unit under all operating conditions. Pedestal mounted pumps shall be provided with a threaded or compression discharge connection. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT.

- B. Impeller
 - 1. The impeller shall be a semi-open or enclosed one-piece casting. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced and securely locked to the shaft by means of a key and self-locking bolt or nut.
- C. Seal Chamber
 - Each heavy-duty pumping unit shall be provided with an oil-filled chamber for seal 1. lubrication. The chamber shall contain a moisture sensor and shall be provided with a fill/drain plug.
- D. Sealing of Mating Surfaces
 - All mating surfaces of major components shall be machined and fitted with O-rings 1. where watertight sealing is required. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.
- E. Lifting Chain
 - Where indicated in the Sump Pump Schedule and Standard Details on the drawings, 1. stainless steel chain or cable suitable for removing and installing each pumping unit shall be selected and provided by the pump manufacturer. The chain or cable shall be rated for at least four times the weight of the pumping unit and shall be of adequate length to reach five feet above the sump cover with the pumping unit in the normal operational position.
- F. Sump Cover
 - 1. Where indicated in the Sump Pump Schedule and Standard Details on the drawings, a sump cover shall be furnished by the pump manufacturer. The cover shall be hot dipped galvanized steel at least 3/8 inch thick or aluminum at least 1/2 inch thick. Openings in the sump cover shall be provided for vent piping, pump discharge piping, controls, and electrical cables. Opening dimensions and cover size shall be as needed to suit the equipment furnished and the sump dimensions indicated on the Drawings. An inspection opening with bolted cover shall be provided. The opening shall be at least 12 inches by 8 inches 200 mm. All openings shall be gasketed gas-tight.
 - 2. The sump cover of pedestal mounted pumping units shall be provided with a bolted and gasketed floor plate for each pumping unit. The floor plate shall be adequate in size to allow removal of a single pumping unit with attached discharge piping. The floor plate shall be galvanized, or epoxy coated steel and shall be at least 1/4 inch thick.
 - 3. Pumping units with guiderail removal systems shall be provided with a hinged access hatch mounted on the sump cover. The access hatch shall be adequate in size to remove

each pumping unit with the guiderail system. The hatch shall be provided with two hinges, handle, and padlock hasp. The hatch shall be gasketed as needed to be gas-tight.

4. Each cover shall be provided with a lifting chain hook and a support bracket for the level control float cables.

2.5 FABRICATION AND MANUFACTURE

- A. Shop Painting
 - 1. All iron and steel parts of heavy-duty pumping units which will be in contact with pumped liquid or submerged after installation, including the inside of the casing, the impeller, and the discharge elbow, shall be shop cleaned in accordance with the coating manufacturer's recommendations and painted with an epoxy coating system. The coating shall have a dry film thickness of at least 10 mils and shall consist of a prime (first) coat and one or more finish coats. At least 1 quart of the finish coat material shall be furnished with each pump for field touchup.

2.6 BALANCE

- A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 4 mils for pumping units with a nominal rotative speed of 1500 rpm or greater, 5 mils for pumping units with a nominal rotative speed of 900 rpm or less.
- B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

2.7 MOTORS

A. Motors



Pumps shall be driven by an air-filled, totally submersible electric motor manufactured by the pump manufacturer. Motors shall have a minimum service factor of 1.05. Motor nameplate rating shall exceed the maximum horsepower kW required by the pump in an operating head range 20 percent above or below the design point. The stator housing shall be an air-filled, watertight casing. Motor insulation shall be moisture resistant, Class F, 155°C. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature and designed for at least 10 starts per hour.

2. Motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The bearings shall have a calculated AFBMA L_{10} Life Rating of 40,000 hours when operating

at maximum operating head. Maximum shaft runout at the mechanical seals shall not exceed 2 mils at any point in the operating head range.

- 3. Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. Cable sizing shall conform to NEC requirements. With the exception of 120 volt units, all cables shall be of sufficient length to terminate in a junction box or control panel outside the sump as indicated on the Drawings, with 10 feet of slack which will be coiled in the sump. Power and control cables for 120 volt units shall be of sufficient length to reach the power supply receptacle or junction box as indicated on the Drawings with 5 feet of slack. Each cable shall be supported by AISI Series 300 corrosion-resistant stainless steel Kellems or woven grips to prevent damage to the cable insulation. Mounting of cable supports in the sump shall be coordinated by the supplier to prevent damage to the cable.
- 4. The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.
- 5. The motor and its integral protective controls shall be rated and labeled for use in an exposure classification like that of the pump, under both submerged and unsubmerged conditions.

2.8 CONTROLS

- A. Each pumping unit shall be provided with a complete control system as indicated herein. The control system type shall be as indicated in the Sump and Sewage Pump Schedule.
- B. Heavy-Duty Duplex Control System
 - 1. Heavy duty duplex control systems shall consist of a control cabinet and sump level sensors for control of heavy-duty duplex pumping systems.
 - 2. Control Cabinet



The control cabinet shall include for each pump all controls specified herein or required for a properly operating system. The cabinet shall include the following features:

- 1) NEMA Type 4X metallic enclosure.
- 2) One main thermal magnetic circuit breaker disconnect with external lockable operating handle.
- 3) Two NEMA rated combination magnetic motor starters with motor circuit protector and manually reset bimetallic ambient compensated overload relays.
- 4) One pump alternator.
- 5) Two control power transformers with both primary leads fused and one secondary lead fused. One secondary lead shall be grounded.

- 6) Independent control power circuit for each pump. Control power circuits shall be interlocked such that one control power circuit serves as a backup to the other control power circuit.
- 7) Ground terminal, control relays, numbered and wired terminal strip.
- 8) Two 3 position "Test-Off-Automatic" selector switch for pump operation. Selector switch shall be spring return from Test to Off position. In "Test" position the pump shall run, in "Off" position the pump shall be off, in "Automatic" position the pumps shall run as specified in the control sequence paragraph.
- 9) One high water alarm "Test-Auto-Silence" switch when high water alarm is specified in the Sump and Sewage Pump Schedule. Switch shall be spring return from Test and Silence position to Auto position.
- 10) One high water audible alarm horn and silence pushbutton and alarm light when high water alarm is specified in the Sump and Sewage Pump Schedule. Alarm horn shall be 4 inch 95 dB and shall be mounted on the bottom of the cabinet. Alarm light shall be a red flashing light mounted on top of the cabinet.
- 11) Two red running lights, two white control power on lights, two red motor overload lights, two red motor high temperature alarm lights, two red moisture detected alarm lights.
- 12) Two elapsed time meters.
- Two isolated dry type contacts for high water alarm, one common isolated dry type contact for motor overload, motor high temperature, moisture detected.
- 14) One alarm reset pushbutton. This button shall reset all alarm contacts. Alarm lights shall stay illuminated until the alarm condition is cleared.
- 3. Motor Protection
 - a. Each motor of heavy-duty pumping units shall be protected by temperature switches mounted in each phase winding and designed to operate at $140^{\circ}C \pm 5^{\circ}C$. The oil-filled seal chamber shall be provided with a moisture detection system furnished by the pump manufacturer, complete with all sensors, cables, control power transformers, auxiliary relays, and junction boxes. Motor protection controls shall be mounted inside the control cabinet. The temperature switches and moisture detection system shall be provided with a manual reset for explosionproof pumps and automatic reset for non-explosionproof pumps.
 - . Liquid Level Sensors
 - Liquid level sensors consisting of an assembly of weighted ball floats with integral switches shall be furnished by the pump manufacturer. The sensors shall be suitable for duplex pump operation with high water alarm and shall be Weil "8230 Series." Each system of sensors shall be furnished complete with all required mounting brackets, weights, galvanized steel mounting pipes and accessories, control power transformers, auxiliary relays, cables, and junction boxes.
- 5. Control Sequence
 - a. Upon an increase in sump liquid level, the lead pump shall be energized. If the liquid level continues to rise, the lag pump shall be energized. Upon a further

increase in liquid level, the high-water alarm light located on the face of the pump control panel shall be illuminated, an audible alarm shall be sounded, and the isolated alarm contact shall close. As the sump liquid level decreases to the "Pumps Off" setpoint, both pumps shall be de-energized. The pumps shall automatically alternate lead-lag duty upon each cycle. Sump liquid level setpoints shall be as indicated in the Sump and Sewage Pump Schedule. In the event that moisture is detected in the seal chamber or if high motor temperature is detected, the respective alarm light located on the face of the control panel shall be illuminated and the pump shall be de-energized. The pump shall require a manual restart.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Pumping units shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards. Grouting shall be as specified in the Grouting section.
- C. Special care shall be taken to ensure that piping stresses are not transmitted to the pump connections. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the pump connections. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.
- D. Control cables shall be supported to avoid tension and damage. Liquid level sensors shall operate freely and shall be adjusted to the levels indicated on the Drawings.

3.2 FIELD QUALITY CONTROL

- A. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.

- D. Performance and Other Testing
 - The equipment manufacturer shall provide performance and other testing services when 1. indicated in the Equipment Schedule section.

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SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the cleaning, testing, adjusting, and balancing of the air system(s) associated with the heating, ventilating, and air conditioning (HVAC).

1.2 GENERAL

- A. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. Coordination
 - 1. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.
 - 2. Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

C. Governing Standards

- 1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.
- 2. All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air systems.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete apparatus report sheets for all air systems shall be accurately and completely filled out in accordance with the Standard's manual. The testing and balancing results shall be submitted on the TAB report forms of the applicable standard. Copies of the final test readings and report sheets shall be submitted in accordance with the Submittals Procedures section.. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report

sheets. Test dates shall be recorded on the individual TAB report forms indicating when the actual testing was performed.

- 2. The apparatus report sheets shall include the following information:
 - Title Page: a.
 - 1) Company name
 - 2) Company address
 - iddineepunposes 3) Company telephone number
 - 4) Project name
 - 5) Project location
 - 6) Project Engineer
 - 7) Project Contractor
 - 8) Project altitude
 - 9) Date
 - b. Instrument List:
 - Instrument 1)
 - 2) Manufacturer
 - Model 3)
 - Serial number 4)
 - 5) Range
 - Calibration date 6)
 - Air Moving Equipment: c.
 - Unit number 1)
 - 2) Location
 - 3) Manufacturer
 - Model and serial number 4)
 - 5) Airflow, design and actual
 - Total static pressure (total external), design and actual 6)
 - 7) Static pressure, inlet and discharge
 - 8) Total pressure
 - Fan RPM, design and actual 9)
 - Electric Motors: d.
 - 1) Manufacturer
 - 2) Motor type and frame
 - 3) HP/BHP
 - Phase, voltage, amperage, nameplate, actual, no load 4)
 - 5) RPM
 - Service factor 6)
 - Starter size, rating, heater elements 7)
 - e. V-Belt Drive:
 - Required driven RPM 1)
 - 2) Driven sheave make, diameter, and RPM
 - Belt make, size, and quantity 3)
 - 4) Motor sheave make, diameter, and RPM
 - 5) Center to center distance, maximum, minimum, and actual

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

- f. Outside Air Data:
 - 1) Unit number
 - 2) System airflow, design and actual
 - 3) Outside airflow, design and actual
 - 4) Outside air temperature
- g. Duct Traverse:
 - 1) System zone/branch
 - 2) Duct size
 - 3) Area
 - 4) Velocity, design and actual
 - 5) Airflow, design and actual
 - 6) Duct static pressure
 - 7) Air temperature
 - 8) Air correction factor
- h. Outlet and Inlet Devices:
 - 1) Air outlet and inlet device number
 - 2) Room number/location
 - 3) Air outlet and inlet device type
 - 4) Air outlet and inlet device size
 - 5) Area factor
 - 6) Velocity, design, preliminary, and final
 - 7) Air flow, design, preliminary, and final
 - 8) Percent of design airflow
- i. Sound Level Report:
 - 1) Location
 - 2) Octave bands equipment off
 - 3) Octave bands equipment on
- j. Air Cooled Split System Heat Pump:
 - 1) Unit number
 - 2) Location

5)

- 3) Manufacturer and model
 - Refrigerant type and cooling/heating capacity
 - Entering DB air temperature, design and actual
- 6) Leaving DB air temperature, design and actual
- 7) Number of compressors
- 8) Suction pressure and temperature

Product data indicating cleaning materials and treatment, chemicals, and reports on the analysis of system water after cleaning and after treatment, shall be submitted in accordance with the Submittals Procedures section.

1.4 QUALITY ASSURANCE

A. Contractor shall provide the services of a licensed independent contractor, certified by AABC, NEBB, or TABB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air systems. The work shall be performed in

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accordance with the latest edition of the procedural standards as published by the National Organization associated with the testing, adjusting, and balancing contractor.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the equipment sections.

2.2 CONSTRUCTION

- A. Painting
 - 1. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings sections.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Dampers shall be open and access doors and panels shall be closed during the testing and balancing period.
- B. A resistance shall be placed at all filter locations to simulate dirty filter conditions. The filter resistance shall be as follows:

Filter Type

A

Simulated Loss

2 inch pleated

0.35 inch water column

3.2 STARTUP REQUIREMENTS

System equipment shall be subject to preliminary field tests as indicated in Startup Requirements section.

3.3 FIELD PERFORMANCE TESTING

A. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material

shall be replaced, and the inspection and tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

B. Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

<u>Filter Type</u>	Dirty Filter Conditions
2 inch pleated	1 inch water column

- C. Refrigerant Piping
 - 1. The refrigerant piping system shall be tested in accordance with ANSI/ASME B31.5.
 - 2. After testing of the refrigerant piping system is completed, the system shall be charged with the proper refrigerant and placed in operation.
 - 3. The completed refrigerant system shall be guaranteed to be sufficiently free from leaks for 1 year from the date of acceptance. The loss of refrigerant shall not exceed 5 percent over that period.

3.4 CLEANING

A. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3.5 ADJUSTING & BALANCING

- A. The air system shall be adjusted and balanced.
- B. All instrumentation shall be calibrated in accordance with the governing standard manual and shall be checked for accuracy before testing, adjusting, and balancing the systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.
- C. All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.
- D. Following final acceptance of the certified balancing reports, the testing and balancing contractor shall permanently mark the settings of all adjustment devices, including valves and dampers, and shall lock the memory stops.
- E. All ceiling tiles, belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.
- F. Air Systems

Testing, Adjusting, and Balancing

- 1. Air systems shall be adjusted to the design airflows indicated on the Drawings. Airflows shall be adjusted to maintain a net positive (supply airflow greater than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the Drawings. Dampers located behind air outlet and inlet devices shall be used to adjust the airflow only to the extent that the adjustments do not create objectionable air movement en in the elsed in or noise. Fans shall not be adjusted above the maximum safe speed as determined by the fan manufacturer.
 - Dampers with operators shall be checked for tight shutoff when in the closed position.

SECTION 23 09 11 - BUILDING SYSTEMS CONTROLS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the design, furnishing, and installation of control systems and instrumentation associated with the heating, ventilation, and air conditioning (HVAC) equipment and systems including all associated equipment, devices, and controls necessary for proper operation.

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. All software and documentation developed for the project building system controls shall become the property of the Owner upon completion of the project. These include but are not limited to system documentation, project graphic images, project database, record drawings, and specific project application programming code.
- C. Coordination
 - 1. The control and instrumentation shall be designed and coordinated for proper operation with the controlled equipment and materials furnished under other sections, under other contracts, and with related existing equipment. All controls devices and instruments shall be applied in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the device manufacturer and controlled equipment manufacturer unless exceptions are noted by Engineer.
 - 2. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.



Contractor to make sure that new system components to be incorporated into the existing DDC system at the facility which is utilized in other buildings throughout the site. Owner's current standard includes Distech controllers integrated with using Niagara framework and programming.

- 4. Where two or more units of the same class of equipment or instrumentation are needed, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
- 5. Contractor shall provide coordination with the other contractors and supervision of installation as needed during construction. This includes products furnished but not

necessarily installed, products installed but not necessarily furnished, and products not furnished and installed but integrated with the building control systems.

- 6. Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. The temperature controls supplier shall design and furnish a complete and functional control system in accordance with this Section, the Drawings, specifications, and sequence of operation. The control wiring shall be furnished and installed as described herein so that all HVAC equipment will function as described in the HVAC sequence of operation
- 7. Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper and valve actuators, temperature/digital control panels, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the cable and raceways paragraph. Cable and conduit for all HVAC power circuits shall be as specified in the Electrical section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
- 8. Motor starters will be provided with terminal blocks for the termination of conductors for operational control and run/off status of the equipment. Refer to the electrical schematics for additional information.
- 9. The temperature controls supplier shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on supplier representatives for temperature controls shall be included with the submittals.
- 10. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.
- D. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Governing Standards

- . Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.
- 2. When indicated by the applicable codes, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing organization acceptable to the governing authority.

- F. Power Supply
 - 1. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or necessary for a properly operating system.
- G. Metal Thickness
 - 1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.
- H. Mechanical Identification
 - 1. Mechanical identification for equipment, control devices, piping, valves, and ductwork shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.
- I. Lubrication
 - 1. Lubrication shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

A. Drawings and Data

b.

- 1. Complete assembly and installation drawings, power wiring, control wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications shall include, but shall not be limited to, the following:
 - a. Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.
 - Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring and instrument piping with all terminals and ports accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.
 - c. Written sequence of operation for each system corresponding to the control schematics.

- d. Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.
- e. Space thermostat schedule indicating the types of covers and means of adjustment for each space.
- f. Conduit and wire types.
- g. Data for DDC system hardware, software, and architecture including schematic diagrams for all control, communication, and power wiring. The schematic diagrams shall indicate how each device is wired and powered and include a schematic flow diagram with air and refrigeration system components and control devices.
- h. A point list for each system controller including both physical inputs and outputs along with virtual points. The list shall include the name, scanning frequency, units, default value, alarm values and alarm differentials to return to normal condition, massage and alarm report, and description.
- i. A list of color graphic screens indicating the conceptual layout of pictures and data to be available at the operator terminal.
- B. Operations and Maintenance Data and Manuals
 - 1. Adequate operation and maintenance information shall be supplied as required in the Submittal Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.
- B. Contractors Qualification
 - 1. The entire system shall be designed, coordinated, and supplied by a qualified Contractor who is regularly engaged in the business of designing and building instrument and control systems for heating, ventilating, and air conditioning equipment. The Contractor shall have at least 5 years of documented experience in designing and installation of the products specified and shall be employed by the control manufacturer or be an approved certified installer with full responsibility for proper operation of the control including startup and calibration of each component in the controls system.

The qualified Contractor shall have particular experience with Niagara programming for new system integration with the existing operating DDC system at the facility.

C. Y Tolerances

1. Unless otherwise indicated, the controls shall maintain space temperatures within $\pm 2^{\circ}$ F, and the relative humidity within ± 5 percent of the setpoint.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

- A.
 Extra materials shall be furnished for the systems as follows:

 Extra Materials
 Quantity

 Thermostats
 1 of each type

 Current sensor
 1 of each type
- B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.
- C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. A complete system of automatic temperature controls shall be furnished and installed to accomplish the control described in the sequence of operations. All control equipment shall be compatible for operating with the control system provided.
- B. The control system shall consist of all necessary thermostats, control valves, switches, relays, timers, and gauges in accordance with the sequence of operation indicated on the Drawings. Technical engineering services, including but not limited to engineering, programming, installation supervision, commissioning, and troubleshooting shall be provided for a complete and functional system.
- C. Elevation
 - 1. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2.3 ACCEPTABLE MANUFACTURERS

A. The temperature control components and systems shall be manufactured by Distech or approved equal. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated. Niagara programming framework shall be utilized for the new components for their integration into existing DDC system.

2.4 MATERIALS

- A. All products used shall be new and part of the manufacturer's current product line. Materials shall be supported for at least 5 years after completion with extra materials available.
- B. Electric/Electronic Control Systems
 - 1. Electric/electronic control systems shall be furnished and installed as indicated on the Drawings and specified herein.
 - 2. Thermostats
 - a. Thermostats specified in the individual equipment paragraphs shall be provided with the respective equipment.
 - <u>Two Position Wall Mounted Thermostats (Blowers)</u>. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch," Penn Controls "A19BAC-1," or Siemens Building Technologies.

Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35° F to 100° F with a nonadjustable differential of 3.5° F. The thermostats shall have a spdt switch rated for 1 horsepower.

2) <u>Two Position Corrosion Resistant Wall Mounted Thermostats (Pipe Galleries)</u>. Two position wall mounted thermostats located in wet or corrosive environments shall be Honeywell "T631F."

Two position corrosion resistant wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35° F to 100° F 2 with a nonadjustable differential of 3.5° F. The thermostats shall have a spdt switch rated for 1 horsepower.



Low Limit Thermostats. Low limit thermostats shall be Honeywell "L480," or Penn Controls "Model A11A-1," or Siemens Building Technologies.

Low limit thermostats used for low temperature cutout shall be capillary, line-voltage type, complete with spst switches. The sensing elements shall be at least 20 feet long. The thermostat shall be responsive to the lowest temperature along the measuring element, shall have a range of approximately 35° F to 45° F, and shall be manually reset.

4) <u>Programmable Wall Mounted Thermostats</u>.

Programmable, wall mounted thermostats shall be provided by split system DX heat pump manufacturers.

Programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45° F to 95° F 7° with the following features:

- a) 7-day programming with 2 occupied/unoccupied periods per day.
- b) Automatic heat/cool changeover.
- c) Battery backup.
- d) Setback controls to automatically restart and temporarily operate system during setback periods.
- e) Digital display.
- f) Temporary override of setpoints.
- g) Configurable LED's.
- h) Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.
- 5) <u>Hydrogen Sulfide Gas Detectors</u>. Gas detectors denoted H2S on the drawings to be provided by Div. 22 and connected to DDC system for ventilation interlock and general alarming.

H2S Gas Detectors shall have an electrochemical sensor, to be 3 wire, with sink or source current output 4-20mA, input voltage 24 VDC, and have 3 relay SPDT outputs.

Full scalable range shall be form 10.0 to 100.0 ppm with default alarm point A1 - 10 ppm and A2 - 20 ppm. Accuracy <+- 1ppm.

The sensor housing to be constructed from stainless steel and shall come with integral mounting plate with 4 x mounting holes for M8 bolts. IP66 rated.

Basis of design model: Honeywell Sensepoint XCD. Equivalent products are acceptable: Rosemount, ABB, or MSA.

- C. Direct Digital Control Systems
 - 1. General



The Direct Digital Control (DDC) system shall be furnished and installed as indicated on the Drawings and as specified herein. The DDC system shall consist of all sensors, controllers, network managers, control relays, actuators, wiring, and other devices necessary for a complete and functional system. The system shall be capable of integrating multiple HVAC system functions, including data sharing, alarm/event management, scheduling, trending, and device/network management.

The DDC system of FRSA AGS shall provide remote monitoring, accessing and control of the HVAC equipment. The facility consists of two buildings. Each building has a localized Temperature Control Panel (TCP) and only Pipe Gallery has Equipment Control Panel (ECP). The panels shall house all necessary relays, controllers, terminal strips and power supplies. The DDC panel shall be located in MCC Room and provided the aggregation of the controls data from the two building. The DDC panel shall provide communication with the existing plant DDC System.

- c. The Contractor shall furnish and install a direct digital control (DDC) building automation system (BAS) based on the Niagara framework with Distech controllers. The Contractor prior the bidding to verify onsite the spare capacity of the existing DDC system to tie-in new facility building control system.
- d. The Contractor shall provide all relays, controllers, gateways, thermostats, damper actuators controlled by DDC. A dedicated DDC control panel will be located inside the MCC Room.
- e. New graphics shall be created and added into the existing Operator's Station on the plant. A Web access remote access point shall be provided for special plant personnel determined by the Owner.
- f. The Contractor to provide in the submittals a detailed description of the DDC system and its components, both hardware and software including:
 - 1) A block diagram of the BAS showing overall configuration and identification of all major components.
 - 2) A list, along with technical data of every hardware component provided, including stand-alone panels, interface devices, communication devices, sensors, relays, transducers, etc.
 - 3) A detailed description of the operating system and Operator Control Language (OCL) software, and list of description of all alarms, reporting, and trending routines, and other applications.
- g. The DDC system shall consist of, but shall not be limited to, the following:
 - 1) A network of interoperable, stand-alone digital controllers for control of make-up air unit and exhaust fans, . Electric unit heaters, wall heaters are controlled locally via vendor provided thermostats, while DDC system monitors them for common alarm/failure status.
 - 2) Hydrogen sulfide gas detectors (H2S) to be provided and be part of the DDC system and not the plant PCS system.
 - 3) An integrated, open protocol communication network consisting of multilevel buses for communication between the operator interface, building controllers, custom application controllers, and application specific controllers.
 - 4) Sensors, transmitters, detectors, and accessories necessary for proper operation of the system and equipment.
 - 5) Documentation and software forming a complete operating system to achieve the sequence of operations indicated on the Drawings.
 - A workstation for use as a operator graphical interface for alarm management, configuration, and programming.

Contractor to coordinate with Owner if interface graphics can be integrated into existing operator stations or a new operator's terminal shall be supplied (by the Contractor).

- The system shall be of modular design and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers, and operator devices.
- i. The failure of any single component, including the building controller, or network connection shall not interrupt the execution of control strategies at other operational devices. Master controllers shall employ a spare control strategy to ensure control execution is not interrupted.

- 2. Performance
 - a. The system performance, control stability, and accuracy shall be as in the individual device paragraph and as indicated below.

Control Variable	Control Accuracy	Range of Medium
Air Pressure	± 0.2 inch wc ± 0.01 inch wc	0-6 inches wc -0.1 to 0.1 inch wc
Airflow	$\pm 10\%$ of full scale	
Space Temperature	±2° F	
Duct Temperature	±3° F	

- b. The system design shall be sized at all levels such that the system can be expanded to at least twice the number of input and output objects required for this project.
- 3. Networking/Communications
 - a. The DDC system shall be an integrated open protocol communication network system configured to perform the functions described in the sequence of operation. The system arrangement shall be a multi-level system consisting of a high speed, peer-to-peer bus for communication between the workstation and building controllers and a secondary bus for communication between building controllers, custom application controllers, and application specific controllers. The communication buses shall be capable of communicating information such as global objects, alarms, and operator-entered commands and information requests. The system's design shall include provisions to expand or modify the network.
 - b. The design of the network system shall be as required to communicate with third party systems using an open protocol or gateway for proprietary type systems.
 - c. The DDC controllers shall be capable of full stand-alone operation allowing execution of control strategies with default values when bus communication and global data is not available. In addition, the controllers shall reside on the network so that communications may be executed directly to and between DDC controllers, and shall allow intelligent interface for program changes, command inputs, and output of operating data.
 - d. The digital control system shall allow all operator devices, either network resident or connected via the Internet, to access all point status, status information, system software, custom programs, and application report data on the network. Access to system data shall not be restricted by the hardware configuration of the DDC system and shall be capable of system access by a standard web browser over the Internet.
 - When it would be inefficient or impractical to provide multiple sensors, the digital control system shall provide global data sharing or global point broadcasting between DDC controllers.

f. The network design shall provide:

- 1) Data transfer rates for alarm reporting and quick point status from multiple DDC controllers.
- Support of any combination of DDC controllers. A minimum of 50 DDC controllers shall be supported on a single local network or control bus. The bus shall be addressable for up to 50 DDC controllers.
- 3) Detection of single or multiple failures of DDC controllers or the network media.

- 4) Error detection, correction, and re-transmission as necessary to guarantee data integrity.
- 5) Commonly available, multiple-sourced, networking components shall be used.
- 6) Use of an industry standard protocol, such as Ethernet, for communications interface at the network interface level.
- 7) Automatic synchronization of controller time clocks at least daily. A change to the time clock in any controller shall automatically broadcast to all controllers on the network.
- g. Each building controller, custom application controller, and application specific controller shall include provisions for connection to a portable operator's terminal which will allow the system operator to interface with the control network.
- 4. Operator Workstation (applicable if required)
 - a. See chapter in section above C-1-b-6 for coordination whether the Operators Workstation to be provided or only graphics updated at the existing plant workstation.
 - b. The operator workstation shall be furnished by the Contractor.
 - c. The operator workstation shall be provided as a graphical user interface for command entry, information management, network alarm management, and database management functions. The workstation shall consist of a personal computer with color monitor, mouse, keyboard, and printer. The workstation will allow a user to interface with the network via dynamic color graphics. Each mechanical system, floor plan, and control device will be depicted by point-and-click graphics. The workstation performance shall display a graphic with 20 dynamic points with all current data within 10 seconds and be able to refresh within 8 seconds. Any command by the operator shall cause a reaction at the device in less than 2 seconds. All scanned data shall be current within the previous 6 seconds.
 - d. The workstation shall have multiple-level password access protection so that each user can have a unique username and password. Operators will be able to perform only the commands available for their respective passwords as set by the system administrator. Menu selections displayed at any operator device shall be limited to only the items defined for the access level of the password used to log-on. A user-definable, automatic log-off timer shall be provided to automatically log off the current operator should keyboard or mouse inactivity be detected. The same passwords shall be used at any controller for the specific user and all security system data shall be stored in an encrypted format.

The operator interface shall allow the operator to perform commands including, but not limited to, the following:

- 1) Start up or shut down selected equipment.
- 2) Adjust setpoints.
- 3) Add/modify/delete control strategies.
- 4) Enable/disable process execution.
- 5) Enable/disable totalization for each point.
- 6) Enter temporary override schedules.
- 7) Define holiday schedules.
- 8) Change time/date.
- 9) Add/modify/delete alarm points and limits.
- 10) Command controller outputs for maintenance/test operations.
- 11) View and acknowledge a minimum of the last 50 alarms.
- 12) Create, delete, or modify control strategies.
- 13) Add/delete objects to the system.
- 14) Generate reports formatted for printing.

5. Software Features

- a. <u>System Software</u>. The system software shall provide a multitasking type environment that allows the user to run several applications simultaneously while monitoring information and annunciating alarms. The software shall be graphically orientated allowing up to 10 graphic screens to be displayed at once. Graphic screens shall have the capability to contain objects for text, real-time values, animation, logs, graphs, document links, schedule objects, and links to other graphic screens. A graphics library of HVAC system elements shall be included with the ability for the user to edit objects and add custom symbols.
- b. The workstation shall provide the ability for off-line storage of system information for each controller database. The database shall be automatically updated each time a change is made for any controller. In the event a controller database is lost, the workstation shall automatically update the controller database or shall be manually restored. The system shall automatically monitor operation of workstation, network connections, and controllers and alarm on the failure of any component.
- c. For each system point, high/low limits shall be configurable to alarm in and out of the normal state. Alarm messages shall use English language descriptor such that the source, location, and nature of the alarm can be determined without use of acronyms or other mnemonics. From the alarm, the operator shall be able to view details of the alarm, determine what action if any should be taken, and be able to acknowledge the alarm.
- d. The workstation software shall have the capability to easily define trend logs for any data object in the system and display the data. Data shall be able to be saved to file and/or printed. Each system alarm and change of state shall be viewable from any location in the system. Events shall be listed chronologically.
- e. Software shall provide report and log archiving and historical reporting. Each report shall be definable and in a format that is readily accessible by other standard software applications. A library of standard reports that can be easily customized shall be provided.
- f. Application editors on the workstation shall be provided to support the editing of all system applications downloaded and executed at the controllers. The editor shall be full screen that allows the operator to view and change the configuration, names, control parameters, set points, and set schedules.

The workstation shall also have custom application tools for creating, modifying, and debugging custom application programming. The system shall support creating, editing, compiling, and downloading custom programs while other system applications are operating.

h. The software shall be able to generate reports with monthly summaries indicating the information listed below. In addition, a twelve-month summary report shall be available for each month.

- 1) Electrical Meter Reports (each meter)
 - a) Daily electrical consumption
 - b) Daily peak demand with time
- 2) Gas Meter Report (each meter)
 - a) Daily natural gas consumption

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- 3) Weather Report Data
 - a) Daily minimum
 - b) Daily maximum
 - c) Average outdoor temperature
 - d) Heating degree days for each day
 - e) Cooling degree days for each day
- i. <u>Controller Software</u>. All necessary software to form a complete operating system shall be provided as an integral part of the DDC system and shall not be dependent upon a higher-level computer for execution. All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization. The programs shall be applied to building equipment described in the Sequence of Operations. As a minimum, the software shall include the following:
 - 1) Scheduling: Control software shall include a capability to schedule each object or group of objects in the system. Scheduling shall include provisions for time of day, calendar, weekly, exception, and holiday scheduling.
 - 2) Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
 - 3) Energy Management Applications: The DDC system shall be able to perform any or all of the following energy management routines:
 - a) Optimal Start
 - b) Optimal Stop
 - c) Run time totalization
 - d) Demand Limiting
 - e) Load Rolling
 - 4) Programming Capability: The DDC system shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.

Process Inputs and Variables: It shall be possible to use any of the following in a configured process:

- a) Any system-measured point data or status
- b) Any calculated data
- c) Any results from other processes
- d) Conditional statements (if, then, else, else-if)
- e) Boolean logic operators (and, or, not)
- f) Relations (equal, less than, greater than, not equal)

Process Triggers: Configured processes may be triggered based on any combination of the following:

- a) Time of day
- b) Time interval
- c) Calendar date
- d) Other processes
- e) Events (e.g., point alarms)
- 6) Data Access: A single process shall be able to incorporate measured or calculated data from any DDC controller and shall be able to issue commands to points in any and all other DDC controllers on the network.
- 7) Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each controller shall perform distributed, independent alarm analysis and filtering

to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. Alarms shall be displayed and acknowledged via the operator workstation. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.

The DDC system's ability to report alarms shall be affected neither by operator activity at the local I/O device, nor by communications with other DDC controllers on the network.

Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.

The user shall be able to identify the conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

In addition to the point description and the time and date for alarm messages, the user shall be able to display or store an alarm message to more fully describe the alarm condition or direct operator response. Each message may be assignable to any number of points in the panel.

- 6. DDC Controllers
 - a. Each DDC controller shall operate as a stand-alone controller capable of performing its specified control strategies independently of other controllers in the network. Each DDC controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.
 - b. Each DDC controller shall have sufficient memory to support its own operating system and data bases, including the following:
 - 1) Control processes.
 - 2) Energy management applications.
 - 3) Operator I/O port (portable service terminal).
 - c. The operator interface to any DDC controller point data or programs shall be through the network resident workstation or portable operator's terminal connected to any DDC controller on the network. DDC controllers shall directly support the temporary use of a portable service terminal that can be connected to the DDC controller via an input jack located on the controller.
 d. All system setpoints, proportional bands, control algorithms, and any other

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the DDC controller.

- Each controlled device or function shall be a separate output of the DDC controller and a single controller shall only control one piece of equipment. All points associated with a control loop shall be monitored or controlled from a single controller. Programmable controllers shall be able to execute PID control loops at a selectable frequency of at least once each second. This includes the updating of process value and output generated.
- f. DDC controllers shall be capable of operating in an environment with a temperature range of 32° F to 120° F and 10% to 90% relative humidity, non-condensing.

e.

- g. Each controller shall have LED indication for power, communication, and processor status.
- h. Building Controllers
 - 1) An adequate number of building controllers shall be provided to achieve the sequence of operation and meet the DDC system performance requirements. The controller shall have sufficient memory to support it operating system, database, and programming requirements. The controllers shall manage the input and output communications signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms. The controller shall have an integrated real-time clock,
 - 2) The controller shall be provided with physical points available for future use. The number of spare points shall equal 20 percent of all physical points.
 - 3) Building controllers shall continuously perform self diagnostics, communication diagnostics, and status check of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode as specified in the sequence of operations and generate a local and remote alarm notification.
 - 4) The controller shall be suitable for operation when the voltage is between 90% to 110% of normal voltage. In the event of power loss, there shall be an orderly shutdown of the controller to prevent the loss of database or software programming. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
 - 5) Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.
- i. Standard Application Controllers
 - Standard application controllers are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user-programmable but are customized for operation within the confines of the equipment they are designed to serve. The controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss. Standard application controllers shall communicate with other controllers on the secondary bus but is capable of stand-alone operation to provide control functions without being connected to the network.
 - Standard application controllers shall continuously perform self diagnostics, communication diagnostics, and status check of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode as specified in the sequence of operations and generate a local and remote alarm notification.
 - The controller shall be suitable for operation when the voltage is between 90% to 110% of normal voltage. In the event of power loss, there shall be an orderly shutdown of the controller to prevent the loss of database or software programming. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
 - 4) Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention. Standard application controllers shall be capable of program execution frequency of at least once every 5 seconds with the actual execution time consistent with the mechanical process under control.

3)

- 7. Sensors and Controllers
 - Wall Mounted Temperature Sensors. Space temperature sensors shall use a a. precision type accurate to $\pm 0.5^{\circ}$ F $\pm 0.3^{\circ}$ C over a temperature range of 40° F to 90° F 5° C to 32° C. The assembly shall be installed within a ventilated off white enclosure suitable for wall mounting. The output shall be compatible with the controller it serves. Where manual overrides are indicated, the sensor shall include push button override capability, thermometer or temperature indication, sliding warmer/cooler mechanism for adjusting the temperature setpoint, and latching cover.
 - Duct Mounted Temperature Sensors. Duct mounted temperature sensors installed b. in ducts smaller than 10 square feet 0.92 square meters shall be a single point type. Duct mounted temperature sensors installed in ducts greater than 10 square feet 0.92 square meters or subject to temperature stratification shall be averaging type. Sensors shall be a general purpose type with an operating range as needed for the application and an accuracy of $\pm 1^{\circ}$ F $\pm 0.5^{\circ}$ C over the full range. The output shall be compatible with the controller it serves.
 - Wall Mounted Humidity Sensors. Wall mounted humidity sensors shall be capable c. of providing continuous measurement of percent relative humidity with an accuracy of ± 5 percent over the range of 10 to 80 percent RH. The assembly shall be installed within an enclosure matching the wall thermostat cover. The output shall be compatible with the controller it serves.
 - d. Pressure Sensors. Pressure sensors shall be suitable for air or water service. Accuracy shall be ± 1 percent of full scale for water service and ± 0.1 inch we for air service. The unit shall have temperature compensation so that thermal effects are no more than ± 0.5 percent of the full scale from 32° to 100° F. The transmitter shall be suitable for the media and pressure measured.
- 8. Power Supply
 - Auxiliary transformers, where required, shall be factory wired with overcurrent a. protection in both primary and secondary circuits and shall be UL listed. Transient voltage and surge protection for all workstations and controllers shall be provided and shall be selected to meet the recommendations of the control system manufacturer.
- D. **Temperature Control Panels**
- 1.
- Temperature control panels, denoted by the symbol "TCP" and an identifying number, shall be manufactured by Hoffman Engineering, Hubbell, or Rittal Corporation. Temperature control panel enclosures shall be NEMA Type 12 unless otherwise indicated on the electrical Drawings with a special area designation. Where a panel is located in a room with a special area designation, the panel shall be constructed to meet the special area designation requirements. Panels shall be designed for wall mounting and shall be completely prewired and checked. All electrical accessory devices and internal wiring shall be furnished and installed.
 - 2. Where required by the applicable codes and ordinances, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing agency acceptable to the governing authority.

- 3. All controllers, selector relays, switching relays, interlock relays, manual switches, timers, alarm, and other devices indicated to be panel mounted shall be mounted in or on the respective control panel. Accessories such as indicating lights, pushbuttons, alarm horns, and selector switches shall be mounted on the front hinged covers of the panels. The accessories and panels shall be identified with an identification plate as described in the Equipment Identification paragraph. The identification plates shall be fastened to the panel with corrosion resistant pan head screws.
- 4. Each temperature control panel shall supply power to all associated control system field control components, including but not limited to, damper operators, thermostats, sensors, smoke detectors, and valves. The controls shall include all necessary relays, interlocks, and control devices to enable the control panel to function as described in the sequence of operations on the Drawings.
- 5. All interconnecting wiring and wiring to terminals for exterior connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame-resistant covering rated for at least 90° C. Power distribution wiring on the line side of panel fuses shall be at least 12 AWG. Wiring for secondary power distribution and for control, annunciation, and indicating light circuits shall be at least 14 AWG. Wiring shall be color coded in accordance with the color coding legend on the panel wiring diagrams.
- 6. Equipment operational control and run/off status shall be provided from terminal blocks within the respective motor starter. Refer to the electrical Drawings for additional information.
 - a. <u>Selector Switches</u>. Selector switches shall be Micro Switch "Type PT," Cutler-Hammer "Type 10250T," or General Electric "CR." Selector switches shall be heavy-duty 30 mm oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the Drawings or as necessary for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty.
 - b. <u>Push Buttons</u>. Push buttons shall be Micro Switch "Type PT," Cutler-Hammer "Type 10250T," or General Electric "CR." Push buttons shall be heavy-duty, oiltight type, with legends engraved on the faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac.

Indicating Lights. Indicating lights shall be Micro Switch "Type PT," Cutler-Hammer "Type 10250T," or General Electric "CR." Alarm, indicator, and running status lights shall be furnished with lamps. Indicating lights shall be heavy-duty, 30 mm, push-to-test, oiltight type with LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the device.

- d. <u>Alarm Horns</u>. Alarm horns shall be Federal Signal "Model 350." Alarm horns shall have a sound output of 100 dB at 10 feet [3 m] and shall be rated for 120 volts ac. Horns shall be furnished with mounting hardware suitable for flush mounting.
- e. <u>Relays</u>. Relays shall be Eagle Signal "Series 22, 80"; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series A3, A4." Relays shall be of the plug-in socket base type, with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts

rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have goldplated or gold alloy contacts suitable for use with low level signals. Relays used for alarm input or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials or engraved switch settings marked in seconds and shall have timing repeatability of ± 2 percent of setting. Latching and special purpose relays shall be as needed for the specific application.

- f. <u>Terminal Blocks and Panel Wiring</u>. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated, shall be complete with marking strip, covers, and pressure connectors, and shall be labeled to agree with the identification on the temperature control manufacturer's submittal drawings.
- g. <u>Control Power Transformers</u>. Where 24 volt ac control power is necessary for the temperature control components, 120/24 volt transformers shall be furnished and mounted in the respective temperature control panel. Control power transformers shall be sized by the manufacturer based on the equipment load of the panel, shall be copper wound, vacuum impregnated with solid polyester varnish, and shall be 100 percent tested in strict compliance with ANSI, CSA, and UL codes. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded. The control power transformers shall be sized by the manufacturer based on the equipment load of the panel.
- <u>Terminals</u>. A terminal shall be provided for each conductor of external circuits, plus one ground cable. At least 8 inches 203 mm of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. At least 25 percent spare terminals shall be provided.
 All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or shall be routed in Panduit or similar non-metallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and shall have a space of at least 40 percent of their depth remaining for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.
- i. <u>Painting</u>. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with universal primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surfaces shall be filled before the surface is painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils 100 μm. One quart of paint shall be furnished with the panels for future touchup painting.

Accessory Components

All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2.5 CONSTRUCTION

- A. Shop Painting
 - 1. Unless otherwise indicated, shop painting shall be as specified in the General Equipment Stipulations. Surface finish damaged during installation shall be repaired to the satisfaction of the Engineer. Field painting shall conform to the requirements of the Protective Coating section.

2.6 CABLE AND RACEWAYS

- A. Cable
 - 1. Cable used in the temperature control system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations. All cable necessary for the system, except 120 volt ac power, shall be furnished and installed by the System Supplier.
- B. Raceways
 - 1. All cable shall be installed in conduit furnished under this section. Conduit materials shall conform to the applicable paragraphs of the Electrical section.

2.7 ELECTRICAL

A. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.8 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.
- B. Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3.2 PREPARATION

- A. Field Measurement
 - 1. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.
- B. Surface Preparation
 - 1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.
 - 2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Architectural Painting and Protective Coatings sections.

3.3 INSTALLATION

- A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the Drawings. Control equipment shall be installed with adequate operating and maintenance access space.
- C. Temperature Control Panels
 - 1. The panels shall be mounted so that selector switches and indicating lights on the panel are located approximately 5 feet above the finished floor.
- D. Thermostats



Wall-mounted thermostats shall be mounted above the finished floors as indicated in the Electrical section. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

- 2. Wall-mounted thermostats in non-air conditioned areas shall be furnished and installed with a cast aluminum or wire guard.
- E. Device Tag Numbering System
 - 1. All devices shall be provided with permanent identification tags numbered to agree with the manufacturer's equipment drawings. All field-mounted control devices shall bear securely fastened identification tags. Hand-lettered labels or tape will not be acceptable.

- 2. Phenolic nameplates shall be provided and permanently attached to the wall at each control device to indicate the equipment controlled. The letters used shall be the same as the equipment designations indicated herein and on the Drawings. Nameplates shall have white letters on black backgrounds.
- F. DDC System
 - 1. Controllers shall be mounted in accordance with manufacturer's installations. All software shall be installed, initialized, programmed, and tested. System point names shall be modular in design with location, system, identification, and action represented, allowing easy operator interface without the use of a written point index.
- G. Cable
 - 1. Cable shall be installed in conduit as described in the cable installation paragraphs in the Electrical section. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.
- H. Raceways
 - 1. Conduit shall be installed as described in the conduit installation paragraphs in the Electrical section.

3.4 FIELD QUALITY CONTROL

- A. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- C. Functional Testing.

1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.

- D. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.
- E. Field Testing
 - 1. After the installation of the equipment and systems has been completed, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

3.5 ADJUSTING

- A. The building system controls supplier shall provide initial startup and adjustment of the control systems, and setpoint maintenance for one year.
- B. The building system controls supplier shall be responsible for establishing the final control system settings necessary for proper operation of the equipment and systems. These settings and calibration shall have the concurrence of the equipment manufacturer's representative.
- C. The building system controls supplier shall demonstrate to Owner the complete and correct functioning of all control systems and equipment, and shall make all necessary repairs, replacements, or adjustments to items which fail to perform to the satisfaction of the Owner.

3.6 CLEANING

A. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to the Owner.

3.7 OPERATOR INSTRUCTION AND TRAINING

- A. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided as required. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:
 - 1. Documentation in the final Operation and Maintenance Manuals.
 - 2. Use the Operation and Maintenance Manuals.
 - 3. Equipment and system startup and shutdown.
 - 4. System operation procedures for all modes of operation.
 - 5. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.
- B. The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.
- C. At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

Not to be used for bilding pumposes

SECTION 23 30 13 - AIR DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of air distribution equipment, fans, ductwork, duct mounted devices, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.
- B. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. Coordination
 - 1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
 - 2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
 - 3. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.



Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

- D. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria specification section 01 67 00.2.
- E. Governing Standards
 - 1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.
 - 2. All work shall comply with UL safety requirements.
- F. Power Supply
 - 1. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.
- G. Metal Thickness
 - 1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.
- H. Mechanical Identification
 - 1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Complete fabrication, assembly, and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Makeup Air Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Input and output heating capacities.

Filter velocities.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified. Controls wiring diagrams to be included.

Electrical requirements including voltage, number of phases, and amperage.

Where specified, information on equipment manufacturers' representatives.

Fans

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Where specified, information on equipment manufacturers' representatives.

Controls wiring diagrams with controllers or other interlocks indicated.

Equipment (not specifically listed)

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Sheet Metal Ductwork

Sheet metal duct fabrication drawings indicating dimensions of individual shop and field fabricated sections, top and/or bottom duct elevations, joint locations, and dimensions of duct from walls or column rows.

Pressure and seal classifications.

Reinforcement types and spacing.

Joint and seam types.

Hanger and support types, spacing, and attachment methods.

Access panel and door construction, sizes, and locations.

Duct sealant, adhesive, gasket, and tape information.

Product data for adhesives and sealants shall include VOC content.

Coatings.

Ductwork materials and thicknesses.

Product data demonstrating compliance with ASHRAE 62.1.

FRP ductwork

Manufacturer's name. Brand designation/type of duct. Resin manufacturer and type of resin. Pressure, vacuum, and temperature rating.

Certification of compliance with referenced standards.

Layouts and dimensions of subassemblies to be shipped.

Detailed instructions for field butt joints including lay-up sequence, width of each reinforcement layer, and total number of layers.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section 01 67 00.2.

B. Operation and Maintenance Data and Manuals



Adequate operation and maintenance information shall be supplied as required in the Submittal Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. Equipment designations used shall correspond to those indicated on the Drawings. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

2. In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

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1.4 QUALITY ASSURANCE

- A. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.
- B. The manufacturer of FRP ductwork shall have available a laboratory and quality control facility capable of performing tests and inspections as required by the referenced standards. Material testing, inspection procedures, and manufacturing methods are subject to inspection by the Engineer.
- C. The FRP ductwork manufacturer or designated representative shall provide hands-on training for the installation contractor's employees in the proper assembly of butt joints. The FRP ductwork manufacturer's representative shall be on-site for at least one 8-hour day, during which they shall observe the assembly of at least three butt joints. The ductwork manufacturer shall submit written certification that the installation contractor's employees have satisfactorily completed all training and instruction and can perform the jointing required for this project in accordance with the FRP ductwork manufacturer's recommendations and as specified herein. All field butt joints shall be made by representatives of the FRP ductwork manufacturer or by employees of the installation contractor who have been trained and certified by the FRP ductwork manufacturer. Qualified fitters shall carry and have visible at all times a certificate of qualification issued by the FRP ductwork manufacturer. Contractor shall arrange the qualifying training.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.
- B. FRP ductwork and fittings shall be properly supported to avoid damage caused by flexural strains. Pipe and fittings shall not be thrown or dropped.

1.6 EXTRA MATERIALS

- A. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.
- B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.
- C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.
- B. Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve to the left of the peak pressure/efficiency point.
- C. Dimensional Restrictions
 - 1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.
- D. Elevation
 - 1. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MATERIALS

Makeup Air Units

- 1. Makeup air units, denoted by the symbol "MAU" and an identifying number, shall be 100 percent outside air, constant volume type, and shall be completely assembled, wired, and tested at the factory. Direct fired units shall be as manufactured by Hastings HVAC, Inc. "SBD Series," Engineered Air "Series HE" or Weather-Rite "Model TT"."
- 2. Where indicated in the schedules on the Drawings, makeup air units including sensor and control elements, shall be given a special coating resistant to the corrosive atmosphere as indicated.

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BV Project No. 411752 12/20/2022 3. The manufacturer of the equipment provided shall have a local service center.

4.	Extra Materials shall be as follows.			
	Extra Materials	Quantity		
	Sets of matched belts per unit	1		
	Sets of air filters per unit	2		

- 5. Construction
 - a. The casing of the makeup air unit shall be of sectionalized construction consisting of a fan section, heating section, filter section, and, when located outdoors, an inlet hood. The unit housing shall be constructed of heavy gage galvanized paint grip carbon steel or aluminized steel, braced and reinforced with steel framework as needed for the operating pressures. The cabinet and casing shall be provided with the manufacturer's standard enamel finish. Gasketed access panels or hinged doors with lever type handles shall be furnished to provide access to all internal components.
 - b. The fan, heating, and accessory sections shall be internally insulated with 1 inch thick, 1-1/2 pound per cubic foot density mat-faced cleanable fiberglass insulation securely fastened to the panels. When available, the heating section shall be internally insulated with 1 inch thick, 1-1/2 pound per cubic foot 24 kg/m3 density foil-faced fiberglass insulation. Where the insulation is not installed below the floor, the insulation shall be protected by a metal liner. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1. The insulation shall meet the requirements of NFPA.
 - c. Makeup air units installed outdoors shall be of weatherproof construction, with roof panels overlapping the side panels on all sides. Seams in the roof panels shall be constructed of triple-break seams or roof panels pitched for drainage. All exterior joints shall be factory sealed weather tight.
 - d. Makeup air units installed outdoors shall have a stormproof weather hood with birdscreen sized for 100 percent outside air mounted on the unit inlet. The hood shall include a two-position motorized control damper which opens when the unit is energized and closes when it is de-energized unless a discharge damper is indicated in the schedules on the Drawings. Where a discharge damper is indicated, only the inlet hood shall be provided.

Fan Section

a.

- The makeup air units shall be equipped with centrifugal fans with forward-curved or backward inclined blades which shall be dynamically balanced and tested after being installed in the factory assembled fan section. Bearings shall be heavy-duty, self-aligning, grease lubricated type for units with wheel diameters greater than 18 inches and permanently lubricated or grease lubricated for units with wheel diameters of 18 inches and smaller.
- b. Static pressure values indicated in the schedules are external to the complete unit. The heating section, filter, and housing losses are not included. An allowance of 0.35 inch water column shall be used for filter losses.

- 7. Motor and Drive
 - a. Units located outdoors shall have internally mounted motors. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the Drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.
 - b. Fan drive motors shall be as specified in the Electrical paragraph.
 - c. Makeup air units with smaller than 10 horsepower motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets.
 - d. Fans shall be speed-controllable via on-board VFD(s) integral to the unit.
- 8. Heating Section
 - a. The complete fuel burning assembly of gas fired units shall conform to the requirements of UL/ETL and FM. The burner assembly and gas piping arrangement shall include, but not be limited to, pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valves, and electric modulating main gas valves. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment.
 - b. Each unit shall be designed for use with natural gas at a pressure range of 10-14 inches w.c.
 - 1) Direct Fired

b)

- a) Direct fired makeup air units shall be independently certified to meet ANSI Z83.4.
 - Burners shall be in-line type, suitable for use with the fuel gas type as required, and shall be complete with stainless steel firing plates, cast iron gas feed, and stainless steel side plates for flame rods and ignition spark rods mounted in ceramic isolated bushings. The profile plates shall be adjustable and shall be sized to maintain the required velocity across the burner. The burners shall be capable of modulating turndown of 20 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff An observation port shall be provided on the burner section for viewing the pilot and main flames.

Filter Section

a. Filter sections for makeup air units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 350 feet per minute at design conditions unless otherwise indicated in the schedules on the Drawings. Access doors shall be provided for removal of filters from either side of the section. The filters shall be 2 inch pleated type and shall conform to the Air Filters paragraph.

- 10. Controls
 - a. Each unit shall be furnished with a complete control system consisting of fan starters and overload devices, an airflow proving switch, control circuit fuses, and a factory installed integral disconnect switch. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect switch for field installation on the unit shall be provided. Controls shall be suitable for interfacing with and enacting the control sequence and concept indicated on the Drawings.
 - b. A factory installed electronic discharge air temperature sensor and controller shall be provided. The controls shall include controls to lock out the heating section when the outside air temperature is above the outdoor air inlet sensor setpoint.
 - c. An equipment control panel, denoted by the symbol "ECP" and an identifying number, shall be furnished with the makeup air unit and located where indicated on the Drawings. The panel shall be NEMA Type 12 and shall allow for remote operation of the unit with a "Winter-Off-Summer" switch, a supply temperature setpoint adjustment, and indicating lights for fan on, heat, safety lockout, and dirty filters. Where indicated in the sequence of operations, a room override thermostat shall be mounted in the serviced space.
- 11. Accessories
 - a. Makeup air units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage thickness zinc-coated steel with a nominal 2 by 4 inch wood nailer strip and with supply air opening where indicated on the Drawings. The curb shall be a minimum of 16 inches high. The curb shall be approved by the National Roofing Contractors Association.
- B. Fans
 - 1. Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the schedules on the Drawings, and shall be UL listed. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1.
 - 2. The manufacturer of the equipment provided shall have a local service center.
 - 3. Each fan shall be complete with an electric motor, factory mounted safety disconnect switch with wiring to the motor, drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower motors and fixed sheaves for 10 horsepower and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.
 - 4. Fan drive motors shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the Drawings.

- 5. The external static pressure values indicated in the schedules on the Drawings are external to the complete unit. Internal fan housing and when furnished, backdraft damper and filter losses are not included. An allowance of 0.35 inch water column shall be used for pleated filter losses.
- 6. A solid state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.
- 7. Where indicated in the schedules on the Drawings, fans shall be given a special coating resistant to the corrosive atmosphere indicated.
- 8. Extra Materials shall be as follows.

Extra Materials

Sets of matched belts per fan

- 9. Power Roof Ventilators
 - a. Power roof ventilators, denoted by the fan type "PRV" in the schedules, shall be Greenheck "CUBE," PennBarry "Domex," or Loren Cook "ACE."

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Quantity

- b. Power roof ventilators shall be centrifugal or propeller type, as indicated in the schedules on the Drawings, and shall be statically and dynamically balanced for quiet, vibration-free operation. Each fan shall be complete with a weather hood, a safety disconnect switch mounted in the hood, a 1/2 inch mesh aluminum bird screen over all openings, and, where indicated in the schedules on the Drawings, a backdraft damper. Fan housings shall be constructed of aluminum and shall have an aluminum base of the self-flashing type, suitable for mounting on the curbs indicated on the Drawings.
- 10. Propeller Fans

b.

a. Propeller fans, denoted by the fan type "PF" in the schedules, shall be Greenheck "Model SE1-VG", PennBarry, or Loren Cook equivalents.

Propeller fans shall consist of a panel frame, wire guard, motor, fan blades, and a disconnect switch. Fan blades shall be constructed of steel with corrosion-resistant coating as scheduled on the Drawings. Propeller fans shall be statically and dynamically balanced to ensure quiet, vibration-free operation, and be suitable for mounting as indicated.

- When indicated in the schedules on the Drawings, a wall mounting kit shall be provided. The wall mounting kit shall consist of a wall collar, motor wire guard, and weather hood with birdscreen.
- C. Dampers
 - 1. Backdraft Dampers
 - a. Backdraft dampers, denoted by the symbol "BDD" not specified to be furnished with equipment, shall be Arrow United Industries "Type 655," or Ruskin "BD6."



Backdraft dampers shall be constructed with 1 inch by 4 inch by 0.081 inch thick extruded aluminum frame. Blades shall be at least 0.070 inch aluminum with blade edge seals mechanically locked to blade edge and aluminum shafts operating in synthetic bearings. The leakage rate shall not exceed 20 cubic feet per minute per ft2 when tested at 1 in wc for all sizes 24 inches wide and above.

- 2. Control Dampers
 - a. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet or with any blade dimension exceeding 48 inches shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit. The leakage rate shall not exceed 4 cubic feet per minute per ft2 when tested at 1 in wc for all sizes 24 inches wide and above.
 - b. Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.
 - c. Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.
 - d. Control dampers shall be given a special coating identical to the coating applied to the connected ductwork and equipment.
 - e. Duct Mounted Control Dampers
 - Control dampers and face bypass dampers mounted in ductwork and equipment curbs shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-50." The damper frames shall be constructed of 5 inch Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch wide airfoil-shaped extruded aluminum.
 - 2) Control dampers denoted on the Drawings to be face and bypass dampers shall be vertically arranged. The face damper dimensions shall be coordinated with the heating coil dimensions. The bypass area shall be half the area of the face damper. Face and bypass damper submittals shall indicate coil size, face dimensions, and bypass dimensions.

Wall Mounted Control Dampers

Control dampers mounted in walls behind louvers shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-40." Control damper frames shall be constructed of 4 by 1 inch 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch wide airfoil-shaped extruded aluminum.

D. Damper Operators

- 1. The damper operators shall be direct coupled type. Each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.
- 2. Each operator shall have sufficient torque to operate the connected control damper based on at least 130 percent of the control damper area. Each damper operator shall have at

1)

least a 50 inch-pound normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators or operators with a greater running torque shall be furnished to produce the torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the Drawings. Face dampers shall fail to the closed position and bypass dampers to the open position.

- 3. Electric Damper Operators
 - a. The electric damper operators shall be two-position type, as indicated in the sequence of operation or schedules on the Drawings
 - b. Two-Position Electric Damper Operators
 - Two-position direct coupled electric damper operators shall be Belimo "NFBUP-S" or AFBUP-S," Honeywell "MS4100 Series," or Johnson Controls.
 - 2) Damper operators shall be spring return and shall have at least one internal SPDT auxiliary switch rated 5 amperes at 120 volts ac or the power supply available from the temperature control system furnished. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers where required, shall be factory wired to the damper operator and installed in a NEMA enclosure with a rating equal to or better than the damper operator.
 - a) Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable for round shafts. The operators shall be suitable for direct mounting to shafts up to 1 inch and shall be complete with mounting brackets and damper position indicator.
- E. Air Outlet and Inlet Devices
 - 1. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, or Titus. Air outlet and inlet devices shall be furnished and installed where indicated on the Drawings.
 - 2. Where air outlet and inlet devices are installed in ductwork given a special coating, an identical coating shall be applied to the air outlet and inlet devices.
 - 3. Registers and Grilles
 - Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the Drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

- F. Flexible Connections
 - 1. Flexible connections located indoors shall be Ventfabrics "Ventglas." Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon."
 - 2. Ductwork connections to the air handling equipment, and where indicated on the Drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches 76 mm of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.
 - 3. Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20° to 180° F and shall weigh at least 27 ounces per square yard.
 - 4. Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10° to 250° F and shall weigh at least 24 ounces per square yard .
- G. Air Filtration Equipment
 - 1. Pleated Air Filters
 - a. Pleated air filters shall be American Air Filter "AM-AIR 300X" or Farr "30/30." Filters shall be disposable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have a minimum efficiency reporting value (MERV) based on the ASHRAE 52.2 guidelines of at least MERV 8.
 - b. Two inch pleated air filters shall have at least 12 pleats per linear foot and at least 4.2 square feet of media per square foot of filter area. Two inch filters shall have a maximum initial resistance of 0.13 inch we at 300 feet per minute.
 - c. Pleated air filter is part of 01-MAU-0001 make up air unit.
- H. Draft Gauges

1.

Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge."

Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20 to 140° F, and a range of 0 to 1.0 inch wc, with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves. When mounted across filters, the signal flag shall be set at 0.75 inches water column.

- 3. Sheet Metal Ductwork
 - a. Aluminum sheet metal ductwork shall be installed in the Stairwells of Pipe Gallery and Blower Building only.
 - b. Ductwork, accessories, bracing, and supports shall be constructed of aluminum, except where otherwise specified herein. Where more than one material is indicated, ductwork, accessories, bracing, and supports shall be constructed of galvanized steel unless otherwise indicated. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards unless otherwise indicated. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork.
 - c. Aluminum ductwork shall be constructed of aluminum alloy 3003-H14, or better, in accordance with ASTM B209.
 - d. Plenums shall be constructed of reinforced 0.08 thickness aluminum sheet metal.
 - e. Sheet metal fan boxes shall be fabricated with 0.125 inch thickness aluminum sheet metal skin and structural framing of sufficient strength to support the fan box and the fan mounted on the box. Drawings of the fan boxes shall be submitted in accordance with the Submittal Procedures section.
 - f. Sealants shall be suitable for the duct service and shall maintain leakage integrity at pressures in excess of the ductwork pressure classification.
- 4. Fiberglass Reinforced Plastic Ductwork
 - a. FRP ductwork shall be installed in the Pipe Gallery as indicated for the supply air ducting of the 01-MAU-0001 unit.
 - b. FRP ductwork, including fittings, shall be constructed of fiberglass reinforced plastic, as manufactured by Spunstrand, Monoxivent, Viron, or equal approved by Engineer.
 - c. Ductwork shall be manufactured per SMACNA, and industry standard PS 15-69 minimums. Designed for a minimum of 10" w.c. pressure and 10" w.c. vacuum. A minimum designed structural safety factor of 4 shall be used. All ductwork, fittings, and appurtenances shall be suitable for the following temperature conditions: -10°F to 120°F.
 - d. The ductwork shall be suitable for wastewater treatment plant service, and will exhaust air from wet corrosive areas. The ductwork shall have a minimum 10 mil liner and 100 mil corrosion barrier. Resin shall be of the premium vinyl ester type and shall not contain fillers except as required for thioxtropic control of fire retardance. The duct shall achieve a Class 1 flame spread rating. The resins shall contain antimony trioxide for fire retardance. The flame spread rating shall be less than 25. The duct and fittings, as a finished composite shall meet the flame requirements (25) of a Class 1 duct per UL 181 and UMC 10-1, and ASTM E-84Ductwork shall be manufactured per SMACNA, and industry standard PS 15-69 minimums. Designed for a minimum of 10" w.c. pressure and 10" w.c. vacuum. A minimum designed structural safety factor of 4 shall be used. All ductwork, fittings, and appurtenances shall be suitable for the following temperature conditions: -10°F to 120°F.
 - e. Wall thickness shall comply with SMACNA Thermoset Duct Construction Standards. The ductwork shall be furnished with the minimum wall thicknesses as required by the SMACNA standard. Rectangular ductwork wall thickness shall be determined by substituting the long side for the round diameter.

- f. The inner surface shall contain a 10 mil thick "C" veil saturated with a premium resin. This will be followed by a 100 mil corrosion barrier (2 layers of 1-1/2 oz. chopped mat) with the same resin as used on the 10 mil liner. The structural layer shall be as required for design service and shall be filament wound using a premium resin. The duct exterior shall have a relatively smooth surface free of exposed fibers. Duct located indoors shall have final (2) coats of PPG 42-7 intumescent paint to achieve the smoke developed rating of less than 50. All resin and joint material shall be suitable for a 200°F service. Wall thickness shall comply with SMACNA Thermoset Duct Construction Standards. The ductwork shall be furnished with the minimum wall thicknesses as required by the SMACNA standard. Rectangular ductwork wall thickness shall be determined by substituting the long side for the round diameter.
- g. Field joints shall be butt-type wet lay-up method. Flanged connections shall be provided where indicated on the contract drawings. Joining materials shall be of the same material as the duct, forming a continuous FRP component system. Manufacturer's installation instructions shall be followed. Shop fabricated assemblies should be provided to the maximum extent possible, to minimize the number of field joints. Shop fabrications including fittings and specials must be constructed by the ductwork manufacturer or ductwork manufacturer's certified pipe fabrication source.
- h. Flanged joints shall be provided at each damper and item of equipment to facilitate disassembly, at each change in material, and where indicated on the Drawings. Stainless steel bolts, nuts, washers, and neoprene gaskets shall be provided for all flanged connections in the system, including connections to equipment.
- i. Expansion joints shall be furnished at the locations indicated on the Drawings and at other locations required for proper pipe installation. Expansion joints shall be resistant to ultraviolet light and shall be suitable for the service conditions.
- j. Expansion joints shall be fully molded type rated for a minimum 3 psi working pressure and shall consist of an inner tube, body, and outer cover to be compatible with the specified service conditions. The tube shall be a minimum of 1/4 inch thick EPDM with two ply of high tensile nylon, polyester, or kevlar fabric reinforcement. The cover shall be a minimum 1/16-inch elastomer and shall be resistant to ultraviolet light.
- k. Slip on type expansion joints shall fit tightly on the outside diameter of the piping and shall be secured in place by stainless steel adjustable bands with worm screw type adjustments to provide a gastight connection.
 - Flanged type expansion joints shall have split stainless steel retaining rings and shall have ASTM D3982 diameter and drilling. Expansion joints shall be Red Valve "Duct Expansion Joints", Mercer Rubber Company, or Holz Rubber Company.
- m. Turning vanes and splitters shall be fiberglass matching the construction of the ductwork, and shall be provided where indicated on the drawings. All bolts for flange connections shall be 316 stainless steel.
- n. Supports and hangers shall be designed, fabricated, and installed in accordance with the requirements of SMACNA's FRP Duct Construction Manual.
- o. Ductwork shall be protected as required for protection of the material and coatings during shipping, handling and storage. Ductwork shall be shipped, delivered, and handled in accordance with the Manufacturer's instructions where they differ from the Product Delivery Requirements and the Product Storage and Handling Requirements sections.

1.

- I. Duct Insulation
 - 1. Interior duct liner shall be Knauf "Atmosphere," CertainTeed "ToughGard R," or Johns Manville "Linacoustic RC."
 - 2. Interior duct liner shall be 1-1/2 pound per cubic foot density, spray coated duct liner with an "R" value of at least 4.2 ft²·hr °F/BTU per inch thickness at 75° F. The insulation shall be suitable for temperatures up to 250° F and shall have at least a 0.55 NRC per 1 inch thickness. The insulation shall conform to ASTM C1071. The insulation surface shall be resistant to microbial growth in accordance with UL 181, ASTM C1338, or comparable test method and shall be cleanable in accordance with NAIMA recommended practices.
- J. Access Doors
 - 1. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for non-insulated ductwork. Insulated doors shall be insulated with the same thickness insulation as the duct in which it is installed. Ductmounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

2.5 ELECTRICAL

A. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.6 DRIVE UNITS

A. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2.7 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2.8 SHOP TESTING

A. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, ARI, NBS, NFPA, and UL Standards.

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2.9 BALANCE

- A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.
- B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.
- B. Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3.2 PREPARATION

A. Field Measurement

- 1. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.
- B. Surface Preparation
 - 1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.
 - 2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3.3 INSTALLATION

A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

- B. The space beneath baseplates shall be grouted as specified in the Grouting section.
- C. Makeup Air Units
 - 1. Flexible connections shall not be in tension when the fans are operating. The units shall be firmly anchored to the equipment curbs with corrosion resistant fasteners.
 - 2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.
- D. Fans
 - 1. Where indicated on the Drawings, flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.
 - 2. Power roof ventilators shall be secured with corrosion resistant lag screws to the roof curb.
 - 3. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.
- E. Damper Operators
 - 1. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.
 - 2. The damper operator shall be installed to prevent entry of moisture from contacting internal parts. Conduit shall enter the operator from below or horizontally and incorporate a drip leg to prevent water from following the conduit into the operator interior.

The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position, face dampers shall fail to the closed position, and bypass dampers to the open position.

- F. Air Outlet and Inlet Devices
 - 1. Air outlet and inlet devices shall be installed level and plumb and in accordance with the manufacturer's written instructions.

- G. Draft Gauges
 - 1. Draft gauges for filters located more than 8 feet above the finished floor shall be mounted on the nearest wall, 5.5 feet above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

H. Sheet Metal Ductwork

- 1. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards. The locations, arrangement, and sizes of ductwork shall be as indicated on the Drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.
- 2. Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch.
- 3. Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards in accordance with the following:

<u>D</u>		Duct Type		
	<u>Sur</u>	<u>oply</u>	<u>Exhaust</u>	<u>Return</u>
Duct Location	\leq 2 inches wc	> 2 inches wc		
Outdoors	А	А	А	А
Unconditioned Areas	В	А	В	В
Conditioned Spaces				
(concealed ductwork)	С	В	В	С
(exposed ductwork)	А	А	В	В

Sealing Levels

A All transverse joints, longitudinal seams, and duct wall penetrations

B All transverse joints and longitudinal seams

C - Transverse joints only

All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

5. Ductwork shall be supported as required by SMACNA. Where ductwork is connected to equipment, it shall be independently supported with no weight bearing on the equipment and in such a manner that the equipment maybe removed for service without temporary support of the ductwork. Ductwork shall be supported within 24 inches of each elbow and within 48 inches of each branch intersection. Strap or wire hangers shall not be used where the hanger length exceeds 5 feet.

Air Distribution Systems

- 6. Ductwork shall be constructed and installed in accordance with the Drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch lighting allowance between the ceiling and the bottom of the ductwork.
- 7. In vertical ducts with a closed bottom which terminate less than 24 inches above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch drain hole in the bottom of the duct.
- 8. Turning vanes shall be installed in all elbows with 45 degree or greater angles. Vanes shall be double thickness or a minimum 4.5 inch radius type for vanes 30 inches and longer, where installed in ducts with velocity greater than 2000 fpm, or where installed in ducts with a pressure classification greater than 2 inches wc. Where 4.5 inch or double thickness type turning vanes are required, each vane shall be welded to the vane runner
- I. FRP Ductwork
 - 1. FRP ductwork joints shall be carefully and neatly made in accordance with the following specified requirements. All field joints made by trained and certified employees that are not representatives of the pipe manufacturer shall be made using individually packaged joint kits.
 - 2. Flange bolts shall be tightened sufficiently in a crisscross pattern to slightly compress the gasket and make a good seal, but not so tight as to distort the flanges. A flat washer shall be installed under each nut and bolt head.
 - 3. Laminated butt joints shall be made in accordance with the manufacturer's recommendations. Finished joints shall be built up in successive layers, shall be as thick as the pieces being joined, and shall be as crevice-free as is commercially practicable. The width of the first layer shall be at least 4 inches. Successive layers shall be increased uniformly to provide the specified minimum total width of overlay which shall be centered on the joint. Crevices between jointed pieces shall be filled with resin, leaving a smooth inner surface. The interior of joints shall also be sealed by covering with not less than 0.05 inch of liner of the same material as the ductwork. Inside welds should be done on duct 24 inches and larger where accessible.

The inner surface shall be free of cracks and crazing, with a smooth finish, and with an average of not more than two pits per square foot, provided the pits are less than 1/8 inch in diameter, not more than 1/32 inch deep, and covered with sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits. Such surfaces may be reinforced with glass surfacing mat, synthetic fibers, or other suitable material.

- J. Duct Liner
 - 1. The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.
 - 2. The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.
 - 3. The following ducts shall be insulated with interior duct liner unless otherwise indicated or indicated on the Drawings to be wrapped:

<u>Location</u>	Ductwork	Insulation Thickness
	, C	
Interior within	a. Heating supply and return	1 inch
conditioned space (heated or cooled)	b. Cooling supply and return	1 inch
(1104104 01 000104)	c. Heating and cooling supply and return	1 inch
	d. Makeup air outside area served	1 inch
	e. Outside air (including plenums)	1.5 inches
Interior within	a. Heating supply and return	1.5 inches
unconditioned	b. Cooling supply and return	1.5 inches
space	c. Heating and cooling supply and return	1.5 inches
	d. Makeup air outside area served	1.5 inches
	e. Outside air (including plenums)	2 inches

Note: Exhaust systems shall not be internally lined unless indicated to be so on the drawings.

3.4 FIELD QUALITY CONTROL

A. Installation Supervision

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The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.

B. Installation Check

1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.

- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- D. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.
- E. FRP Ductwork Field Testing
 - 1. Joints in ductwork shall be tight and free of leaks. Each joint which is found to leak, by observation or during any specified test, shall be repaired, and the tests repeated. All necessary testing equipment and materials, including tools, appliances, and devices, shall be furnished by Contractor. All tests shall be made by and at the expense of Contractor. Tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to demonstrate compliance with specified requirements. The Engineer or Engineer's representative shall be present during testing and shall be notified of the time and place of testing at least 3 days prior to commencement of the work.

Leakage may be determined by loss-of-pressure, soap solution, or positive and accurate method acceptable to Engineer. All equipment or other accessories which would be damaged if subjected to the specified test pressure shall be disconnected, and ends of branch lines plugged or capped, as required, during the testing procedures.

3.5 CLEANING

A. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3.6 TRAINING

A. Training shall be provided in accordance with the requirements of Section 01 91 00 – Commissioning and 01 79 00 – Demonstration and Training.

End of Section

SECTION 23 50 13 - HEATING SYSTEM EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of heating system equipment and associated devices and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.
- B. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. Coordination
 - 1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
 - 2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
 - 3. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.
 - Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

- D. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria specification section 01 67 00.2.
- E. Governing Standards
 - 1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.
 - 2. All work shall comply with UL safety requirements.
- F. Power Supply
 - 1. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.
- G. Metal Thickness
 - 1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.
- H. Mechanical Identification
 - 1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

a.

- 1. Drawings and Data
 - Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:
 - 1) Equipment
 - a) Name of manufacturer.
 - b) Type and model.
 - c) Construction materials, thicknesses, and finishes.
 - d) Manufacturer's performance data.
 - e) Overall dimensions and required clearances.
 - f) Net weight and load distribution.
 - g) Wiring diagrams.
 - h) Locked rotor current.

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- 2) Seismic Design Requirements
 - a) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section 01 67 00.2.

B. Operation and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittal Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE

A. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.5 DELIVERY, STORAGE, AND HANDLING

1. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

- A. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.
- B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.
- C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Equipment capacities shall be as indicated on the schedules.
- B. Gas fired Make-up Air Unit shall be suitable for operation with the gas inlet pressure range specified in the individual equipment paragraphs.
- C. Dimensional Restrictions
 - 1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.
- D. Elevation
 - 1. Equipment shall be designed to operate at the elevation as indicated on the Drawings.

2.3 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.
- 2.4 MATERIALS.
 - A.
 - A. Heaters
 - 1. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the Drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.
 - 2. The manufacturer of the equipment provided shall have a local service center.
 - 3. Electric Unit Heaters

Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the Drawings.

- 1) Electric Unit Heaters (corrosion resistant)
 - a) Where indicated on the Drawings to be corrosion resistant, unit heaters shall be manufactured by Chromalox "HD3D," Ruffneck "CR1 Triton," or Indeeco "Triad." Each heater shall include fan and motor assembly, operating and safety controls, and shall be suitable for use with a single point power supply indicated in the schedules on the Drawings.
 - b) Heater elements shall be Type 304 or 316 stainless steel, fin tubular type, with stainless steel fittings forming a watertight seal between the elements and the junction box. Unit heater fan motors shall be totally

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I enclosed, permanently lubricated ball bearing type designed to resist corrosion and moisture. The fan blades shall be epoxy coated aluminum and the heater housing shall be at least a 20 gage Type 304 stainless steel. Where indicated on the Drawings to be wall hung, a swivel wall mounting bracket shall be provided.

- c) The controls shall include automatic reset thermal cutout, fan delay relay, built-in control and motor contactors, control transformer, and terminal block all housed in a NEMA 4X enclosure. A pilot light visible on the heater exterior shall indicate heater operation.
- 4. Wall Heaters
 - a. Wall heaters, denoted by the symbol "WH" and an identifying number, shall be manufactured by Indeeco "WAI," or Brasch "932/934 Series."
 - b. Wall heaters shall be architectural, downflow type; designed for mounting as indicated on the Drawings; and shall include an electric heating element, a thermal limit switch, a fan delay switch, a fan and motor assembly, and a built-in thermostat. The heaters shall be suitable for use with the specified power supply and shall have the capacity indicated in the schedules on the Drawings.

2.5 ELECTRICAL

A. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.6 DRIVE UNITS

A. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2.7 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2.8 SHOP TESTING

A. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

B. Fans and Air Handling Unit shall be factory tested prior shipment with reports included within the delivery packages.

2.9 BALANCE

- A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.
- B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.
- B. Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3.2 PREPARATION

- A. Field Measurement
 - 1. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.
- B. Surface Preparation



2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3.3 INSTALLATION

- A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Heaters
 - 1. The bottom elevation of unit heaters shall be minimum 8 feet above finished floor unless otherwise indicated.
 - 2. Electric duct heaters shall be installed with a minimum distance of 4 feet from all ductwork transitions and obstructions on both sides of the heater.
 - 3. The bottom elevation of wall heaters shall be 16 inches above finished floor unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- D. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

E. Operator Instruction and Training

- After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:
 - a. Documentation in the final Operation and Maintenance Manuals.
- b. Use the Operation and Maintenance Manuals.
- c. Equipment and system startup and shutdown.
- d. System operation procedures for all modes of operation.

- e. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.
- 2. The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives and/or contractor's commissioning team representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.
- 3. At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5 CLEANING

A. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner. Each fan and make-up air unit shall be thoroughly cleaned in accordance with the manufacturer's instructions prior to being placed in service.

End of Section

SECTION 23 80 00 - REFRIGERATION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of refrigerant piping and accessories, ductless split heat pump systems, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) system for the AGS Support Facilities MCC.
- B. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. Coordination
 - 1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
 - 2. All the component parts of the system shall be the products of one manufacturer.
 - 3. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.
 - 4. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

- D. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section 01 67 00.2.
- E. Governing Standards
 - 1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.
 - 2. All work shall comply with UL safety requirements.
 - 3. The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1, IEEC 2015, unless otherwise indicated on the Drawings.
 - 4. Capacity ratings for condensing units, heat pumps, packaged air conditioning units, and packaged heat pumps with capacities less than 135,000 BTUH shall be in accordance with AHRI Standard 210/240.
- F. Power Supply
 - 1. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Controls wiring between outdoor and indoor units shall be as per manufacturer's requirement and as indicated in the schedules. If thermostat is a wired type, 24VDC power supply to be provided unless otherwise indicated or required for a properly operating system.
- G. Metal Thickness
 - 1. Metal thickness and gauges specified herein are minimum requirements. Gauges refer to US Standard gauge.
- H. Mechanical Identification
 - 1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

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Refrigeration Systems

Refrigerant Piping

Schematic arrangement showing equipment, coils, piping sizes, valves, and accessories.

A refrigerant piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction.

Ductless Split System Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Location and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Multiline wiring diagrams with field and factory wiring clearly identified and electrical requirements. External LCD thermostat wiring shall be included.

Net weight and load distribution.

Where specified, information on equipment manufacturers' representatives.

B. Operation and Maintenance Data and Manuals

- 1. Adequate operation and maintenance information shall be supplied as required in the Submittal Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
- 2. In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1.4 QUALITY ASSURANCE

Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

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1.6 EXTRA MATERIALS

- A. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.
- B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.
- C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.
- B. For equipment including fans, each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.
- C. Dimensional Restrictions
 - 1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.

D. Elevation

1. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MATERIALS

- A. Refrigerant Piping and Accessories
 - 1. Refrigerant piping shall conform to ASTM B280 Seamless Copper Tube for Air Conditioning and Refrigeration Field Service. Piping shall be supported as specified in the Pipe Supports section. Refrigerant filter dryers, expansion valves, solenoid valves, combination sight glass and moisture indicators, charging valves, relief valves, and other accessories shall be furnished and installed as needed for proper operation of the system.
 - 2. Refrigerant piping shall be insulated with "AP Armaflex" closed-cell foam insulation with 1/2 inch thickness suitable for refrigerant service. Equal products from Knauf and JohnsManville will be considered.
 - 3. Refrigerant piping insulation jacket shall be "3M VentureClad Tape 1577CW-E".

2.5 EQUIPMENT

- A. Ductless Split Heat Pump Systems
 - 1. Ductless split systems shall be furnished and installed where indicated on the Drawings. The ductless set shall include two indoor ceiling cassette units, branch box controller, and an outdoor remote heat pump. The set shall be fully charged with R-410A refrigerant and compressor oil. A programmable wall-mounted thermostat shall be provided for control of the system.
 - 2. Ductless split system shall be as manufactured by Mitsubishi "MXZ/PEAD", Samsung "Max Heat", Daikin "Model FDMQ/RX" or approved equal.
 - 3. The manufacturer of the equipment provided shall have a local service center.
 - 4. Fan Coil



- Each indoor ceiling cassette, denoted by the symbol "FC" and an identifying number, shall be of the ductless, indoor, under-ceiling mounted, direct expansion type. Each fan coil unit shall consist of a fan, evaporator coil, air filter, return grille, supply louver, mounting harness, and drain pan.
- b. Fans shall be centrifugal type designed for quiet operation. Evaporator coils shall be copper tube with aluminum fins and galvanized steel tube sheets. The fins shall be bonded to the tubes by mechanical expansion. Air filters shall be of the cleanable type. Each unit shall be provided with access doors for easy removal of the filters. Each fan coil shall be provided with a mounting system and supports.
- c. Each fan coil fan shall be suitable for the power supply indicated on the Drawings.
- d. Each fan coil is powered by the outdoor unit.

5. Heat Pump

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- a. A heat pump, denoted by the symbol "HP" for heat pumps and an identifying number, shall be factory assembled suitable for outdoor installation.
- b. A heat pump shall have a galvanized steel cabinet that shall be bonderized and coated with a baked-enamel finish. The housing shall have removable panels, weep holes, and mounting holes. Compressors shall be high-efficiency, hermetically sealed reciprocating, rotary inverter-driven, or scroll type with overload protection. Condenser coils shall consist of louvered aluminium fins mechanically bonded to copper tubing. A unit shall be provided with resilient compressor vibration isolators to minimize noise. Each fan shall have a TEFC motor.
- c. The outdoor unit shall have low ambient heat option which makes unit suitable to provide heating at very low ambient conditions at -9F.
- 6. Branch Selector Controller
 - a. A branch selector, denoted by the symbol "BS" and tagged as 02-BS-0001, shall be factory assembled and shall be of one manufacturer.
 - b. The branch controller shall have minimum two refrigerant piping connection points for two indoor units minimum.
 - c. The branch controller shall be powered by 208V/IPh
 - d. The basis of design branch selector denoted in the equipment schedules, doesn't require a condensate drain. If a Contractor proposed an equivalent manufacturer with the condensate drain requirement from the branch selector, this additional work and/or rework shall be completed by the Contractor without any expense, change order, or reimbursement by the Engineer or the Owner.
- 7. Accessories
 - a. Each indoor unit shall be provided with an electric LCD screen programmable thermostat capable of controlling all unit functions. The thermostat shall be automatic changeover type with integral sub-base.
 - b. Where indicated on the Drawings, an internal condensate pump shall be provided to remove condensate from the drain pan.
 - c. All copper surfaces shall be protected against corrosion by a shop applied special coating.
 - d. Each unit shall be provided with a low ambient control kit to allow operation when outdoor temperatures are between 0° and 60° F. External service valves and electrical knockouts shall be provided.

2.6 ELECTRICAL

Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.7 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2.8 SHOP TESTING

A. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2.9 BALANCE

- A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.
- B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION

A. Field Measurement

Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

B. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3.3 INSTALLATION

- A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. The space beneath the baseplate shall be grouted as specified in the Grouting section.

C. Valves

- 1. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the valve sections.
- D. Refrigerant Piping and Accessories
 - 1. The refrigerant piping shall be sized and arranged in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and transmission of sound to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform return of oil to the compressor. The suction gas line shall be sized to produce a minimum load gas velocity of 1,000 feet per minute in vertical risers with upward gas flow and 500 feet per minute in horizontal piping. The full load pressure drop should not exceed 3 psi or 2° F change in saturated refrigerant temperature. The maximum gas velocity shall not exceed 4,000 feet per minute . The liquid lines shall be sized to limit the pressure loss to the equivalent of 2° F of temperature change and a maximum liquid line velocity of 360 feet per minute. A piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction shall be submitted in accordance with the Submittal Procedures section.
- E. Condensing Units/Heat Pumps
 - 1. The condensing units and heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be levelled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the Drawings.



After the refrigerant system has been tested, the system shall be fully charged with refrigerant and compressor oil.

- 3. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.
- F. Ductless Split Systems
 - 1. Ductless split systems shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be levelled and installed to maintain the recommended clearances.

2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3.4 FIELD QUALITY CONTROL

- A. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- D. Performance and Other Testing
- E. Operator Instruction and Training
 - 1. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:
 - a. Documentation in the final Operation and Maintenance Manuals.
 - b. Use the Operation and Maintenance Manuals.
 - c. Equipment and system startup and shutdown.
 - d. System operation procedures for all modes of operation.
 - e. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.
 - 2. The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as required.
 - 3. At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5 CLEANING

At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be A. cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other et damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

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SECTION 26 05 11 - ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.
- B. This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.
- C. This section covers installation of equipment furnished by Owner.

1.2 GENERAL

- A. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.
- B. Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are accepted by Engineer.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence
- D. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- E. Coordination
 - Electrical work shall conform to the construction schedule and the progress of other trades.
- F. Anchor Bolts and Expansion Anchors
 - 1. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch [19 mm] will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

- G. Drawings
 - 1. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1.3 CODES AND PERMITS

A. All work shall be performed, and materials shall be furnished in accordance with the NEC-National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

AEIC	The Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Fed Spec	Federal Specification
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories

B. Equipment covered by this section shall be listed by UL, or by a nationally recognized third party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. If no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to be used.

1.4 SEISMIC DESIGN REQUIREMENT.

Seismic Design Requirements

1.5 IDENTIFICATION.

- A. Conduit
 - 1. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 19 gage

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Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

stainless steel, with 1/2 inch stamped letters and numbers as indicated on the Drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

- B. Conductors
 - 1. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.
 - 2. Conductor Identification Number
 - a. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at the point of termination.
 - b. The wire markers shall be of the heat-shrinkable tube type, with custom typed identification numbers.
 - c. The wire numbers shall be as indicated on the equipment manufacturer's drawings.
 - d. The wire markers shall be positioned to be readily visible for inspection.
 - 3. Conductor Color Coding
 - a. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.
 - b. The following color coding system shall be used:
 - 1) 120/240V single-phase black, red, and white
 - 2) 120/208V, three-phase black, red, blue, and white
 - 3) 120/240V, three-phase black, orange, blue, and white
 - 4) 277/480V, three-phase brown, orange, yellow, and gray
 - 5) 2400/4160V, three-phase black, red, blue, and white
 - 6) 7200/12470V, three-phase black, red, blue, and white
 - c. Where 120/240 and 120/208 volt systems share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.

Control and instrumentation circuit conductors shall be color coded as indicated in the Cable Data Figures at the end of this section.

Motor Starters

d.(

- Motor starters shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the Drawings. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the motor starters.
- D. Control Stations
 - 1. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop",

etc.) as indicated on the Drawings. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.

- E. Circuit Breakers
 - 1. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the circuit breakers.
- F. Disconnect Switches
 - 1. All switches shall have front cover-mounted permanent nameplates that include switch type, manufacturer's name and catalog number, and horsepower rating. An additional nameplate, engraved or etched, laminated black-over-white plastic, with 1/8 inch letters, shall be provided to identify the associated equipment. Both nameplates shall be securely fastened to the enclosure.
- G. Arc Flash Hazard Labels
 - 1. Lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter socket enclosures, and other electrical equipment likely to be worked on energized shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E. Equipment must be accessed by qualified personnel only.

Turn off all power sources prior to working on or inside equipment.

2. Additional information shall be provided on the labels where specified in the Arc Flash Hazard Analysis section of this section.

1.6 SUBMITTALS

Drawings and Data – General

- Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:
 - a. Drawings and data.
 - b. Operating manuals.
 - c. Samples.

- d. Test reports.
- e. Studies.
- B. Submittal Details & Identification
 - 1. Information covering all materials and equipment shall be submitted for review in accordance with the Submittal Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:
 - a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.
 - b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.
 - c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.
 - d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.
 - e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.
 - f. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.
- C. Engineering and Testing Firm
 - 1. Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the protective device study and the on-site testing.
- D. Cable and Conduit Submittal
 - 1. Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.
- E. Cable Samples

In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

- F. Seismic Design Requirements
 - 1. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

Electrical

1.7 PROTECTION AND STORAGE

A. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2.1 CABLE

- A. All cables of each type (such as lighting cable or 600 volt power cable) shall be from the same manufacturer.
- B. All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.
- C. Lighting Cable
 - 1. Lighting and receptacle circuits shall be as specified for 600 volt (Figure 3-26 0511 THHN-THWN) power cable.
- D. 600 Volt Power Cable
 - 1. Cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are required, shall be 600 volt (Figure 2-26 0511 XHHW-2) power cable.
- E. Instrument Cable
 - 1. Cable for electronic circuits to instrumentation, metering, and other signaling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be (Figure 4-26 0511 single pair).
- F. Multiconductor Control Cable

1. When indicated on the Drawings, cable in control, indication and alarm circuits shall be multiconductor. Cable shall be (Figure 7-26 0511 14 AWG THHN-THWN).

Variable Frequency Drive Cable

1. Cable for connection to the main power terminals of the secondary of a variable frequency drive shall be (Figure 15-26 0511 VFD).

2.2 RACEWAY

A. Conduit shall be as described in the following paragraphs:

- B. Rigid Steel Conduit
 - 1. Rigid steel conduit shall be heavy wall, hot-dip galvanized, shall conform to NEMA C80.1, and shall be manufactured in accordance with UL 6.
- C. Liquidtight Flexible Metal Conduit
 - 1. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moisture proof polyvinyl chloride jacket, and shall be UL labelled.
- D. Rigid Nonmetallic (PVC) Conduit
 - 1. PVC conduit shall be heavy wall, Schedule 40, UL labelled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL 651.
- E. PVC-Coated Rigid Steel Conduit
 - 1. The conduit shall be rigid steel. Before the PVC coating is applied, the hot-dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils.
 - 2. A chemically cured two-part urethane coating, at a nominal 2 mil thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.
 - 3. Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches, whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils.
 - 4. All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.
 - 5. PVC coated rigid steel conduit shall be manufactured by Calbond, Ocal, or Robroy Industries.
- F. Rigid Aluminum Conduit (RAC)
 - Rigid aluminum conduit and fittings shall be manufactured of 6063-T1 alloy, shall conform to ANSI C80.5, and shall be manufactured in accordance with UL 6A.

2.3 WIRING DEVICES, BOXES, AND FITTINGS

A. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

- B. Conduit Boxes and Fittings
 - 1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, or O Z Gedney. In applications utilizing aluminum conduit systems, aluminum boxes and fittings manufactured by Crouse-Hinds, Appleton, or O Z Gedney shall be installed.
 - 2. PVC coated device boxes shall be manufactured by Calbond, Ocal, or Robroy Industries.
 - 3. Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.
- C. Device Plates.
 - 1. Galvanized or cadmium-plated device plates shall be used on surface mounted outlet boxes where weatherproof plates are not required.
 - 2. Device plate mounting hardware shall be countersunk and finished to match the plate.
 - 3. Device plates for switches outdoors or indicated as weatherproof shall have provisions for padlocking switches "On" and "Off", and shall be Appleton "FSK-1VS", Crouse-Hinds "DS185" or O Z Gedney "FS-1-WSCA".
 - 4. Device plates for receptacles indicated as weatherproof shall be Appleton "FSK WRD", Crouse Hinds "WLRD1", or O Z Gedney "FS 1 WDCA.
 - 5. Device plates for ground fault interrupter receptacles indicated to be weatherproof shall be Appleton "FSK-WGFI", Eaton "S966", or O Z Gedney "FS-1-GFCA".
 - 6. Receptacle covers outdoors or otherwise indicated to be weatherproof while in-use shall be die cast aluminum and shall include a padlock eye. Covers for standard convenience outlets shall be Hubbell "WP8M" or Thomas and Betts Red Dot "CKMUV". Covers for ground fault interrupter receptacles shall be Hubbell "WP26M" or Thomas and Betts Red Dot "CKMUV".
 - 7. Engraved device plates, where required, shall be manufactured by Leviton, or equal.
- D. Wall Switches
 - 1. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Eaton "AH1221V" through "AH1224V", Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I".
 - Switches for pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, center "Off", Eaton "1995V", Hubbell "1557I" or Leviton "1257-I".
- E. Receptacles
 - 1. Standard convenience outlets shall be duplex, three-wire, grounding, 20 amperes, 125 volts, Eaton "AH5362V", Hubbell "5362I" or Leviton "5362-I" for 120 volt circuits,

and 250 volts, Eaton "AH5462CV", Hubbell "5462I" or Leviton "5462-I" for 240 volt circuits.

- 2. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Eaton "SGFH20", Hubbell "GFRST20I" or Leviton "G5362-I".
- 3. Ground fault circuit interrupter receptacles in damp or wet locations shall be duplex, 20 amperes, 125 volts, Hubbell "GFWRST20I" or Leviton "G5362-WTI".
- 4. 600 volt welding receptacles shall be 30 amperes, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ADRE3034-100", Crouse-Hinds "AR348" plus "ARRC33" and "AR30" or Leviton " 430MI5W". One matching plug, Appleton "ACP3034BC", Crouse-Hinds "APJ3485" or Leviton "430P5W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

2.4 JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS

- A. Indoor boxes (larger than switch, receptacle, or fixture type) and gutters shall be constructed of sheet steel, shall be galvanized after fabrication, and shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.
- B. Indoor boxes and gutters in corrosive areas indicated on the Drawings and outdoor boxes and gutters shall be NEMA Type 4X, ABS or stainless steel and shall be rigidly supported by PVC-coated or stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.
- C. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 lbs, shall have rigid handles. Covers larger than 3 by 4 feet shall be split.
- D. Where indicated on the Drawings, junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2.5 LIGHTING FIXTURES

- A. Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. Lighting fixtures shall be furnished complete with lamps. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise specified. Lighting fixtures shall be provided with disconnects in accordance with NEC requirements.
- B. Electronic Drivers
 - 1. Electronic drivers furnished with LED type lighting fixtures shall be certified as meeting requirements of ANSI C82.77 with a THD level of not more than 20 percent.

2.6 LIGHTING PANELS

- A. Each lighting panel shall be a dead-front, 120/240 volt, single phase or 120/208 volt, three phase panelboard with circuit breakers, in accordance with the Drawings and the following:
- B. Acceptable Manufacturers
 - 1. The equipment shall be manufactured by General Electric (by ABB) or Square D without exception.
- C. Cabinet
 - 1. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a hinged trim (cover). Breaker operating handles shall be accessible through a latched, lockable, door. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.
- D. Circuit Breakers
 - 1. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip. Breakers shall have interrupting ratings not less than 10,000 amperes. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed. Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings indicated on the Drawings.
 - 2. Where indicated on the Drawings, circuit breakers shall include arc-fault circuit interrupter (AFCI) and/or ground fault circuit interrupter (GFCI) protection functions. Where GFCI breakers dedicated to protect heat tracing circuits, GFCI breakers shall be configured for equipment protection with a ground fault trip threshold of 30 mA. Otherwise, GFCI breakers shall be configured for personnel protection with a ground fault trip threshold of 5 mA.
- E. Buses
 - 1. The panel shall have main and neutral buses insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2.7 POWER PANELS

A. Unless otherwise specified, each power panel shall be dead-front, 3 phase panelboard with circuit breakers, in accordance with the Drawings and the following:

- B. Acceptable Manufacturers
 - 1. The equipment shall be manufactured by General Electric (by ABB) or Square D without exception.
- C. Cabinet
 - 1. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a door with latch and lock. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.
- D. Circuit Breakers
 - 1. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip type. Breakers up to 240 volts shall have interrupting ratings not less than 10,000 amperes. Breakers for 277 volts shall have interrupting ratings not less than 65,000 amperes. Breakers for 480 volts shall be rated 600 volts, with interrupting ratings not less than 65,000 amperes at 480 volts. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed.
- E. Buses
 - 1. The panel shall have 3 phase buses and a ground bus. Buses shall be copper, with ampere and voltage ratings and main lugs or breakers as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2.8 SURGE PROTECTIVE DEVICES

- A. Scope
 - 1. Surge protective devices (SPD) shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.



Each SPD shall be furnished and installed for the electrical equipment indicated on the Drawings or as specified herein. All new lighting and power panels shall be furnished with an integral SPD.

- 3. Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.
- 4. Power panels shall have SPD's rated for medium exposure levels.

- B. Standards
 - 1. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:
 - a. ANSI/IEEE C62.41 and C62.45;
 - b. ANSI/IEEE C62.1 and C62.11;
 - c. IEEE C62.62;
 - d. National Electrical Manufacturers Association (NEMA LS1 Guidelines);
 - e. National Fire Protection Association (NFPA 20, 70 [NEC], 75, and 780);
 - f. Underwriters Laboratories UL 1449 and 1283
 - 2. The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.
- C. Environmental Requirements
 - 1. Operating Temperature: $0^{\circ}F$ to $+140^{\circ}F$.
 - 2. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.
- D. Electrical Requirements
 - 1. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.
 - 2. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.
 - 3. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.
 - 4. Protection Modes. Four-wire configured systems shall provide, Line-to-Neutral (L-N), Line-to-Ground (L-G), and Neutral-to-Ground (N-G), and Line-to-Line (L-L) protection. Three-wire configured systems shall provide, Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.
 - 5. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and shall be no less than listed in the following table.

X
<i>Y</i>

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

6. UL 1449 Voltage Protection Rating (VPR). The maximum VPR per mode for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
120/208 3-phase	800 V	800 V	800 V	1200 V
480 V 3W		1200 V		2000 V

- 7. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.
- 8. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.
- 9. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200 kA symmetrical fault current with 600 volts ac applied.

At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.

The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

- 10. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit. When furnished integral to the panelboard, the status indicators shall be viewable when the panelboard door is opened.
- E. Installation
 - 1. Each SPD shall be installed according to the manufacturer's recommendations. If possible, for the integral units, provide direct bus connections.
- F. Miscellaneous
 - 1. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL 1449 listed as such, and the UL 1449 Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding the published maximum surge current magnitude without failure or damage to the switch.
 - 2. Enclosure. For the SPD units to be mounted externally of the protected electrical equipment, provide NEMA rated enclosures suitable for the locations indicated on the Drawings.
 - Dual Form "C" Dry Contacts. The SPD shall be provided with a set of form "C" dry contacts (normally open and normally closed) to facilitate connection to a plant control system or other remote monitoring system. The contacts shall be normally open or normally closed and shall change state upon any alarm condition.
- G. Acceptable Manufacturers
 - 1. Integral SPD's shall be manufactured by Eaton, General Electric, or Schneider-Electric. External SPD's shall be manufactured by Eaton, General Electric, Siemens Energy &

Automation, Schneider-Electric, or Current Technology. The products of other manufacturers will not be acceptable.

2.9 SEPARATELY ENCLOSED MOTOR STARTERS

- A. Separately enclosed motor starters, unless otherwise specified, shall be full voltage, magnetic, nonreversing and NEMA rated. The starter enclosures shall have NEMA type designations appropriate for the locations where they will be installed. Unless otherwise noted, NEMA Type 4X stainless steel enclosures shall be provided for outdoor locations.
- B. As indicated on the Drawings, heaterless overload protection shall be provided by three current sensors monitored by a microprocessor. The overload device shall also include phase loss, phase reversal, voltage unbalance, under voltage on any one or more phases, trip class selection, and Class II ground fault protection. The overload shall have the option for auto or manual reset. When auto is selected the overload shall reactivate after power line conditions return to an acceptable level. Trip and reset delays shall prevent nuisance tripping due to rapidly fluctuating power line conditions
- C. Each starter shall include auxiliary contacts as required, plus one spare NO and one spare NC contact.
- D. Contractor shall match the sizes of control power transformers, overload devices, heaters, and starters to the equipment furnished, as they may differ from the values indicated on the Drawings. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.
- E. All starters shall be provided with control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.
- F. All push buttons, selector switches, and pilot lights indicated on the schematics to be provided on or in the starter enclosure shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps. Push buttons on starters located outdoors shall be provided with protective caps.
- G. Three Phase Starters



Three phase starters shall be circuit breaker combination type consisting of 3 phase, 60 Hz contactors with heaterless overloads, a 120 volt ac coil, a dry type control power transformer where required, and a circuit breaker disconnect. Control power transformers shall be sized to handle all simultaneous loads. Starters shall be at least NEMA Size 1, or shall be sized as indicated on the Drawings.

- 2. Circuit breakers shall be 600 volt magnetic motor circuit protectors for motors smaller than 100 horsepower and 600 volt thermal-magnetic type for 100 horsepower and larger motors. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism.
- 3. Three phase starters shall be furnished with external manual breaker operating handles and provisions for up to three padlocks. The access door shall be interlocked with the

motor circuit protector, so that the door cannot be opened, except by an interlock override, while the breaker is closed.

- 4. The complete 3 phase starter shall have an interrupting rating of at least 65,000 amperes at 480 volts.
- H. Single Phase Starters
 - 1. Single phase starters shall consist of single phase, 60 Hz contactors with thermal overloads and an integral or separately enclosed short-circuit protection device. Starters shall be at least NEMA Size 0, or shall be sized as indicated on the Drawings. Integral short-circuit protection devices for single-phase starters shall be 120/240 volt, magnetic motor circuit protectors.
 - 2. Separately enclosed short-circuit protection devices for single phase starters shall be molded-case circuit breakers for motor loads 6 amperes and higher and fused switch disconnects for motor loads lower than 6 amperes. Circuit breaker disconnects shall be 120/240 volt, molded-case, thermal-magnetic circuit breakers. Fused switch disconnects shall have quick-make, quick-break mechanisms and 250 volt, dual-element, time-delay fuses.
 - 3. The short-circuit protection devices shall have external operating handles capable of being padlocked in the open position, and shall have an interrupting rating of at least 10,000 amperes at 240 volts.

2.10 CONTROL STATIONS

A. Control stations shall be provided as indicated on the one-line diagrams or schematics or as required by the equipment furnished. Pilot devices shall be 30.5 mm heavy-duty, oiltight construction, and shall perform the functions indicated. Pilot lights shall be full voltage type with LED lamps. Indoor control stations shall have NEMA Type 13 enclosures. Control stations outdoors or indicated to be weatherproof shall have NEMA Type 4X stainless steel enclosures with protective caps on the control devices. Control stations in NEC Class I, Division 1 and Division 2, Group D hazardous areas shall have NEMA Type 7 enclosures, or be factory sealed type, Appleton "Contender Series" or Killark "Seal-X Series".

2.11 DISCONNECT SWITCHES

- A. Unless otherwise specified, each disconnect switch shall be 3 pole, nonfusible, 600 volts, with a continuous current rating as indicated on the Drawings.
- B. Where indicated on the Drawings, fused switches shall be furnished complete with fuses. Fuse sizing shall be as indicated on the Drawings, as required by the results of the protective device study, or as recommended by the respective protected equipment manufacturer.
- C. Switches located indoors shall have NEMA type enclosure designations as required by the locations where they will be installed. Switches located outdoors shall have NEMA Type 4X enclosures. Switches in chlorine rooms, or in other areas where contact with caustic substances may occur, shall have NEMA Type 4X enclosures of molded reinforced polyester.

- D. Switches shall have high conductivity copper, visible blades; nonteasible, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base. Each switch shall have a handle whose position is easily recognizable and which can be locked in the "Off" position with three padlocks. The "On" and "Off" positions shall be clearly marked.
- E. All switches shall be UL listed and horsepower rated, and shall meet the latest edition of NEMA KS1. Switches shall have defeatable door interlocks that prevent the door from being opened while the operating handle is in the "On" position.

2.12 LIGHTING AND AUXILIARY POWER TRANSFORMERS

A. Separately mounted transformers shall be provided in the phases, kVA, and voltages indicated on the Drawings. Transformers shall be self-air-cooled, dry type, wall- or floor-mounted, and enclosed for wiring in conduit. Transformers installed outdoors shall be weatherproof. Transformers shall have at least four full capacity voltage taps, two above and two below rated voltage. Transformers shall meet DOE 10 CFR 431 guidelines for energy efficiency.

2.13 LIGHTING CONTACTORS

A. Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 20 amperes, 600 volts ac, for all types of loads. Terminals shall accept 18 through 10 AWG conductors. Contactors shall operate in any position and may be manually operated for testing and maintenance. Contactors shall be ASCO 918. Contactor control panels shall be UL 508A listed. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

2.14 PHOTOELECTRIC CONTROLS

A. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.

PART 3 - EXECUTION

3.1 INSTALLATION, TESTING, AND COMMISSIONING

A. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

3.2 ARC FLASH HAZARD ANALYSIS

- A. Contractor shall commission an Arc Flash Hazard Analysis in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584 and shall submit an Arc Flash Hazard Analysis report as specified hereing. The scope of the analysis shall include arc flash labeling for each piece of electrical equipment including lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter sockets, medium-voltage transformers, and other electrical equipment likely to be worked on energized.
- B. The scope of the analysis shall include all new or modified electrical equipment and any equipment who's incident energy is impacted as a result of the design. Contract shall request the most recent existing arc flash analysis and computer model files from the Owner and modify the existing model as required to perform the analysis. The Contractor shall field verify the existing computer model data and update as required.
- C.
- C. The analysis shall calculate the incident energy value and arc flash boundary at defined working distances for all AC, three-phase, 208 volt through 15kV, electrical equipment in accordance with the IEEE 1584 calculation method.
- D. AC single-phase equipment, rated 208 volt and above, shall be calculated using single-phase fault current values applied to the three-phase equations in accordance with IEEE 1584.
- E. AC single-phase equipment, rated below 208 volt, with a maximum available fault current of 25 kA and a maximum fault clearing time of 2 cycles, shall be analyzed and labelled using the Arc-Flash PPE Categories for Alternating Current Systems, Table 130.7(C)(15)(a), in NFPA 70E (2018).
- F. DC system and equipment shall be analyzed and labelled using the Arc-Flash PPE Categories for Direct Current Systems, Table 130.7(C)(15)(b), in NFPA 70E (2018).
- G. The Arc Flash Hazard Analysis shall be performed in association with, or as a continuation of, the short circuit study and protective device study. Protective-device settings shall be selected to provide the necessary equipment protection and device coordination required while balancing the goal to reduce the calculated incident energy to the greatest extent possible.
- H. The analysis shall be performed for multiple electrical system modes of operation in order to calculate the worst-case incident energy at each piece of equipment. At a minimum, the system shall be analyzed for the minimum and maximum available fault current and X/R ratios from the electric utility supplying service or for the separately derived power system. The Contractor shall be responsible for obtaining the available fault current values from the local electric utility. The analysis shall not assume bolted fault current values.
- I. For equipment with an integral main overcurrent protective device that is not adequately isolated from the bus, the upstream protective device shall be used as the fault clearing device in the analysis. Where arc reduction maintenance mode switches are installed on protective devices, the arc reduction shall only apply for downstream equipment that is adequately isolated from the protective device. Adequately isolated equipment shall be confirmed by the equipment manufacturer and shall be submitted to Engineer for review.

- J. The Contractor shall be responsible for collecting all field data for a complete analysis. Assumptions should only be made after every effort has been made to obtain the needed information. All assumptions used in the analysis shall be documented in the report for review by Engineer.
- K. The results shall include, but shall not be limited to, a tabulated spreadsheet of the following items for each piece of equipment included in the analysis:
 - 1. Equipment name.
 - 2. Three-phase bolted fault current.
 - 3. Arcing fault current.
 - 4. Arcing fault current through the protective device.
 - 5. Protective device clearing the fault.
 - 6. Protective device opening time.
 - 7. Bus gap.
 - 8. Worst-case incident energy and corresponding working distance. Equipment with arc reduction maintenance mode switches shall include the calculated incident energy level with and without the switch enabled.
 - 9. Arc flash protection boundary.
- L. An Engineering and Testing Services firm acceptable to Engineer shall conduct the Arc Flash Hazard Analysis.
- M. Arc Flash Analysis Software
 - 1. The Arc Flash Hazard Analysis shall be performed using the latest version of ETAP electrical power system analysis software, without exception. After the final version of the study and analysis are completed and accepted, Contractor shall provide a copy of the electronic computer model files to Owner.
- N. Arc Flash Hazard Report.

Contractor shall be responsible for submitting complete and accurate arc flash analysis information in the Arc Flash Hazard Report. The report shall be submitted to Engineer for review before the final report is prepared.

- 2. The report shall include the following information at a minimum:
 - a. Executive summary.
 - b. Description of scope and study methodology.
 - c. Documentation of the modes of operation evaluated in the analysis including applicable input data such as utility fault current values.
 - d. Discussion of results and any recommendations.
 - e. Tabulated results spreadsheet.

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- f. List of assumptions.
- g. One-line diagram(s) from the computer model software showing equipment names and other applicable information.
- h. Documentation of software study parameters and configuration settings.
- i. Recommended arc flash Personal Protective Equipment (PPE) selection in accordance with NFPA 70E.
- 3. A bound hardcopy and digital PDF of the final Arc Flash Hazard Analysis report shall be submitted in accordance with the Submittal section.
- 4. The final report shall be signed and sealed by a registered Professional Engineer
- O. Arc Flash Labeling
 - 1. After approval of the Arc Flash Hazard Report, Contractor shall furnish and install arc flash labels on the applicable electrical equipment. The label template shall be subject to review and acceptance by Engineer. The arc flash labels shall comply with ANSI Z535.4 and NFPA 70E requirements. Labels shall include, at a minimum, the nominal system voltage, the arc flash boundary distance, worst-case incident energy and the corresponding working distance, date of the analysis, and equipment name.
 - 2. Switchgear, motor control centers, and other multi-section equipment shall be provided with a duplicate label for each vertical section.
 - 3. Equipment with arc reduction maintenance mode switches shall include a dual label with the worst-case calculated incident energy level with and without the switch enabled. The label shall clearly identify the associated maintenance mode switch that shall be enabled in order for the lower incident energy level to apply.

3.3 PROTECTIVE DEVICE STUDY

- A. Contractor shall commission a short circuit study and protective device study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination and protective device settings report as specified herein. The study shall be in compliance with IEEE 242 and include the entire distribution system, including any and all existing power distribution components which will impact the results of the protective device study, starting with the smallest 480 volt, 3 phase, 60 Hz circuit protective device on the load end, to the nearest protective device on the power company's line side. Where existing electrical distribution system components are part of the study, the Contractor shall field verify and report the respective ratings and settings of each device as found as a prerequisite to the study analysis being performed. Protective device settings shall be selected to provide selective coordination to the maximum extent possible for equipment protection and device coordination while balancing the goal to reduce the calculated incident energy to the greatest extent possible.
- B. Contractor shall be responsible for and shall ensure that all relays, protective devices and circuit breakers shown on the Drawings and Specifications are sized and set according to the study results.
- C. The study shall include, but shall not be limited to, the following:

- 1. Color-coded printouts of coordination curves prepared with calculation software.
- 2. A tabulation of all protective relay and circuit breaker trip settings and recommended sizes and types of medium-voltage fuses.
- 3. Motor starting profiles for all 50 horsepower and larger motors.
- 4. Transformer damage curves and protection, evaluated in accordance with IEEE C57.109.
- 5. Coordination curve(s) from the power company, if available.
- 6. Calculated short-circuit values at all nodes in the distribution system included within the scope of the protective device study.
- 7. Protective device settings shall include, but not limited to, motor and pump RTD settings, motor starts per hour, bus and transformer differential settings, synch-check settings, under and over-voltage settings, under and over-frequency settings, low-voltage breaker and MCC starter overload settings, and all protective functions shown on the Drawings and Specifications
- 8. Adjustable frequency drive settings evaluated in accordance with the manufacturer's recommendations and driven equipment requirements
- D. An Engineering and Testing Services firm acceptable to Engineer shall conduct the protective device study.
- E. Contractor shall be responsible for obtaining the following:
 - 1. The coordination curves for relays, fuses, and circuit breakers.
 - 2. Transformer damage curves.
 - 3. Motor and pump data.
 - 4. Other applicable information for all new and existing electrical equipment.
- F. Contractor shall coordinate with the power company to obtain the required protective device curves and shall be responsible for all the field work associated with obtaining the necessary data on existing relays, circuit breakers, fuses, and transformers to be included in the protective device study.
- G. The available 3 phase, symmetrical fault current at the point of service shall be obtained from the Power Company.
- H. The protective device report shall be bound in a standard 8-1/2 by 11 inch three-ring binder and shall be submitted in accordance with the Submittal Procedures section. Final selection of all protective device settings or sizes shall be subject to review and acceptance by Engineer.

3.4 CABLE INSTALLATION

- A. General
- B. Except as otherwise specified or indicated on the Drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits as indicated on the one-line diagrams shall be installed continuous and may not be spliced unless approved by the Engineer.
 - 1. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.
 - 2. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may only be used for terminations at lighting fixtures.
 - 3. Splices may be made only at readily accessible locations.
 - 4. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.
 - 5. All 5,000 volt rated cable and above shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be tape or molded rubber type as required. Shielded cable splices and stress cone terminations shall be made by qualified splicers. Materials shall be by 3M Company, Plymouth/Bishop, or Raychem Electric Power Products.
 - 6. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.
 - 7. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J".
 - 8. Cables operating at more than 2000 volts shall be fireproofed in all cable vaults, manholes, and handholes. Fireproofing shall be applied with a half-lapped layer of 3M "Scotch 77 Arc-Proofing Tape", anchored at each end with a double wrap of 3M "Scotch 69 Glass Cloth Tape" or with equivalent tape by Anixter or Plymouth/Bishop.
 - Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.



Spare cable ends shall be taped, coiled, and identified.

- 11. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.
- 12. All cables in one conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.

- 13. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.
- 14. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.
- 15. Cables operating at more than 2,000 volts which terminate at medium-voltage padmounted equipment bushings shall include a metal oxide varistor surge protective elbow terminator conforming to IEEE Standard 386. Elbows shall provide a weatherproof, dead-front, hot-stick operable separable connection. Surge protector rating shall be as recommended by the terminator supplier.
- C. Underground Cable Pulling Procedure
 - 1. Care shall be taken to prevent excessive physical stresses that would cause mechanical damage to cables during pulling. Before pulling cables into the underground duct system the Contractor shall submit a pulling procedure for Circuit Numbers SWGR-3-1 and SWGR-6-1.
 - 2. The procedure shall include the following information:
 - a. Point of cable entrance into the duct system.
 - b. Point of cable exit from the duct system.
 - c. Type of cable grip to be used.
 - d. Type of pulling device to be used.
 - e. Method of continuously monitoring cable tension during pulling.
 - f. Identification of manholes through which cable will be pulled or where splices will be made.
 - g. Size and type of cable sheave assemblies to be used.

3.5 RACEWAY INSTALLATION

- A. Contractor shall be responsible for routing all raceway. This shall include all conduits indicated on the one-lines, riser diagrams, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.
- B. Except as otherwise specified or indicated on the Drawings, conduit installation and identification shall be completed according to the following procedures.
- C. Installation of Interior and Exposed Exterior Conduit
 - 1. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified

or indicated on the Drawings. No conduit shall be exposed in water chambers unless so indicated on the Drawings.

- 2. Unless otherwise indicated on the Drawings, Contractor shall be responsible for routing the conduit to meet the following installation requirements:
 - a. Conduit installed in all exposed indoor locations, except corrosive areas indicated on the Drawings, and in floor slabs, walls, and ceilings of hazardous (classified) locations, shall be aluminum. Exposed conduit shall be rigidly supported by stainless steel hardware, including nuts and bolts, and aluminum framing materials.
 - b. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 40 PVC.
 - c. Conduit installed in all exposed outdoor locations shall be PVC-coated aluminum, rigidly supported by aluminum framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.
 - d. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be aluminum liquidtight flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet unless otherwise acceptable to Engineer.
 - e. (Not Used)
 - f. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.
 - g. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.
 - h. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues.
 - (Not Used)



Rigid Schedule 40 and 80 PVC conduit shall have supports and provisions for expansion as required by NEC Article 352.

- . Metallic conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.
- 1. Rigid Schedule 40 and 80 PVC conduit shall be secured to sheet metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.
- m. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of

reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.

- n. Conduits that cross structural joints where structural movement is allowed shall be fitted with concretetight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 40 or 80 PVC conduits. The couplings shall be Appleton Type DF, Crouse-Hinds Type XD, or O-Z Type DX.
- o. Conduit shall be clear of structural openings and indicated future openings.
- p. Conduits through roofs or metal walls shall be flashed and sealed watertight.
- q. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of fire rated structure elements shall be sealed in a manner that maintains the fire rating as indicated on the Architectural Drawings.
- r. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.
- s. Exposed conduit stubs for future use shall be terminated with aluminum pipe caps.
- t. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.
- u. (Not Used)
- v. Horizontal conduit shall be installed to allow at least 7 feet of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.
- w. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Engineer.
 - (Not Used)

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All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.

- Conduit which turns out of concrete slabs or walls, shall be connected to a 90 degree elbow of PVC-coated aluminum conduit before it emerges. Conduits shall have PVC-coated aluminum couplings embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.
- aa. (Not Used)

- D. Underground Conduit Installation
 - 1. All excavation, backfilling, and concrete work shall conform to the respective sections of these Specifications. Underground conduit shall conform to the following requirements:
 - a. All underground conduits shall be concrete encased unless indicated otherwise on the Drawings. Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations shall be reinforced as detailed on the Drawings.
 - b. Concrete encased conduit shall be schedule 40 PVC. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from walls and the coupling shall extend 2 inches from the wall. All PVC joints shall be solvent welded in accordance with the recommendations of the manufacturer.
 - c. Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches above grade, with top crowned and edges chamfered.
 - d. The top surface of all duct bank concrete shall be dyed red by brooming dye into the wet concrete. Caution tape and locating wires shall be installed at least 6 inches above each finished duct bank during backfilling.
 - e. Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug. The termination of the duct bank shall be reinforced with bars 100 diameters long that shall be terminated 2 inches from the bulkhead. Matching splice bars shall be 50 bar diameters long. Each longitudinal bar shall be provided with a Lenton "Form Saver" coupler and plate or a Dayton "Superior DBR" coupler at the bulkhead. The coupler shall be threaded to accept a dowel of like diameter in the future. Threads shall be protected with screw-in plastic caps. A 1-3/4 by 3/4 inch deep horizontal shear key shall be formed in the concrete encasement above and below the embedded conduits. After concrete placement, conduit and bar connector ends shall be cleaned and coated with two coats of thixotropic coal tar.
 - f. Underground conduits indicated not to be concrete encased shall be rigid Schedule 40 PVC.
 - g. Underground conduit bend radius shall be at least 2 feet at vertical risers and at least 3 feet elsewhere.
 - h. Underground conduits and conduit banks shall have at least 2 feet of earth cover, except where indicated otherwise.
 - Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in the Cast-In-Place Concrete section.

Underground nonmetallic conduits, which turn out of concrete or earth in outdoor locations, shall be connected to 90 degree elbows of PVC-coated aluminum conduit before they emerge.

- k. Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.
- 1. Underground conduits shall be sloped to drain from buildings to manholes.
- m. Each 5 kV or higher voltage cable, each 250 kcmil or larger cable, and each conduit group of smaller cables shall be supported from manhole walls by Kindorf "D-990" or Unistrut "P-3259" inserts, with Kindorf "F-721-24" or Unistrut "P-2544" brackets and Unistrut "P1753" or "P1754" fiberglass reinforced polyester cable saddles.

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- n. Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.
- E. Sealing of Conduits
 - 1. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch and larger conduit connections to equipment.
 - 2. Conduits entering hazardous (classified) areas and submersible or explosion proof enclosures shall have Appleton "Type ESU" or Crouse-Hinds "EYS" sealing fittings with sealing compound.
- F. Reuse of Existing Conduits
 - 1. Existing conduits may be reused subject to the concurrence of Engineer and compliance with the following requirements:
 - a. A wire brush shall be pulled through the conduit to remove any loose debris.
 - b. A mandrel shall be pulled through the conduit to remove sharp edges and burrs.

3.6 WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION

- A. Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:
- B. Conduit Boxes and Fittings
 - 1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.
 - 2. Galvanized or cadmium plated sheet steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.
 - 3. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

PVC coated boxes and fittings shall be installed in PVC coated conduit systems.

- C. Device Plates
 - 1. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.
- D. Wall Switches
 - 1. Wall switches shall be mounted 3'-6" above floor or grade.

2. After circuits are energized, all wall switches shall be tested for proper operation.

E. Receptacles

- 1. Convenience outlets shall be 18 inches above the floor unless otherwise required.
- 2. Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.
- 3. Welding receptacles shall be surface-mounted 4 feet above the floor.
- 4. After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.
- 5. Conduit and wire for convenience outlet installation is not shown on the Drawings and shall be sized, furnished, and installed by Contractor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for convenience outlet installation.
- F. Special Outlets
 - 1. Wall thermostats shall be 4'-6" above the floor unless otherwise required. Thermostats on exterior walls shall be suitably insulated from wall temperature.

3.7 EQUIPMENT INSTALLATION

- A. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.
- B. Setting of Equipment
 - 1. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch thick corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.
- C. Sealing of Equipment

All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795" or General Electric "SCS1200".

3.8 GROUNDING

A. General

- 1. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:
 - a. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.
 - b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections, Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with highcompression two-hole lugs.
 - c. Ground cable through exterior building walls shall enter within 3 feet below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch copper disc over the cable. The copper disc shall be installed on the exterior of the wall and shall be a minimum thickness of 12 gauge and have a diameter that is a minimum of 2 inch larger than the diameter of the core hole that the ground cable passes through. The copper disc shall be soldered to the ground cable and caulk shall be applied around the outside edge of the copper disc where it adjoins the exterior wall. Caulk rated for submerged application shall comply with the Joint Sealants section.
 - d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches. The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches below grade, or below the frost line, whichever is deeper.
 - e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.
 - f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.

The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches.

- i. Ground rods not described elsewhere shall be a minimum of 3/4 inch in diameter by 10 feet long, with a copper jacket bonded to a steel core.
- j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.
- B. Grounding System Resistance
 - 1. The ground system resistance shall comply with National Electrical Code.
 - 2. The grounding system design depicted on the Contract Drawings is the minimum design required for each building or structure. Each system shall comply with the maximum resistance of 5 ohms to ground. Contractor shall confirm the system grounding resistance with the results of the testing specified herein. Systems exceeding the maximum resistance specified shall be supplemented with additional grounding provisions and retested until the maximum specified resistance is achieved.
- C. Grounding System Testing
 - 1. The grounding system of each new building or structure and each existing building or structure indicated below, shall be tested to determine the resistance to earth. Testing shall be performed by an independent electrical or grounding system testing organization. Testing shall be completed after not less than three full days without precipitation and without any other moistening or chemical treatment of the soil.
 - 2. New Grounding Systems
 - a. Grounding systems of each new building or structure shall be tested for resistance to earth utilizing the three-point fall of potential test as defined by IEEE 81. Testing shall be completed prior to installation of the electrical distribution equipment to ensure the grounding system is isolated from the utility grounding system and the systems of other structures. The current source probe for the test shall be placed in soil at a distance of 5 to 10 times the distance of the widest measurement across the grounding system ring or grid to ensure adequate measurements outside of the grounding system's sphere of influence. Test probe measurements shall be taken at a distance of one foot from the grounding system reference connection and at each 10 percent increment from the grounding system reference on a graphical plot with resistance in ohms on the vertical axis and distance in feet on the horizontal axis. The results shall clearly indicate a system resistance plateau which confirms a valid test procedure.
 - 3. Grounding System Test Report
 - a. A report certified by the testing organization shall be prepared and submitted in accordance with the Submittal Procedures section. The final report shall include complete testing results for each building or structure, graphical representation of the test point results for the three-point fall of potential method, and complete observations of all site weather conditions and other environmental conditions that

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may affect the test results. Final acceptance of the results reported shall be subject to the review and approval of Engineer.

3.9 LIGHTING FIXTURE INSTALLATION

- A. The Drawings indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.
- B. Conduit and wire for lighting fixture installation is not shown on the Drawings and shall be sized, furnished and installed by Contractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for lighting fixture installation.

3.10 MODIFICATIONS TO EXISTING EQUIPMENT

A. Modifications to existing equipment shall be completed as specified herein and indicated on the Drawings. All existing facilities shall be kept in service during construction. Temporary power or relocation of existing power and control wiring, equipment, and devices shall be provided as required during construction. Coordination and timing of outages shall be as specified in other sections of these Specifications. Electrical power interruptions will only be allowed where agreed upon in advance with Owner, and scheduling at times of low demand may be required.

B. Demolition

1. Unless otherwise specified or indicated on the Drawings, all cable and all exposed conduit for power and control signals of equipment indicated to be removed shall be demolished. Conduit supports and electrical equipment mounting hardware shall be removed, and holes or damage remaining shall be grouted or sealed flush. Conduit partially concealed shall be removed where exposed, and plugged with expanding grout flush with the floor or wall. Repairs shall be refinished to match the existing surrounding surfaces. Demolished equipment shall be discarded or salvaged as indicated on the Drawings and as specified in other sections of these Specifications.

End of Section

STANDARD SPECIFICATIONS								
R EFERENCE:	RENCE: ICEA S-95-658 (NEMA WC 70).							
CONDUCTOR:	Concentric-lay	Concentric-lay, uncoated copper; strand Class B. Wet/dry maximum operating temperature 90°C.						
INSULATION:	Cross-linked th	nermosetting poly	ethylene, ICEA S	-95-658, Paragra	ph 3.6.			
SHIELD:	None.					Ġ		
JACKET:	None.							
FACTORY TESTS:	Cable shall me	et the requirement	ts of ICEA S-95-	658.		0,5		
			Cable Details			y		
Siz	ze	Number of Strands	Conductor Thick	Insulation	Maximum Ou	tside Diameter		
AWG or kcmil	mm ²		in.	μm	in.	mm		
14	2.5	7	0.030	760	0.17	4.32		
12	4.0	7	0.030	760	0.19	4.83		
10	6.0	7	0.030	760	0.21	5.33		
8	10.0	7	0.045	1140	0.27	6.86		
6	16.0	7	0.045	1140	0.31	7.87		
4	25.0	7	0.045	1140	0.36	9.14		
2	35.0	7	0.045	1140	0.42	10.67		
1	40.0	19	0.055	1400	0.48	12.19		
1/0	50.0	19	0.055	1400	0.52	13.21		
2/0	70.0	C 19	0.055	1400	0.57	14.48		
4/0	95.0	19	0.055	1400	0.68	17.27		
250	120.0	37	0.065	1650	0.75	19.05		
350	185.0	37	0.065	1650	0.85	21.59		
500	300.0	37	0.065	1650	0.98	24.89		
750	400.0	61	0.080	2030	1.22	31.00		
1,000	500.0	61	0.080	2030	1.37	34.80		
*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than								

90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, XHHW-2, conductor size, and voltage class.



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STANDARD	SPECIFICATIONS
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REFERENCE: UL 83, ICEA S-95-658 (NEMA WC 70).

CONDUCTOR: Stranded, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, UL 83, Type THHN and THWN, ICEA S-95-658.

SHIELD: None.

JACKET: Conductor: Nylon, 4 mils (100 μ m) minimum thickness, UL 83.

FACTORY TESTS: Cable shall meet the requirements of UL 83 for Type THHN and THWN.

Cable Details							
Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter		
AWG or kcmil	mm ²		in.	μm	Pin.	mm	
14	2.5	19	0.015	381	0.12	3.05	
12	4.0	19	0.015	381	0.14	3.56	
10	6.0	19	0.020	508	0.17	4.32	
8	10.0	19	0.030	762	0.23	5.84	
6	16.0	19	0.030	762	0.26	6.60	
4	25.0	19	0.040	1016	0.33	8.38	
2	35.0	19	0.040	1016	0.39	9.91	
1	40.0	19	0.050	1270	0.44	11.18	
1/0	50.0	19	0.050	1270	0.50	12.70	
2/0	70.0	19	0.050	1270	0.54	13.72	
4/0	95.0	19	0.050	1270	0.66	16.76	
250	120.0	37	0.060	1520	0.72	18.29	
350	185.0	37	0.060	1520	0.83	21.08	
500	300.0	37	0.060	1520	0.96	24.38	
750	400.0	61	0.070	1780	1.17	29.72	
1,000	500.0	61	0.070	1780	1.32	33.53	

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, THWN or THHN, conductor size, and 600 volt.

600 Volt, Single Conductor Power Cable (600-1-PVC-THHN-THWN)

BLACK & VEATCH

Cable Data

Figure 3-26 05 11

505

STANDARD SPECIFICATIONS							
REFERENCE:	UL 66, UL 1277.						
CONDUCTOR:	16 AWG (1.5 mm ²), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.						
INSULATION:	Polyvinyl chloride, not less minimum thickness, UL 66,	Polyvinyl chloride, not less than 15 mils (380 μ m) average thickness; 13 mils (330 μ m) minimum thickness, UL 66, Type TFN.					
LAY:	Twisted pair with 1-1/2 inch	to 3 inch (38.10 n	nm - 63.5 mm)	lay.	Ġ		
SHIELD:	Cable assembly, combination minimum size, tinned copper insulated conductors.	Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm ²) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.					
JACKET:	Conductor: Nylon, 4 mils (100 μ m) minimum	thickness, UL	66.			
	Cable assembly: Black, flar cable core.	ne-retardant polyv	inyl chloride, U	JL 1277, applied ove	r tape-wrapped		
CONDUCTOR IDENTIFICATION:	One conductor black, one co	onductor white.		5			
FACTORY TESTS:	FACTORY TESTS: Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.						
		Cable Details	0				
		Assemb	ly Jacket mess*	Maxir Outside I	mum Diameter		
		in.	μm	in.	mm		
S	ingle Pair	0.045	1140	0.34	8.64		
*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.							
A durable marking sl Marking shall includ	A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single pair, and voltage class.						
600	Volt, Single Pair, Shielded I	nstrument Cable	(600-SINGLE	-PAIR-SH-INSTR)			
BLACK & VEATCH	ł	Cable Data		Figure 4-26	05 11		

STANDARD SPECIFICATIONS							
REFERENCE: UL 83, UL 1277, ICEA S-73-532, ICEA S-58-679.							
CONDUCTOR:	14 AWG (2.5 mm ²), 7 or temperature 90°C dry, 75	19 strands, concentric-la °C wet.	y, uncoated copper. Ma	ximum operating			
INSULATION:	Polyvinyl chloride, not le minimum thickness, UL {	ss than 15 mils (380 μ m) 33, Type THHN and THV) average thickness; 13 n WN.	nils (330 µm)			
SHIELD:	None.			65			
JACKET:	Conductor: Nylon, 4 mil	s (100 μ m) minimum thi	ckness, UL 83.	S			
	Cable assembly: Black, f cable core.	lame-retardant polyvinyl	l chloride, UL 1277, app	lied over tape-wrapped			
CONDUCTOR IDENTIFICATION:	ICEA S-58-679, Method or green conductors shall	1, Table 2 or ICEA S-58 not be provided.	-679, Method 3, Table 2	. White			
FACTORY TESTS: Insulated conductors shall meet the requirements of UL 83 for Type THHN-THWN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the flame test requirements of UL 1277 for Type TC power and control tray cable.							
Cable Details							
Number of Conductors	Assembly Jacket Maximum Thickness* Outside Diameter						
	in.	μm	in.	mm			
2	0.045	1140	0.38	9.65			
3	0.045	1140	0.39	9.91			
4	0.045	1140	0.44	11.18			
5	0.045	1140	0.46	11.68			
7	0.045	1140	0.49	12.45			
9	0.045	1140	0.61	15.49			
12	0.060	1520	0.66	16.76			
19	0.060	1520	0.77	19.56			
24	0.060	1520	0.93	23.62			
30	0.080	2030	0.98	24.89			
37	0.080	2030	1.05	26.67			
 *The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above. A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type THWN or THHN, conductor size, number of conductors, and voltage class. 							
600 Volt,	Multiconductor 14 AW	G (2.5 mm ²) Control Ca	ble (600-MULTI-THH	N-THWN)			
BLACK & V	ЕАТСН	Cable Data	Figu	re 7-26 05 11			

STANDARD SPECIFICATIONS									
REFERENCE: ICEA S-95-658 (NEMA WC 70).									
CONDUCTOR	CONDUCTOR: Stranded, uncoated copper. Maximum operating temperature 90°C.								
INSULATION	INSULATION: Cross-linked polyethylene. ICEA S-95-658.								
GROUND:	Cor	mer conducto	r sized per NF	EC with green	insulation.				
G		1 11		1					
SHIELD:	Cat 100	percent cove	r over insulate	ed conductors.	oil-polyester i	ape, shield ap	plied to achie	eve	
JACKET:	Cab cab	ble assembly: le core.	Black, flame-	retardant poly	vinyl chlorid	e, UL 1277, aj	pplied over ta	pe-wrapped	
FACTORY TE	EST: Cab bur	ole shall meet ner flame test.	the requireme	nts of ICEA S	S-95-658, UL1	277 and IEEF	E Standard 12	202 ribbon	
				Cable Details	5				
c:	70	Number	*Conc	luctor	**Assemb	oly Jacket	Maximu	n Outside	
51	ze	Strands	Insulation	Thickness	Thicl	cness	Diar	neter	
AWG or kcmil	mm ²		in	mm	i	//m	in	mm	
12	4	7	0.060	1.52	0.060	1520	0.66	16.80	
10	6	7	0.060	1.52	0.060	1520	0.71	18.14	
8	10	7	0.070	1.78	0.060	1520	0.93	23.74	
6	16	7	0.070	1.78	0.080	2030	1.04	26.40	
4	25	7	0.070	1.78	0.080	2030	1.21	30.67	
2	35	7	0.070	1.78	0.080	2030	1.35	34.40	
1	40	7	0.070	1.78	0.080	2030	1.35	34.40	
1/0	50	19	0.090	2.29	0.080	2030	1.70	43.07	
2/0	70	19	0.090	2.29	0.080	2030	1.77	44.94	
4/0	95	19	0.090	2.29	0.110	2800	2.02	51.34	
250	120	37	0.105	2.67	0.110	2800	2.30	58.49	
350	185	37	0.105	2.67	0.110	2800	2.63	66.70	
500	300	37	0.105	2.67	0.110	2800	3.12	79.26	
 *The average thickness shall be not less than indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above. *The average thickness shall be not less than indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above. A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, RHW, Type TC, conductor size, and voltage class. 									
_				_					
	2000 Volt, 3	Conductor V	ariable Frequ	iency Drive (Cable (2000-3	-VFD-XLP-F	PVC-SH-TC)	
BLA	CK & VEAT	ГСН	•	Cable Data	•	Fig	gure 15-26 05	5 11	

Electrical

Project and Location Circuit Designation				Project N Date	Jo			
DC 1	EST DATA	A						
			DC Test Voltag	ge				
100% Test Voltage Is Applied	Phase A	Phase B	Phase C	Cable Installati	ion: New Used Years			
1		D		Cable: Size	Length: 🖒			
2				Oper. kV	GroundedUngrounded			
3				Rated Cable Vo	oltage			
4				Insulation Wall	1			
6					(Type & Thickness)			
7				Conductor Jack	ket Wall(Type & Thickness)			
8				Shield				
9				[]	Гуре)			
10				Cable Manufac	cturer			
11				Temperature	Humidity			
13				Type of Termin	nation			
14				Type of Splice	& Location			
15								
kV dc after 1 min Decay				Remarks				
APPLICATION OF TEST VOL The initially applied direct-current the initially applied voltage to the The duration of the direct-current Test Curve	TAGE nt voltage sha e specified test t voltage test	Ill be not g st voltage shall be 1.	freater than shall be not 5 minutes fo	3.0 times the rated alternati over 100 percent in 10 seco or shielded cables and 5 mir	ing-current voltage. The rate of increase onds nor less than 100 percent in 60 sec nutes for nonshielded cables.	e from onds.		
Current								
Microamperes 0 1 2 0 1 2 2 2 2 2 3 <t< td=""><td>2 3 Voltage Is Aj</td><td>4 5 pplied</td><td>6</td><td>7 8 9 10 1</td><td>11 12 13 14 15</td><td></td></t<>	2 3 Voltage Is Aj	4 5 pplied	6	7 8 9 10 1	11 12 13 14 15			
Plot results of tests on all three pl 2. Assign and indicate values for ea	hases on this gr ch division on t	aph. the microan	nperes scale a	is required for the circuit being	tested.			
2. Assign and indicate values for each division on the microamperes scale as required for the circuit being tested.								
			Cable 10	est Data Form				

SECTION 26 05 83 - ELECTRICAL EQUIPMENT INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of electrical equipment.

1.2 GENERAL

- A. Equipment specified to be installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. The electrical equipment identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.
- C. Coordination
 - 1. When manufacturer's field services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 14 days prior to the need for manufacturer's field services furnished by others.
 - 2. Submittals for equipment furnished under the original procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery

When sills are required for electrical equipment, they shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed.

- B. Storage
 - 1. Upon delivery, all equipment and materials shall immediately be stored and protected by Contractor in accordance with Product Storage and Handling Requirements section, and in accordance with manufacturer's written instructions, until installed in the Work. Equipment shall be protected by Contractor against damage and exposure from the elements. At no time shall the equipment be stored on earth or grass surfaces or come into contact with earth or grass. Contractor shall keep the equipment clean and dry at all

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I ŝ

times. Openings shall be plugged or capped (or otherwise sealed by packaging) during temporary storage.

- C. Handling
 - 1. Electrical equipment shall be moved by lifting, jacking, or skidding on rollers as described in the manufacturer's instructions. Special lifting harness or apparatus shall be used when required. Lifting and jacking points shall be used when identified on the equipment. Contractor shall have required unloading equipment on site to perform e put pose unloading work on the date of equipment delivery.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

INSTALLATION, TESTING, AND COMMISSIONING 3.1

- All installation work shall be in accordance with manufacturer's written instructions. A.
- All material, equipment, and components specified to be installed according to this section shall B. be installed, tested, and commissioned for operation in compliance with NECA 1000 - NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.
- Electrical equipment cubicles and vertical sections shall be installed plumb and level. Drawout C. equipment carriages, circuit breakers, and other removable components shall operate free and easy without binding or distortion.
- D. Unless otherwise indicated or specified, all indoor floor-mounted electrical equipment and control cabinets shall be installed on concrete equipment pads four inches in height.
- Indoor metalclad switchgear shall be bolted to steel floor channels which are installed level and E. flush with the top of the concrete floor or equipment pad.
- F. Outdoor metalclad switchgear and interrupter gear with integral floor channels or beams shall be secured to concrete pads with anchor bolts and clips.
- Motor control centers with integral floor sills shall be secured to concrete floors or equipment G. pads with anchor bolts.
- H. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

Electrical Equipment Installation

- I. Cleaning
- All deposits of oil, grease, mud, dirt or debris shall be cleaned from the electrical 1. equipment following installation and field wiring. A detergent water based solution, or other liquid cleaners not harmful to material or equipment finishes, shall be used as Adto be used for bidding pumpose recommended by the manufacturer.

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SECTION 26 24 23 - 600 VOLT CLASS MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers motor control center (MCC) equipment which shall be furnished and installed as specified herein and as indicated on the Drawings. Motor control centers shall meet the following requirements, and the design conditions and features specified herein.
- B. Motor control centers shall be designated and shall be located as follows:

Tag number(s)	MCC-1501
	MCC-1502
Motor control center designation(s)	AGS MCC
	AGS MCC

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless Engineer notes exceptions.
- B. General Equipment Stipulations

Location of motor control center(s)

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

AGS Facilities

- C. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- D. Dimensional Restrictions
 - 1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

- E. Workmanship and Materials
 - 1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
 - 2. All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except when required by tests.
- F. Governing Standards
 - 1. All equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:
 - a. NEMA ICS 18
 - b. UL 845.
 - 2. The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.
 - 3. Equipment covered by this section shall be listed by UL or a nationally recognized thirdparty testing laboratory. All costs associated with obtaining the listing shall be the responsibility of the Contractor. In the event, no third-party testing laboratory provides the required listing; an independent test shall be performed at the Contractor's expense. Before testing, the Contractor shall submit a copy of the testing procedure that will be used in evaluating the equipment.
- G. Nameplates

2.

- 1. Nameplates with unit description and designation of each control or indicating device shall be provided on all hinged doors. Nameplates shall be black and white laminated phenolic material of suitable size and shall be engraved with 3/8 inch high letters for compartment identity and 3/16 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.
 - Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

H. System Characteristics

1. This equipment will be connected to a power system with characteristics as specified below.

Voltage	480 V
Frequency	60Hz
Туре	Three phase

1.3 SUBMITTALS

A. Drawings and Data

- 1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor control center shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:
 - a. Motor Control Center
 - 1) Elevation, plans, and weight.
 - 2) Unit wiring diagrams showing devices, connections, and terminal designations.
 - 3) Interconnection diagrams.
 - 4) Control schematic diagrams.
 - 5) Circuit breaker time-current characteristic curves.
 - 6) Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.
 - b. Seismic Design Requirements
 - 1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
- B. Operation and Maintenance Data and Manuals
 - 1. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
- 1.4 SPARE PARTS

A. Not used.

1.5 **PROTECTIVE DEVICE STUDY**

A protective device settings study of the power distribution system will be conducted in accordance with the Electrical section. The initial equipment drawing submittal shall include the circuit breaker coordination curves for the main breaker(s), the tie breaker, the largest circuit breaker utilized in a combination starter, the largest feeder circuit breaker, and the smallest circuit breaker provided as a part of the motor control center assembly.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.
- B. Motor control centers shall be equipped to be handled by a crane. Where cranes are not available, control centers shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The equipment shall be manufactured by General Electric (by ABB) or Square D without exception.

2.2 CONSTRUCTION

- A. Each control center shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the Drawings or specified herein. End sections shall include provisions for main, ground, and neutral bus extensions and installation of future vertical sections.
- B. Motor control center wiring shall be NEMA Class II and NEMA Type B. Construction shall be as specified below.

	Tag number(s)	<u>MCC-1501</u>	<u>MCC-1502</u>
	Bus bracing, circuit	65,000 A	65,000 A
	breaker and combination motor starter rating	72	
	Horizontal bus rating	1200 A	1200 A
	Service entrance rated	No	No
$\boldsymbol{\checkmark}$	Cable entry	Top and bottom	Top and bottom
$\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{\mathbf{$	Enclosure type	NEMA Type 1 gasketed	NEMA Type 1 gasketed
	Main SPD exposure level	Medium-high	Medium-high

- C. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.
- D.

4

D. Vertical Sections

- 1. The control center shall consist of standardized, freestanding structures bolted together to form a single dead-front panel assembly containing combination motor control units; feeder units; transformers; lighting panels; and metering, relaying, and interlocking, and miscellaneous control devices, as indicated on the Drawings. A removable lifting angle shall be mounted on the top of each shipping group. Removable front and rear bottom channel sills shall extend the full width of the motor control center.
- 2. Each vertical section shall be 90 inches high and not less than 20 inches wide. Sections shall be 20 inches deep. Each 20 inch wide standard section shall have all necessary hardware and busing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Removable rear plates shall be sectionalized so that it is unnecessary to handle any plate larger than the section width or one-half the section height.
- 3. A metal barrier extending the full height and depth of the section shall be provided to isolate each section from the next section.
- E. Compartmented Units
 - 1. Each vertical section shall be constructed of modular components of various sizes. The modular components shall be designed to accommodate not more than six Size 1 or Size 2 full voltage combination motor starters per vertical section.
 - 2. Removable circuit breaker and motor starter units shall be provided with a mechanical interlock to prevent insertion or withdrawal when in the "on" position.
 - 3. Individual motor starter units, feeder breaker units, transformers, lighting panels, and control device compartments shall be isolated from each other by barriers of metal or a suitable insulating material.
 - 4. Each vertical section shall have a vertical-wiring trough for power and control wiring, and wiring troughs on top and bottom, which are continuous through the entire control center. Wire ties shall be provided in the vertical wireways unless the wireways are separated from the plug-in units by a permanent wall.
- F. Wiring Labels and Terminal Blocks

All internal wires shall be labeled at each termination. Terminals shall also be identified with labels showing the terminal block and terminal number.

- All starter units shall be provided with unit control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.
- G. Busing

1. 🔨

1. The horizontal main bus and the vertical bus extensions shall be tin-plated copper mounted on supports formed of materials having high dielectric strength, low moisture absorbency, and high impact strength. The main bus shall extend the full length of the motor control center and shall have provisions for splicing additional sections onto either end. Both horizontal and vertical busing shall be braced against forces resulting from fault current.

- 2. The vertical bus connecting an incoming power feeder cable shall have the same ampere rating as the main horizontal bus. Each vertical bus extension shall be rated for the total connected load of the vertical section.
- 3. A tin-plated copper ground bus rated 300 amperes shall extend through the entire control center and shall be located where it will not interfere with pulling of external cable. Grounding connections shall be accessible from the front. The ground bus shall be provided with six 0.38 inch holes for each vertical section to accept ground lugs for any loads requiring a ground conductor. A solderless connector shall be provided on the ground bus in each end section for an external ground cable, sized from 1/0 AWG to 250 kcmil.
- 4. Each vertical section shall have a vertical ground bus. The plug-in units shall engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected.
- 5. Neutral Bus
 - a. A tin-plated copper neutral bus shall be provided through all vertical sections and shall be rated full capacity.
- 6. Neutral Pad
 - a. The incoming line section shall be equipped with a neutral bond lug suitable to bond the service entrance neutral conductors. The service entrance neutral pad shall be equipped with a main bonding jumper to the control center ground bus in accordance with the National Electrical Code.
- H. Isolation of Buses
 - 1. The main bus shall be isolated from the horizontal wiring trough. The entire vertical bus assembly shall be enclosed within grounded steel or glass filled polyester barriers. The barriers shall have openings for power stabs of plug-in units. Shutters shall be provided to close the openings when units are removed.
- I. Combination Magnetic Starters



As indicated on the Drawings, control center starters shall be breaker combination, magnetic, reduced voltage, or across-the-line type as follows:

a. Starters shall be 3 phase, 60 Hz contactors with overloads, a 120 volts ac coil, a dry type control transformer, and a molded-case circuit breaker. Control transformers shall be mounted with the removable starters and shall have capacity for all simultaneous loads. Control transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

- b. Contactors shall be NEMA rated and have an 8 hour current rating in accordance with the latest NEMA standards. Contactors of reversing or multispeed starters shall be mechanically and electrically interlocked.
- c. One NO and one NC spare interlock contacts, whether on the starter or a relay, shall be wired separately to the unit terminal board.
- d. Heaterless overload protection shall be provided by three current sensors monitored by a microprocessor. The overload device shall also include phase loss and unbalance protection, trip class selection, Class II ground fault protection, and manual reset.
- e. An external manual breaker operating handle with provisions for up to three padlocks shall be provided on each starter. The access door shall be interlocked with the circuit breaker so that the door cannot be opened, except by an interlock override, while the breaker is closed.
- f. Contractor shall match control transformers, overloads, and minimum sizes of starters to equipment furnished, which may differ from the estimated values indicated on the Drawings. Overload relay elements shall be sized to reflect reduced motor current caused by load-side power factor correction capacitors.
- g. Unless otherwise specified, spare starters shall have breakers and overloads sized for the largest rated motor and 100 watts extra transformer capacity.
- J. Contactors
 - 1. Contactors for control of bus voltage loads other than motors shall be the same as contactors for combination magnetic starters, except overloads will not be required. Mechanically held contactors shall have 120 volts ac coils with disconnecting contacts. Other contactors shall have 120 volt, continuous duty coils and contacts where indicated on the Drawings.
- K. Relays and Timers
 - 1. Auxiliary relays and timers shall have 120 volt, 60 Hz coils for continuous duty in 40°C ambient, and 10 ampere, 120 volts ac contacts. Auxiliary relays shall be NEMA rated.
- L. Control Switches and Pilot Lights
 - 1. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.
- M. Circuit Breakers
 - Control center disconnects shall be three pole, single-throw, 600 volt, molded-case air circuit breakers. Circuit breakers of combination starters shall be magnetic motor circuit protector type. Feeder circuit breakers shall be thermal-magnetic type and shall be manually operated, with quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration. Thermal elements shall trip the breaker at 125 percent of trip rating. The instantaneous elements of 225 ampere frame and larger breakers shall be adjustable and shall be set at 800 percent of trip rating.
 - 2. Main circuit breakers and feeder circuit breakers 225 amperes and larger shall be furnished with a solid-state trip unit complete with built-in current transformers. The

ampere rating of the trip unit shall be as indicated on the Drawings. The trip unit shall have adjustable settings for continuous amperes, and short-time pickup. The trip unit shall be provided with additional short delay trip time adjustment for better system coordination. Where indicated on the Drawings, main circuit breakers shall be provided with instantaneous pickup and integral ground fault protection with shunt trip devices.

- N. Surge Protective Devices
 - 1. Scope
 - a. Surge Protective Devices (SPD) shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the facility's wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.
 - b. SPD's shall be furnished and installed for the electrical equipment indicated on the Drawings and designated in this section and as specified herein. SPD's shall be installed integral to each MCC and MCC panelboard.
 - 2. Standards
 - a. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:
 - 1) ANSI/IEEE C62.41 and C62.45;
 - 2) ANSI/IEEE C62.1 and C62.11;
 - 3) NEMA LS1;
 - 4) NFPA 20, 70, 75, and 78;
 - 5) UL 1449 and 1283
 - b. The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.
 - 3. Environmental Requirements.
 - a. Operating Temperature: $0^{\circ}F$ to $+140^{\circ}F$.
 - b. Relative Humidity: Reliable operation with 5 percent to 95 percent noncondensing.
 - 4. Electrical Requirements

a.

- Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.
- b. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.
- c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.
- d. Protection Modes. Four-wire configured systems shall provide Line-to-Neutral (L-N), Line-to-Ground (L-G), Line-to-Line (L-L), and Neutral-to-Ground (N-G) protection. Three-wire configured systems shall provide Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.
- e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

shall be no less than listed in the following table. Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

f. UL 1449 Voltage Protection Rating (VPR). The maximum VPR for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
480 V 3W		1200 V		2000 V

- g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.
- h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.
- i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200kA symmetrical fault current with 600 volts ac applied.

At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.

The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

- j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit.
- 5. Warranty

The manufacturer shall provide their Standard Limited Warranty (not less than 1 year) from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

- Installation
 - a. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

- 7. Accessories
 - a. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL1449 listed as such, and the UL1449 Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding the published maximum surge current magnitude without failure or damage to the switch.
 - b. Dual Form "C" Dry Contacts. The SPD shall be provided with a set of form "C" dry contacts (normally open and normally closed) to facilitate connection to a plant control system or other remote monitoring system. The contacts shall be normally open or normally closed and shall change state upon any alarm condition.
- O. Incoming Line Metering Compartment
 - 1. The incoming line section(s) shall be provided with a microprocessor-based, digital power meter. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Phase currents, phase voltages, watts, vars, power factor, frequency, watt-hours, watt demand, and total harmonic distortion waveforms shall be available for display. Metering units shall also include a display with touch screen monitor on the front of the equipment. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of Ethernet/IP communication for remote monitoring. The digital power meters shall be Allen-Bradley "Power Monitor 5000", Eaton "Power Xpert Meter 4000", GE "EPM9450", Schneider-Electrie "PowerLogic Model CM4000T", or Siemens "9410 Series".
 - 2. Sufficient lengths of communication cable shall be provided for connection of metering units within the motor control center and as indicated on the Drawings.
- P. Miscellaneous
 - 1. Other items indicated on the Drawings shall conform to the applicable provisions of NEMA ICS 2 and UL 845.
- Q. Special Panels

1.

- Instruments, controls, and accessories shall be mounted either on special doors or on sheet steel panels mounted behind hinged doors, as indicated on the Drawings. All panels and hinges shall be sufficiently strong to support the mounted items.
- R. Shop Painting
 - 1. All iron and steel surfaces, except stainless steel and machined surfaces, shall be plated or shop painted with the manufacturer's standard coating. Finish color for both indoor and outdoor equipment shall be ANSI 61. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

- 2. The underside of equipment to be installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting. The coating may be factory or field applied.
- S. Space Heaters
 - 1. Space heaters shall be furnished at the bottom of each vertical section of motor control centers provided with NEMA Type 3R enclosures. The heaters shall be thermally insulated and shall be located to prevent damage or discoloration to painted surfaces. Heaters shall be located where they do not interfere with cable entrances. The heaters shall be controlled by an adjustable thermostat set to cut out when the temperature rises to 90°F and to cut in when the temperature falls below 85°F and shall have capacity to maintain the section's interior temperature above dew point. Heaters shall be rated 120 volts ac.
 - 2. Space heater wiring, with branch circuit protection, shall be factory installed, with terminals provided for connection of an external power supply.
 - 3. Power to space heaters shall be supplied from a panelboard integral to each motor control center. All wiring and branch circuit protection shall be factory installed.

2.3 SHOP TESTS

A. The complete control center shall be tested at the factory. All circuits, including power and control, shall be given dielectric tests in accordance with NEMA ICS 2-322.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

. Installation Supervision

- 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.

- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- D. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

3.3 TRAINING

The manufacturer's representative shall provide training of Owner's personnel as described in A. the Demonstration and Training specification. All costs for training services shall be included

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

SECTION 26 29 24 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers pulse width modulated (PWM) type variable frequency drives (VFD) for the equipment and locations as specified. VFDs shall meet the design conditions and features specified herein.

Driven equipment Specification number.	43 11 15	43 25 13.23	
Unit designations.	02-VFD-1510	02-VFD-1520	02-VFD-1530
	02-VFD-1610	02-VFD-1620	02-VFD-1630

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Equipment provided under this section shall be fabricated as specified in this section and as shown on the schematics and one line diagrams on the Drawings.
- C. Unless otherwise indicated on the Drawings, one variable frequency drive, complete with all required control components, shall be furnished for each motor.
- D. VFDs shall be designed, manufactured, supplied, and warranted as a complete system by the VFD manufacturer. Fabrication and assembly of the drive system not directly controlled by the VFD manufacturer will not be acceptable.
- E. Coordination

1.

- The design of the variable frequency drive shall be coordinated with the driven equipment. Contractor shall be responsible for coordinating the collection of data and the design effort to limit harmonics to the levels specified.
- Contractor shall be responsible for coordinating variable frequency drive equipment amongst the driven equipment suppliers to ensure all drives are a product of the same manufacturer.
- F. General Equipment Stipulations
 - 1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

- G. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- H. Dimensional Restrictions
 - 1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer
- I. Workmanship and Materials
 - 1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
 - 2. All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
- J. Governing Standards
 - 1. The variable frequency drive shall be designed, constructed, and tested in accordance with the applicable standards of NEMA, ANSI, UL, and IEEE, and shall be designed for installation in accordance with the NFPA 70.
 - 2. The equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be conducted at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.
- K. Nameplates



- Nameplates with the description and designation of each control or indicating device shall be provided. Unless specified otherwise, each drive enclosure shall be provided with a nameplate bearing the unit designation as indicated above. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch high letters for the drive designation and 3/16 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.
- 2. Each control device and each control wire terminal block connection inside the enclosure shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.
1.3 DESCRIPTION

- A. The VFD shall produce an adjustable ac voltage/frequency output and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.
- B. Six-Pulse Drives
 - 1. Drives for motors rated below 100 horsepower, shall be of the pulse-width modulated type and shall consist of a full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.
 - 2. The drive inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by six identical base driver circuits. The drive shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.
- C. Eighteen-Pulse Drives and Active Front End Drives
 - 1. Drives for motors rated 100 horsepower and above, shall be eighteen-pulse or active front end type.
 - 2. Eighteen-Pulse Drives
 - a. Eighteen-pulse drives shall be of the pulse-width modulated type and shall consist of an 18-pulse, full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.
 - b. The phase shifting transformer required to produce the phase shifted input to the 18-pulse rectifier shall be factory wired and mounted within the drive enclosure as an integral part of the drive assembly. External transformers shall not be required.
 - 3. Active Front End Drives
 - Active front end drives shall be of the pulse-width modulated type and shall consist of an active front end with insulated gate bipolar transistors (IGBTs). Incoming power shall be filtered by an integral inductor-capacitor-inductor (LCL) filter. The filter shall filter out the high frequency content of the IGBT front end. The drive shall be able to boost the incoming voltage by 20% and ride through voltage dips of 35%. Power factor shall be adjustable as leading or lagging by up to 20%. The main control board for the IGBT input shall be identical to the main control board for the IGBT output. The drive shall be equipped with an integral input contactor that opens when the drive is not running and closes when a drive run signal is initiated.
 - b. The VFD inverter output shall be generated by IGBTs which shall be controlled by identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed,

torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1.4 SUBMITTALS

- A. Drawings and Data
 - 1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the drive shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:
 - 2. Name of manufacturer.
 - 3. Types and model numbers.
 - 4. Rated drive input kVA and output kVA.
 - 5. Percent efficiency at 100 percent speed and 60 percent speed.
 - 6. Maximum Btu [kJ] heat release data and verification of the drive cooling requirements.
 - 7. Total weight and lifting instructions, height, mounting, and floor space required.
 - 8. Panel interior and front and side exterior view details showing maximum overall dimensions of all transformer, bypass contactor, ac line filter, ac line reactor, and drive compartments.
 - 9. Schematics, including all interlocks.
 - 10. Wiring diagrams, including all internal and external devices and terminal blocks.
 - 11. Locations and sizes of electrical connections, ground terminations, and shielded wires.
 - 12. List of diagnostic indicators.
 - 13. List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.
 - 14. List of standard features and options.
 - 15. List of spare parts to be furnished.
 - 16. Input line protection model numbers and manufacturer's data sheets.
 - 17. Output filter model number and manufacturer's data sheets.
 - 18. UL 508C Certificate of Compliance for short circuit current rating.
 - 19. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

- 20. Certification of conformal coating on all printed circuit boards.
- 21. Harmonic calculations by the drive manufacturer at the points of analysis. Detailed drawings and information showing how protection is applied to comply with harmonic limits.
- 22. Submit a detailed harmonic testing plan. The test plan should include instruments to be used, verification of testing locations for voltage and current harmonic metering, verification of maximum allowable voltage and current distortion, and drive load and speed test parameters.

1.5 OPERATION AND MAINTENANCE DATA AND MANUALS

- A. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section.
- B. Operation and maintenance manuals shall include the following:
 - 1. Manufacturer's operation and maintenance manual for each size of variable frequency drive.
 - 2. Manufacturer's standard manuals for each size and type of bypass contactor, transformer, line reactor, and filter.
 - 3. Schematics, wiring diagrams, and panel drawings in conformance with construction record.
 - 4. Model numbers and up-to-date cost data for spare parts.
 - 5. Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.
 - 6. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
 - 7. Information on testing of power supplies and printed circuit boards and an explanation of the drive diagnostics.
- C. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.6 **SPARE PARTS**

A. Not used.

1.7 PROTECTIVE DEVICE STUDY

- A protective device study of the power distribution system will be conducted as specified in the A. Electrical section. The equipment manufacturer shall provide the following information to Engineer with the initial equipment drawing submittal:
 - 1. Protective relay coordination curves for each solid-state trip device.
 - 2. Time current curves for each circuit breaker.
- B. Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- All drives shall be pulse-width modulated type, as manufactured by Danfoss or ABB without A. exception. Danfoss drives shall be equipped with MCB-105 cards. Active front end drives shall be as manufactured by ABB without exception. The products of other manufacturers will not be acceptable.
- All variable frequency drives shall be a product of the same manufacturer. B.

PERFORMANCE AND DESIGN REQUIREMENTS. 2.2

- A. Performance
 - The variable frequency drive controller shall be of sufficient capacity and shall produce a 1. quality output waveform for stepless motor control from 10 to 100 percent of base speed. The variable frequency drive shall be suitable for loads and shall have voltage ratings as follows:

Unit designations		02-VFD-1510 02-VFD-1520 02-VFD-1530	02-VFD-1610 02-VFD-1620 02-VFD-1630
1	Load type	Variable torque (VT)	Variable torque (VT)
	Input voltage	480 volt, 3 phase	480 volt, 3 phase

2. The variable frequency drive shall be suitable for operation at an elevation below 3300 ft, and shall meet the following ratings and parameters: Input frequency

60Hz

Input voltage and frequency variation	±10 percent voltage variation, ±2 Hz; imbalance, 2 percent maximum.				
	Continued operation with additional momentary 25 percent voltage dip of 0.5 second duration from nominal input voltage level.				
Minimum drive efficiency	95 percent at 100 percent speed, 90 percent at 60 percent speed.				
Ambient temperature	0 to 40°C.				
Relative Humidity	0 to 95 percent non-condensing.				
Displacement Power Factor	95 percent or higher throughout the entire operating speed range, measured at drive input terminals.				
Drive service factor	1.0.				
Overcurrent capability	110 percent for 1 minute for variable torque;150 percent for 1 minute for constant torque.				
Volts/Hz ratio	Voltage varies as the square of frequency over the entire range of the unit for variable torque drives, linear over the entire range of the unit for constant torque drives; except under voltage boost condition.				
Acceleration/deceleration time	Adjustable over a range that meets the requirements of the drive equipment.				
Output speed regulation	0.5 percent.				
Output frequency stability	0.5 percent of nominal.				
Adjustments					
1. The following drive adjustments shall b	The following drive adjustments shall be provided:				
 a. Maximum speed. b. Minimum speed. c. Linear acceleration time. d. Linear deceleration time. e. Volts/Hz ratio; linear, squared, and automatic settings. f. Voltage boost. g. Process follower gain, offset, and bias. h. Torque limit. i. Critical frequency avoidance with adjustable bandwidth. 					
Fault Protection					

Design of the power circuit shall include provisions for protection against fault conditions 1. as follows.

Β.

C.

- 2. Input Protection
 - a. The drive assembly shall be UL 508C listed. A UL Certificate of Compliance shall be submitted to confirm product compliance with UL 508C and to indicate the short circuit current rating. The short circuit current rating shall meet or exceed the available short circuit current indicated on the Drawings.
 - b. Solid state instantaneous overcurrent trip set at 180 percent.
 - c. Adjustable overvoltage and undervoltage protection with automatic restart.
 - d. Phase loss and reverse phase trip with manual restart.
- 3. Internal Protection
 - a. AC line, phase-to-phase transient voltage surge suppression utilizing metal oxide varistors. Drive shall meet the requirements of IEEE C62.41.
 - b. Power device snubbers.
 - c. Power devices rated 2.5 times line voltage.
 - d. Instantaneous overcurrent.
 - e. Static overspeed (overfrequency) protection.
 - f. DC bus overvoltage trip.
 - g. Components and labeling that comply with UL 508 requirements. Drives shall be equipped with an automatic discharge circuit to deplete the charge on the DC capacitor bank to less than 50 volts within 60 seconds after main input power is removed. Labels indicating derivative voltage sources and required wait time for servicing after power removal shall be placed on all applicable enclosures.
 - h. Individual transistor overtemperature and overcurrent protection.
 - i. Control logic circuit malfunction indication.
- 4. Output Protection
 - a. Inverse-time motor overload protection adjustable from 10 percent to 100 percent.
 - b. Overvoltage protection.
 - c. Overfrequency protection.
 - d. Short circuit protection (three phase, phase to phase, and ground fault protection).
 - e. Protection against opening or shorting of motor leads.
 - f. Static overspeed protection.
 - g. Stall protection on overload with inverse time overcurrent trip, adjustable current limit from 10 percent to 120 percent.

D. Harmonic Distortion Abatement

The electrical system shall be provided with the necessary equipment to protect the drive and the power system ahead of the drive from harmonic distortion, as described below. The harmonic distortion abatement analysis shall be based on the information on the Drawings.

- 2. The drive shall operate satisfactorily when connected to a bus supplying other solid-state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt-microseconds.
- 3. Harmonic distortion abatement equipment shall be provided to bring the facility and its electrical system into compliance with IEEE 519 at the points of analysis defined below.

- 4. Current Distortion Limits
 - Maximum allowable total and individual harmonic current distortion limits for each odd harmonic shall not exceed limits set forth in IEEE 519. The Switchgear 3-6 bus connection shall be the primary point of analysis for current distortion.
- 5. Voltage Distortion Limits
 - a. Individual or simultaneous operation of the drives shall result in a maximum total harmonic voltage distortion of 5 percent on the bus feeding the drives. The point(s) of analysis for harmonic voltage distortion testing shall be the nearest electrical bus on the supply side of each drive. The three phase fault current at the bus feeding the drives is 65,000 amps.

2.3 CONSTRUCTION

A. Construction requirements shall be as follows and as specified below:

Unit	02-VFD-1510	02-VFD-1610
designations	02-VFD-1520	02-VFD-1620
	02-VFD-1530	02-VFD-1630
Cable entry	Тор	Тор
Cable exit	Тор	Тор
Enclosure type	NEMA Type 1	NEMA Type 1

- B. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.
- C. Fabrication and Assembly
 - 1. The variable frequency drive system shall be shop assembled in a single enclosure using interchangeable plug-in printed circuit boards and power conversion components wherever possible. Shop assembly shall be performed by the drive manufacturer, or a manufacturer approved assembly center under the direction and control of the drive manufacturer; systems fabricated, assembled, and supplied in whole or in part by parties other than the drive manufacturer will not be acceptable. Changes to the drive manufacturer's product by a distributor or system integrator are not allowed.



Input line reactors, fuses, circuit breakers, and filters, where required, shall be mounted within the drive enclosure, without exception. Isolation/voltage matching transformers, where required, may be enclosed separately from the remaining drive equipment.

3. The variable frequency drive system shall be designed to fit in the space indicated on the Drawings.

D. Wiring

- 1. Internal cabinet wiring shall be neatly installed in wireways or with wire ties where wireways are not practical. Where wireway is used, they are to be mounted to the panel surface with a continuous run of 3M brand, or equal, industrial two-sided adhesive strip. For 12 AWG wire sizes and smaller, and in bundles of six or less, wire tie-down square mounting straps shall be permitted. Tie-down mounts shall be installed at 8" increments or less. All mounting surfaces shall be pre-cleaned with isopropyl alcohol to ensure proper adhesion over the life of the equipment.
- 2. Terminal blocks shall be non-brittle, interlocking, track-mounted type, complete with a marking strip, covers, and pressure connectors. Screw terminals will not be acceptable. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. In freestanding panels, 8 inches of clearance shall be provided between terminals and the panel base for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Terminals shall be labeled to agree with the identification on the submittal drawings. Each control loop or system shall be individually fused, clearly labeled, and located for ease of maintenance.
- 3. All grounding wires shall be attached to the sheet metal enclosure with a ring tongue terminal. The surface of the sheet metal shall be prepared to ensure good conductivity and corrosion protection.
- 4. Wires shall not be kinked or spliced and shall be color coded or marked on both ends. The markings or color coding shall agree with the submittal drawings.
- 5. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for at least 600 volts, with a moisture-resistant and flame-retardant covering rated for at least 90°C.
- E. Enclosures
 - 1. The drive shall consist of factory mounted and wired components within an enclosure, arranged so no electrically live components, terminals, or conductors are accessible on the front panel or door when the enclosure door is open.
 - 2. The complete drive package, including accessories, shall fit into the space indicated on the Drawings.



- 4. Relays, terminals, and special devices inside the control enclosure shall have permanent markings to match the identification on the manufacturer's wiring diagrams.
- F. Printed Circuit Boards
 - 1. All printed circuit boards shall be sprayed on both sides with a conformal coating. The conformal coating shall be a part of the VFD manufacturing process and shall be selectively applied to the circuit board connections only. Heat sinks and resistors on the

circuit board shall not be coated. Conformal coating shall protect the printed circuit board components against chemically reactive environmental substances in accordance with IEC 60721-3-3 Table 4, Class 3C2.

- 2. All plug-in type boards shall be mechanically held at the circuit board connector. Compression fit only at the connector will not be acceptable.
- G. Shop Painting
 - 1. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop cleaned in accordance with the coating manufacturer's recommendations, and finished with the drive manufacturer's standard coating. Finish color shall be medium gray. Dry film thickness of the finish coat shall be at least 4 mils. Field painting, other than touch up, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings.
 - 2. All intermediate and finish coating materials shall be fumeproof and suitable for a wastewater treatment plant atmosphere that contains hydrogen sulfide. Documentation verifying that the coating material is fumeproof shall be submitted. Coatings shall be lead-free and mercury-free.

2.4 OPTIONAL EQUIPMENT

- A. AC Line Reactors
 - 1. Each six-pulse VFD, where isolation/voltage matching transformers are not used, shall be supplied with an input ac line reactor. AC line reactors shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the VFD input power devices. AC line reactors shall be factory mounted and wired within the VFD enclosure. AC line reactors shall be K-rated per IEEE C57-110 and shall be TCI Model KLR, or equal.

B. Harmonic Filters

1. Unless additional harmonic filters are required to comply with the total harmonic distortion limits specified herein, at a minimum the following VFDs shall be furnished with harmonic filters.

AGS Blower No. 1	02-VFD-1510
AGS Blower No. 2	02-VFD-1520
AGS Blower No. 3	02-VFD-1530
WAGS/WLC Pump No. 1	02-VFD-1610
WAGS/WLC Pump No. 2	02-VFD-1620
WAGS/WLC Pump No. 3	02-VFD-1630

- 2. The VFD manufacturer shall design and provide the required filters. The harmonic filters shall utilize an interlocking contactor that shall be automatically operated by the VFD run circuit. The VFD manufacturer shall be responsible for the complete filter unit, including the filter contactor. Harmonic filters shall be TCI Harmonic Guard HG7 Series, or equal.
- C. Isolation/Voltage Matching Transformers
 - 1. Transformers furnished with VFDs to provide the required operating voltage shall be constructed in accordance with applicable NEMA and ANSI standards. Transformer voltages shall be as indicated on the Drawings unless otherwise required by the variable frequency drive. Transformers shall have Class B, F, or H insulation systems. Terminal compartments shall be front-accessible and shall have adequate space for minimum bending radii of the cables to be terminated. The transformers shall be UL listed and shall be provided with a K rating of 15 in accordance with IEEE C57.110.
 - 2. Transformers rated 15 kVA and lower shall be indoor/outdoor, totally enclosed type, with sound levels generated by each transformer not to exceed 45 dB.
 - 3. Transformers rated higher than 15 kVA shall be indoor/outdoor, self-air-cooled type with dripproof enclosures and ventilating openings, in accordance with NEMA and NEC requirements. The ventilating openings shall be located to provide adequate cooling even with other equipment located on both sides. Sound levels generated by each transformer shall not exceed 60 dB.
- D. Output dV/dt Filters
 - 1. Output filters shall be installed inside the drive enclosure on the inverter output. Output filters shall consist of a minimum 1.5 percent impedance reactor, in conjunction with a resistor and capacitor network, to form a damped low-pass filter. Use of output reactors alone is not acceptable. Output filters shall be TCI Model V1000 KLC, or equal.

2.5 CONTROLS

- A. Features
 - 1. Each drive shall include the following features in addition to those indicated on the Drawings:
 - A door mounted membrane keypad with integral two-line, 24 character minimum LCD display that is capable of controlling the VFD and setting drive parameters. The keypad module shall be programmed with factory set drive parameters in nonvolatile EEPROM or FLASH memory and shall be resettable in the field through the keypad.
 - b. Control switches and pilot lights shall be provided as indicated on the schematic diagrams. Manual-automatic and start-stop controls included as features of the drive keypad shall be password protected or disabled to prevent override of control switches and safety interlocks shown on the schematic diagrams.
 - c. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.

a.

- d. Microprocessor-based regulator. Nonvolatile memory modules shall have a useful life of at least 20 years without requiring battery or module replacement.
- e. Input thermal-magnetic molded-case circuit breaker disconnect with interrupting capacity rated in RMS symmetrical amperes as required and labeled in accordance with UL standard 489. The disconnect shall be mounted inside the controller enclosure and shall have door interlocks and a handle with provisions for padlocking in the "Off" position.
- f. Manual speed adjustment.
- g. Indications of power "On", drive "Run", and drive "Fault". Indication of these parameters shall be provided by full voltage type LED pilot lights. Lamps shall be easily replaceable from the front of the indicating light.
- h. Elapsed time meter.
- i. Speed indication calibrated in percent rpm.
- j. Control circuits of not more than 115 volts supplied by internal control power transformers. Control power transformers shall have additional capacity as required by external devices indicated on the Drawings. Control power transformers shall be equipped with two primary leads fused, one secondary lead fused, and one secondary lead grounded.
- k. Automatic controller shutdown on overcurrent, overvoltage, undervoltage, motor overtemperature and other drive fault conditions. Controller shutdown shall be manually reset type. Terminals shall be provided for control wiring from motor temperature switches, or a motor protection relay located in the drive enclosure.
- 1. Diagnostic indicators that pinpoint failure and fault conditions. Indicators shall be manually reset to restore operation after abnormal shutdown.
- m. Accept a remote 4-20 mA speed control signal.
- n. Process control output for remote 4-20 mA speed indication, rated 0 to 100 percent speed.
- o. Spare interlock contacts rated 5 amperes at 120 volts ac, wired separately to the unit terminal board. One NO and one NC isolated spare interlock shall be furnished with each drive. Additional interlock contacts shall be provided as indicated on the Drawings.
- p. Drive fault and run status contacts for remote indication, rated 5 amperes at 120 volts ac.
- q. Speed droop feature, which reduces the speed of the drive on transient overloads. The drive shall return to set speed after the transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive shall automatically compensate to prevent drive trip.
- Individual adjustable speed profile settings for start, stop, entry, slope, and minimum and maximum speed points.
 - Coast, controlled ramp, or dc injection selectable modes of stopping.
- t. PID setpoint control selection.
- u. Adjustable PWM carrier frequency. The inverter output section shall be provided with adjustable PWM carrier frequency from 500 Hz to at least 8 kHz.
- v. Noise level of installed equipment shall not exceed 85 dB, as measured by an appropriate calibrated instrument. The required sound level limit shall be met at a minimum of four locations, each not more than 3 feet above the floor and not more than 10 feet from the equipment. This requirement shall apply to all drives, motors, filters, reactors, and transformers supplied with the drive.
- w. Modbus TCP/IP control and communications for connection to PLC.

- B. Diagnostics
 - 1. Diagnostic indicators on the face of the drive shall display the type of fault responsible for drive shutdown, warning, or failure. If two or more faults occur simultaneously, the diagnostic segment shall record or indicate each condition. The drive shall be capable of storing 6 events.
- C. Motor Protection Relay
 - 1. The VFD shall be capable of providing protection to the motor against overloads (51/49), acceleration time, negative sequence current (46), adjustable current unbalance (46), phase loss (46), multiple starts (48), short circuit (50), ground fault (50G/51G), hot motor compensation, undercurrent minimum load (37), phase reversal (46), adjustable lockout on thermal trip, and mechanical jam.
 - 2. If the VFD is not capable of providing the listed motor protection, a separate three phase modular electronic relay shall be provided for this purpose.

2.6 TESTING

- A. All power switching components shall be pre-run under anticipated operating temperature and load conditions. Any alternative testing procedures shall be submitted and pre-approved before proceeding.
- B. Factory Testing
 - 1. After the drive system has been assembled at the manufacturer's facility, it shall be tested for at least 4 hours before it is shipped.
 - 2. The complete drive system, including all peripherals, shall be factory tested under simulated operating conditions, including normal operating sequences and fault conditions. Contact closure inputs and simulated driven-outputs shall be connected to the system input/output modules.
 - 3. A test report summary indicating satisfactory final test results shall be submitted to Engineer before shipment of the equipment.
- C. Secondary Factory Testing

The drive units shall be assembled with the driven equipment for shop testing. The drive manufacturer shall provide the services of a qualified representative to work with the equipment manufacturer at the equipment manufacturer's facility. The representative shall advise and assist in assembling and testing the equipment and drive unit packages.

2. Personnel conducting the tests shall be competent, authorized representatives of the equipment and drive manufacturers who are familiar with operation of the equipment furnished and who have satisfactory experience in conducting similar tests. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results. Five copies of the report shall be submitted in accordance with the Submittal Procedures section. The information collected shall be used as a basis

for determining acceptability of the manufacturer's test results. In case of conflict, interpretations and calculations made by Engineer will govern.

3. Testing shall be conducted in a manner acceptable to Engineer. At least 2 weeks before the proposed testing date, Contractor shall notify Engineer of the testing date and shall submit a report from the equipment manufacturer detailing the proposed performance testing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

- A. Installation Check
 - 1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Commissioning Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.
 - 2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.
 - 3. All costs for these services shall be included in the Contract Price.
- B. Installation Supervision
 - 1. Installation supervision by the manufacturer is not required.



- 3. Manufacturers' installation supervisor shall observe, instruct, guide, and direct the installing Contractor's erection or installation procedures. The equipment manufacturer will be provided with written notification 10 days prior to the need for such services.
- 4. All costs for these services shall be included in the Contract Price.

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3.3 TRAINING

- The manufacturer's representative shall provide training of Owner's personnel as described in A. the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.
- B. Up to 4 employees of Owner, shall be trained in the proper operation, troubleshooting, and shall consist of combined classroom and hands-on instruction. Training shall be conducted at a

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers furnishing the design of lightning protection systems and the furnishing and installation of lightning protection equipment for the following structures:
 - 1. Activated Granular Sludge Support Facilities.
 - 2. Activated Granular Sludge Reactors.
- B. Lightning protection systems shall be furnished, installed, and tested as specified. Lightning protection equipment shall meet the requirements specified herein.
- C. Lightning protection systems shall consist of, but not be limited to, air terminals; main, bonding, and down conductors; ground terminals; and all required connectors and fittings required to complete the system.
- D. The lightning protection system shall include the bonding of all roof-mounted mechanical equipment, roof drains, roof mounted ladders, chimneys, antennas, and other roof mounted metal objects.

1.2 GENERAL

- A. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor and obtain all inspections to complete the work as specified, and in compliance with all codes, standards, and regulations.
- B. Contractor shall provide coordination with other contractors and supervision of installation as needed during construction.
- C. The design of the system shall include determination of the overall lightning hazard for the geographic location of the project and for the structures, the selection of Class I and/or Class II materials, the need of corrosion protection for the copper and/or aluminum components used, and consideration of other pertinent factors. The design shall produce a zone of protection from lightning to prevent personal injury, structural damage, and equipment downtime.
- D. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of UL unless exceptions are noted by Engineer.
- E. The system shall be installed by an installer who has UL listing and subscribes to the UL Follow-Up Service.

- F. General Equipment Stipulations
 - 1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.
- G. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- H. Governing Standards
 - All system components furnished under this section shall be designed in accordance with ANSI/UL 96 - Lightning Protection Components. All lightning protection systems furnished under this section shall be designed, constructed, and tested in accordance with UL 96A – Installation Requirements for Lightning Protection Systems and ANSI/NFPA 780 – Standard for the Installation of Lightning Protection Systems.
 - 2. Lightning protection systems shall be bonded to grounding electrode systems in accordance with the National Electrical Code.
- I. Workmanship and Materials
 - 1. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
 - 2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, unless required by tests.
- 1.3 SUBMITTALS
 - A. Drawings and Data



Complete certification of design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming the system, shall be submitted in accordance with the Submittal Procedures section.

- B. Meteorological and Seismic Design Criteria Compliance
 - 1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 QUALITY ASSURANCE

A. The lightning protection system shall be inspected and tested after installation by conducting continuity and ground resistance tests as well as a visual inspection. Inspection results and test data shall be submitted in accordance with the Submittal Procedures section. Upon completion of the installation, Contractor shall apply for and deliver the UL Master Label Certificate of Inspection for each structure/building.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The system components shall be manufactured by a company that has been specializing in the design and manufacture of UL listed lightning protection equipment for at least 5 years.

2.2 MATERIALS

A. All manufactured and fabricated components shall conform to NFPA 780 Class I or Class II as needed for the structures on which they will be installed. The system components shall be fabricated from the following metals:

Copper.

Conductors

Air Terminals

Grounding Electrodes

Fasteners

Bimetallic Fasteners

Copper or bronze. Copper clad steel.

Copper or bronze.

Bronze and aluminum.

- B. Aluminum conductors and air terminals shall be mounted on aluminum surfaces only.
- C. All materials furnished for the lightning protection system shall bear the inspection label of UL.

PART 3 - EXECUTION

3.1 INSTALLATION

The lightning protection system shall be installed in a neat and inconspicuous manner so all components will blend in with the appearance of the building. All conductors shall be concealed or semi-concealed during construction using methods recommended in NFPA 780 and UL 96A.

B. Air terminals shall have base supports designed for the surface on which they are used and shall be securely anchored. All exposed metal eave troughs, roof vents, guy wires, antennas, and air handling equipment shall be bonded to the lightning protection system in such a way that two paths to ground are provided.

Lightning Protection for Structures

C. The lightning protection system shall be bonded to structure/building electrical ground rings wherever they are available.

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Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I



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SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

- 1.1 SCOPE
 - A. This section covers the clearing, demolition of existing structures and piping and preparation of the project site.
- 1.2 GENERAL
 - Contractor shall be responsible for all work under this section. Contractor shall provide three (3) working days written notice prior to beginning sitework preparation, demolition, or clearing activities.
 - B. Site clearing work shall create minimum interference with Owner's operations and minimum inconvenience to Owner. Contractor shall provide protection and safety of all roadways, sidewalks, and all accessible areas during demolition activities.
 - C. Blasting will not be permitted.
 - D. Removal of equipment, materials, piping, manholes, etc. shall be included in the Selective Demolition Section and removal of structures shall be in the Structure Demolition Section.

PART 2 – PRODUCTS (Not used.)

PART 3 - EXECUTION

3.2 CLEARING

- A. Existing items removed, and not indicated to be reused as a part of the Work, shall become Contractor's property unless otherwise specified, and shall be removed from the Site.
- B. Contractor shall conduct clearing activities in a manner that prevents damage to existing shrubs, plants and structures which are indicated to remain and shall provide all necessary protection for existing facilities. Any remaining facilities damaged during clearing and site demolition shall be repaired by Contractor to a condition equal to or better than the original condition.
 - When clearing is complete, all debris shall be removed from the Site and the Site graded to the lines and grades indicated on the Drawings. Removal work shall not alter existing overland drainage patterns.
- D. Sitework Clearing and Preparation.
 - 1. Sitework clearing and preparation shall include the following:

- a. Removal of shrubs indicated on the Drawings to be removed and as required to complete the work.
- b. Removal of all riprap as required to complete the work.
- c. Removal of existing yard piping within the limits indicated on the Drawings. All yard piping indicated to be abandoned shall be plugged with concrete.
- 3.2 SALVAGE.
 - A. Items To Be Salvaged by Owner. Not used.
 - B. Items To Be Salvaged by Contractor
 - 1. Removed and salvaged equipment or facilities shall include removal and salvage of all accessories, piping, wiring, supports, associated electrical starters and devices, baseplates and frames, and all other appurtenances, unless otherwise directed.
 - 2. Contractor shall provide Owner first refusal of existing materials and equipment removed, and not reused as a part of the work. Following Owner review, items shall become Contractor's property, unless claimed by the Owner or otherwise specified, and shall be removed from the jobsite. The Contractor shall coordinate its operations with Owner to facilitate the work and to avoid damage to items indicated to be salvaged by Contractor for the Owner.
 - 3. Existing materials and equipment removed, and not reused as a part of the work, shall become Contractor's property unless otherwise specified, and shall be removed from the jobsite.
 - 4. Contractor may, at their option, furnish and install new items instead of those specified or indicated to be salvaged and reused, in which case such removed items will become Contractor's property.

End of Section

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

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SECTION 31 23 11 - EXCAVATION AND FILL FOR STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers earthwork and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation; handling, storage, transportation, and disposal of all excavated material; all necessary temporary earth retention and other protection work; preparation of subgrades; pumping and dewatering as necessary; protection of adjacent property; backfilling; construction of fills and embankments; grading; and other appurtenant work.

1.2 GENERAL

A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed professional engineer in the state where the earthwork is located, to act upon all pertinent matters of the work of this section.

1.3 SUBMITTALS

A. Drawings and Data – General

- 1. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittal Procedures section.
- B. Temporary Excavation Design Certificate
 - 1. Before starting construction on the temporary excavation and in accordance with OSHA requirements enumerated above, the Contractor shall ensure that the temporary excavation design engineer shall complete and submit to Engineer the <u>Temporary Excavation Design</u> <u>Certificate</u>, Figure 1-31 23 11 and the Contractor shall use the temporary excavation design. If required by the OSHA requirements enumerated above or to protect existing facilities, the Contractor is responsible for ensuring that a separate certificate shall be submitted for each unique design. Refer to paragraph in this specification titled, "Temporary Excavations."

C. Filter Fabric Data

- 1. Complete descriptive and engineering data for the fabric shall be submitted in accordance with the Submittals Procedures section. Data submitted shall include:
 - a. A 12 inch square sample of fabric.
 - b. Manufacturer's descriptive product data.
 - c. Installation instructions.

- D. Test Results for Review of Materials
 - 1. Complete test results for tests performed on fill and backfill, and other material specified herein, by an independent commercial laboratory retained by the Contractor, as described in the paragraph titled, "Review of Materials".
- E. CLSM Mix Design
 - 1. Mix design by an independent commercial laboratory retained by the Contractor.
- 1.4 INSURANCE
 - A. Professional Liability insurance shall be provided as specified in the Supplementary Conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Filter Fabric
 - 1. Filter fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris. All filter fabric shall be in accordance with Article 1080.03 of the IDOT Standard Specifications.
 - 2. Filter Fabric Type A

3)

- a. Filter fabric Type A shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter fabric Type A shall be a non-woven fabric consisting of only continuous chains of polypropylene filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties (Minimum average roll value in weakest principal direction):
 - 1) Property Grab Strength
 - a) Test Method : ASTM D4632
 - b) Unit : lbs Min Roll Value : 160
 - 2) Property Grab Elongation
 - a) Test Method : ASTM D4632
 - b) Unit : percentMin Roll Value : 50
 - Property CBR Puncture Strength
 - a) Test Method : ASTM D6241
 - b) Unit : lbs Min Roll Value : 410
 - 4) Property Trapezoidal Tear
 - a) Test Method : ASTM D4533
 - b) Unit : lbs Min Roll Value : 60
 - 5) Property UV Resistance at 500 hours
 - a) Test Method : ASTM D4355
 - b) Unit : % Strength RetainedMin Roll Value : 70

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- b. The apparent opening size (diameter) for the filter fabric Type A shall be no larger than the U.S. Standard Sieve Size 70 per ASTM D4751.
- 3. Filter Fabric Type B. Not used.
- 4. Filter Fabric Type C. Not used.
- B. Polyethylene Film
 - 1. Polyethylene film beneath concrete slabs or slab base course material shall comply with requirements of ASTM D4397, 6 mil minimum thickness.
- C. Fill and Embankment Materials
 - 1. To the maximum extent available, excess suitable material obtained from structure and trench excavation shall be used for the construction of site fills and embankments. Additional material shall be provided from Contractor's offsite source.
 - 2. All material placed in fills and embankments shall be free from rocks or stones larger than 3 inches in their greatest dimension, brush, stumps, logs, roots, debris, and other organic or deleterious materials. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so that they do not interfere with proper compaction.
- D. Granular Fill
 - 1. Granular fill material shall be crushed rock or gravel suitable for use as a free draining subbase beneath slabs and foundations. Granular fill shall be free from dust, clay, and trash; hard, durable, non-friable; and shall have gradation CA-7 in accordance with Article 1004 of the IDOT Standard Specifications. The edges of granular fill shall be confined, either by placing against an excavation face or other fill.
- E. Structure Backfill
 - 1. Structure backfill shall be defined as the material placed around and outside of structures. For structures constructed in open excavations, structure backfill shall extend to the temporary excavation slope so that the entire excavation outside the structure shall be filled with structure backfill. For structures constructed in supported excavations, the structure backfill shall completely fill the space between structure and temporary earth retention, or between structure and excavation face, if these specifications permit removal of the system. Structure backfill shall meet the requirements of the previous paragraph entitled "Fill and Embankment Materials" except that materials shall be limited to materials classified as GW, GP, SW, SP and SM per ASTM D2487, unless the Drawings indicate crushed rock or clean sand structure backfill is to be used. Crushed rock structure backfill shall be gradation CA-6 in accordance with Article 1004.03 of the IDOT standard specifications. Clean sand structure backfill shall be gradation FA-6 in accordance with Article 1003 of the IDOT standard specifications.
 - 2. Crushed Rock Structure Backfill

- a. Crushed rock structure backfill shall be gradation CA-6 in accordance with Article 1004.03 of the IDOT standard specifications.
- 3. Clean sand for structure backfill
 - a. Clean sand structure backfill shall be gradation FA-6 in accordance with Article 1003 of the IDOT standard specifications.
- F. Select Fill
 - 1. Select fill shall be defined as the material placed beneath the structure foundations and slabs below any granular material layer or lean concrete slab indicated on the Drawings. Select fill shall be used to replace any unsuitable material below the structure foundations and slabs and to raise the site grades below and within 5 feet horizontally(unless a different dimension is otherwise indicated on the Drawings or specified) of structural footprints and at locations indicated on the Drawings. Select fill shall meet the requirements of the previous paragraph entitled "Fill and Embankment Materials" except that materials shall be limited to materials classified as GW, GP, SW, SP and SM per ASTM D2487, unless the Drawings indicate crushed rock or clean sand select fill is to be used. Engineer-directed select fill to replace unsuitable soil removal is covered by the Adjustment Unit Price in the Bid Form.
 - 2. Crushed Rock Select Fill. Not used.
 - 3. Clean Sand Select Fill. Not used
- G. Gravel Base Beneath Slabs
 - 1. "Gravel Base Beneath Slabs" is defined as material to be placed directly beneath building floor slabs as shown on the Drawings. Gravel shall be gradation CA-7 in accordance with Article 1004.03 of the IDOT standard specifications.
- H. Controlled Low Strength Material (CLSM). Not used
- I. Geocomposite Sheet Drains
 - 1. The geocomposite sheet drains shall consist of a continuous plastic three dimensional drainage core wrapped on one side in a non-woven filter fabric permeable to water flow. The filter fabric shall be bonded to the individual dimples of the molded plastic core to minimize fabric intrusion into the flow channels caused by the backfill pressure. The fabric shall extend beyond the edges of the core to provide overlap for the adjacent panels. The geocomposite sheet drain shall be CCW-MIRADRAIN 6000XL as manufactured by CARLISLE, or SITEDRAIN Sheet 186 as manufactured by American Wick Drain Corporation, or equal.

2.2 MATERIAL TESTING

A. Review of Materials

Excavation and Fill for Structures

- 1. As stipulated in the Quality Control section, all tests required for preliminary review of materials and materials delivered to the Site shall be made by an acceptable independent testing laboratory at the expense of Contractor. Tests performed by the aggregate supplier are not acceptable. Tests shall have been performed within 2 months of submittal and shall be representative of the material that will be delivered to the Site. Acquisition of samples for testing, both for preliminary review of materials and for testing of materials at the Site, shall be by the Contractor's independent testing laboratory. Samples acquired at the Site shall be obtained after placement and compaction of the material. Aggregate material shall be sampled in accordance with ASTM D75.
- 2. Two initial gradation tests shall be made for each type of general fill, select fill, structure backfill, granular fill, or other specified material, and one additional gradation test shall be made for each additional 500 tons of each material delivered (imported) to the jobsite or suitable onsite material incorporated in select fill or structure backfill. One additional gradation test shall be performed for each additional 2,000 tons of general fill material delivered to the jobsite or suitable onsite material incorporated in general fill. In addition, one set of initial Atterberg Limits test shall be made for each fill material containing more than 20 percent by weight pass the No. 200 sieve and for materials specified by Atterberg Limits. One additional Atterberg Limits test shall be made for each additional 500 tons of each material delivered to the job site or otherwise incorporated in select fill or structure backfill. One additional Atterberg Limits test shall be made for each additional 2,000 tons of each material delivered to the job site or otherwise incorporated in select fill or structure backfill. One additional Atterberg Limits test shall be made for each additional 2,000 tons of each material delivered to the job site or otherwise incorporated in select fill or structure backfill. One additional Atterberg Limits test shall be made for each additional 2,000 tons of general fill material delivered to the job site or suitable onsite material incorporated in select fill or structure backfill.
- B. Field Testing Expense
 - 1. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory at the expense of the Contractor. Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.
- C. Required Field Tests
 - 1. For planning purposes, the Contractor's testing laboratory will use the following general guidelines for frequency of field tests. Additional tests will be performed as necessary for job conditions and number of failed tests.



- For area fills and embankments, an in-place field density and moisture test for each 1000 cubic yards of material placed.
- One in-place field density and moisture test for every 100 to 200 cubic yards of structure backfill or select fill.
- c. One in-place density and moisture test whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
- d. At least one test for every full shift of compaction operations on mass earthwork.
- e. Testing of CLSM will be as follows.
 - <u>Compressive Strength</u>. For every 200 cubic yard of CLSM placed, prepare, cure, remove from molds, and test four 6 by 12 inch test cylinders in accordance with ASTM D4832. Cure cylinders in the molds in accordance with ASTM D4832 until time of testing, at least 14 days. Two cylinders will be tested at 7 days and the other two cylinders will be tested at 28 days.

- 2) <u>Flow</u>. Once each day, the CLSM material will be tested for flow in accordance with ASTM D6103.
- Unit Weight, Yield, and Air Content. Once each day that flowable fill is placed, unit weight, yield and air content will be determined in accordance with ASTM D6023.
- 4) <u>Penetration</u>. Once a day that CLSM is placed, the resistance to penetration from ball-drop apparatus (Kelly Ball) will be measured in accordance with ASTM D6103. (Compliance will be based on maximum depression diameter of 3 inches.)

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. All sites to be occupied by permanent construction or embankments shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for fills and embankments and sites to be occupied by permanent construction shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. All waste materials shall be removed from the site and disposed of by and at the expense of Contractor.

3.2 EXCAVATION

- A. General
 - 1. Permanent excavations shall conform to the lines and grades indicated on the Drawings. Temporary excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.
 - 2. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.
- B. Temporary Excavations



- Except where excavation side slopes are cut to a stable slope, excavations for structures and trenches shall be supported as necessary to prevent caving or sliding. Temporary earth retention systems shall be furnished and installed as necessary to limit the extent of excavations for the deeper structures and necessary backfill under adjacent shallower structures, and to protect adjacent structures and facilities from damage due to excavation and subsequent construction.
- 2. Design of excavations by a professional engineer retained by Contractor is required when necessary to protect adjacent existing facilities, or when design by an engineer is required by the OSHA regulations cited herein. The Contractor's professional engineer shall be licensed in the state of the Project and is responsible for design of entire excavation (both the sloping and supported portions of the excavation). The design of temporary earth

retention shall comply with the paragraph of this specification titled, "Temporary Earth Retention."

- 3. Before starting construction on a temporary excavation requiring design by a professional engineer in compliance with requirements of this specification (to protect existing structures, utilities, and other facilities), the Contractor shall ensure that the temporary excavation design engineer shall complete the Temporary Excavation Design Certificate (Figure $1 31 \ 23 \ 11$) and the Contractor shall submit the certificate along with proof of professional liability insurance for the temporary excavation designer. The Contractor shall use the temporary excavation design. The Contractor shall submit a separate certificate for each unique design.
- C. Classification of Excavated Materials
 - 1. No classification of excavated materials will be made for payment purposes. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.
- D. Preservation of Trees
 - 1. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from damage by construction operations.
- E. Unauthorized Excavation
 - 1. Except where otherwise authorized, indicated, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced with concrete or lean concrete at the expense of Contractor. If structural concrete replacement is chosen, it shall be with concrete placed at the same time and monolithic with the concrete foundation.
- F. Blasting
 - 1. Blasting or other use of explosives for excavation will not be permitted.
- G. Dewatering

Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater and all water, regardless of the source, entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure has been built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result. Contractor to coordinate and provide dewatering as required to facilitate the installation and field testing of AGS Reactor internals and underdrain system.

2. Contractor is responsible for choosing method of groundwater control.

- 3. If contractor chooses to use deep wells or well points, wells and and well points shall be designed, installed, and operated to prevent removal of in-situ materials.
- 4. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of 24 inches beneath such excavations. The specified dewatering depth shall be maintained below the prevailing bottom of excavation at all times.
- 5. Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.
- 6. Contractor shall not utilize or connect to existing FRSA stormwater system, piping, and outfalls. Contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes, and all such pipe or conduit shall be maintained to be clean and free of sediment.
- 7. Contractor shall provide all power for dewatering if Contractor requires more than Owner's supply available as specified in Section 01 50 00 Temporary Facilities.
- 8. Contractor is responsible for any required permits for the dewatering system and its operation. Contractor shall obtain from the appropriate agencies and authorities, the dewatering and stormwater discharge permits required to remove and dispose of groundwater, surface water, and any other water used in Contractor's operations. The permits shall be obtained prior to start of construction.
- H. Temporary Earth Retention
 - 1. Temporary excavations shall be supported with temporary earth retention systems when excavation side slopes cannot be excavated to a stable slope.
 - 2. If the soldier pile and lagging method is used for temporary earth retention, the soldier piles shall be installed by drilling. The lagging shall be seasoned hardwood, with maximum board width (vertical height) of 12 inches. The lagging boards shall be installed from the top down as the excavation advances.
 - 3. The use of the following devices or systems are prohibited for use as temporary earth retention systems when the retention system is required to limit ground movement to protect structures, utilities, and other adjacent facilities.
- a. c.
- soldier piles with plate lagging slide rail systems
- trench shields i.e. trench boxes (trench shields are considered worker protection only, not temporary earth retention systems)
- 4. The above prohibition does not prevent Contractor from using soldier piles with plate lagging, slide rail systems, and trench shields to protect workers in an excavation.
- 5. Excavation support systems and sheeting and shoring shall be removed unless specifically otherwise permitted by Engineer.Unless the excavation support is required to be left in place the design of the excavation support system shall be such as to permit complete removal while maintaining safety and stability in the excavation at all times. Excavation

support systems to be left in place shall be designed and constructed of only steel. No additional payment above the Contract Price will be made for excavation support components left in place. Excavation support elements left in place, shall be cut off 24 inches minimum below the finish grade indicated on the Drawings.

- I. Foundation Subgrade Preparation
 - 1. Subgrades for foundations shall be prepared using the same procedure as required for fills and embankments. After preparation, foundation subgrades shall be firm, dense, and thoroughly compacted and consolidated; and shall be sufficiently stable to remain firm and intact under the feet of the workers. Reinforcing steel and concrete shall be placed as soon as possible after subgrade preparation. Subgrades that are disturbed due to weather or other conditions shall be repaired by removing the disturbed material and replacing with crushed rock select fill. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.
- J. Ring-wall Excavation. Not used
- K. Roadway Excavation
 - 1. Excavation for the roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the Drawings and shall include the excavation of all unsuitable material from the subgrade. After shaping to line, grade, and cross section, the subgrade shall be compacted to a depth of at least 6 inches and shall meet the following:
 - a. Test method to determine maximum density and moisture : ASTM D698.
 - b. Relative compaction and moisture content relative to the optimum : 95%.
 - c. Moisture content relative to the optimum : -2% to +2%.
 - 2. This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material. Engineer-directed unsuitable soil removal is covered by the Adjustment Unit Price in the Bid Form.

3.3 FILLS AND EMBANKMENTS

- A. Fills and embankments shall be constructed to the lines and grades indicated on the Drawings. Fills and backfills placed beneath and around structures shall comply with the requirements of this specification for select fill and structure backfill, respectively. Construction of fills and embankments shall begin from the lowest elevation in each excavation or area and progress upward. Materials shall be deposited in approximately horizontal layers not to exceed 8 inches in uncompacted thickness. Unless otherwise specified herein, the following governing standards apply:
 - 1. Test method to determine maximum density and moisture : ASTM D698.
 - 2. Relative compaction : 95%.
 - 3. Moisture content relative to the optimum : -2% to +2%.

- B. Where new fill is placed adjacent to an existing sloping surface steeper than 5 horizontal to 1 vertical, the existing slope shall be benched in advance of placement of new fill. The bench shall be of sufficient width to allow compaction of the junction between the new fill and existing earth surface.
- C. Backfilling of excavations and construction of fills and embankments during freezing weather shall not be done. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.
- D. Subgrade Preparation
 - 1. After preparation of the fill or embankment site, the subgrade shall be scarified and moisture conditioned to a minimum depth of 6 inches, leveled and compacted to the same relative compaction and moisture content relative to optimum as specified for fill.
 - 2. Unless otherwise directed by Engineer, the subgrade shall be proof-rolled by a rubber-tired roller, a loaded dump truck, or other suitable rubber-tired equipment acceptable to Engineer. A minimum of four passes of the proof-rolling equipment shall be provided such that the last two passes are made perpendicular to the first two passes.
 - 3. All soft, yielding, or otherwise unsuitable material shall be removed and replaced with compacted fill. Engineer-directed unsuitable soil removal is covered by the Adjustment Unit Price in the Bid Form. Compacted fill shall be gradation CA-1, RR-3, CS-01, or CS-02 in accordance with the IDOT standard specifications.
- E. Placement and Compaction
 - 1. All fill and embankment materials shall be placed in approximately horizontal layers not to exceed 8 inches in un-compacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.
 - 2. Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried to achieve the moisture content relative to optimum as specified above, and shall be thoroughly mixed to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to the required degree of compaction at the required moisture content. If the material fails to meet the density specified, compaction methods shall be altered. The changes in compaction methods shall include, but not be limited to, changes in compaction equipment, reduction in uncompacted lift thickness, increase in number of passes, and better moisture control.

Wherever a pipe is to installed within a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench for pipe installation is excavated.

4. Fills and embankments over reservoir or basin roof slabs shall be placed and compacted by using methods that will not damage or overload the structure; compaction in addition to that attained by placement operations will not be required. Rubber-tired equipment shall be used insofar as possible. Individual items of equipment operated on reservoir or basin roof slabs shall not have loaded weight in excess of 14,000 lbs and shall be so operated that no impact loads are imposed on the structure. Fill material shall not be piled on the roof

slab to a depth greater than 12 inches above finished grade elevation. Fill construction shall begin at the walls, and construction equipment shall operate on a layer of fill material at least 12 inches deep. Special care shall be taken to avoid damaging or disturbing any roofing membrane, tile drains, or granular fill material.

- F. Borrow Pits
 - 1. Borrow pits are not permitted.

3.4 FILL AND BACKFILL FOR STRUCTURES

- A. Earth and aggregate materials placed for structures include granular fill, structure backfill, select fill, gravel base beneath slabs, and controlled low strength material In addition to the specific requirements specified herein, all requirements for placement of fills and embankments shall apply to granular fill, structure backfill, select fill, and gravel base beneath slabs. These requirements include, but are not limited to subgrade preparation, lift thickness, and moisture conditioning requirements. All fills and backfills for structures shall be constructed to the lines and grades indicated on the Drawings. Backfilling and construction of fills during freezing weather shall not be done. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.
- B. Granular Fill
 - 1. Granular fills shall be provided where indicated on the Drawings. Granular fills shall be placed on suitably prepared sub-grades in uncompacted lift thickness of 6 inches or less and compacted by vibration. Granular fills shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254. If the thickness of the granular fill is less than 6 inches, the compaction shall be by a minimum four passes (round trips) of a self-propelled or walk-behind type vibratory roller operating in full vibration mode in accordance with manufacturer's instructions.
 - 2. Where granular fills are to be covered with concrete, the top surface shall be graded to the required sub-grade elevation. The completed fill shall be covered by polyethylene film.
- C. Structure Backfill

1.

- Backfill materials shall be deposited in approximately horizontal layers not to exceed 8 inches in uncompacted thickness and shall meet the following requirements:
 - a. Test method to determine maximum density and moisture : ASTM D698
 - b. Relative compaction : 95%.
 - c. Moisture content relative to the optimum : -2% to +2%.
- 2. Compaction of structure backfill shall be performed in such a manner that damage to the structure is prevented. The compaction equipment used within 8 feet of the walls and for the top 8 feet of backfill shall be the static type. Limit of equipment weight shall be 2 ton Compaction of structure backfill by inundation with water will not be permitted.
- 3. No backfill shall be deposited or compacted in water.

- 4. Care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a pipe is to be installed within structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches above the top of pipe before the trench for pipe installation is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.
- D. Select Fill
 - 1. Select fill shall be placed in approximately horizontal layers in uncompacted lift thickness of 8 inches or less and shall meet the following requirements:
 - a. Test method to determine maximum density and moisture : ASTM D698.
 - b. Relative compaction : 95%.
 - c. Moisture content relative to the optimum : -2% to +2%.
- E. Gravel Base Beneath Slabs
 - 1. The gravel base beneath building floor slabs shall be placed in uncompacted lift thickness of 6 inches or less and compacted with a minimum of four passes (round trips) of a self-propelled or walk-behind type vibrating roller. The roller shall be operated in the full vibrating mode and in accordance with the manufacturer's instructions.
- F. Controlled Low Strength Material (CLSM) Fill. Not used
- G. Ringwall Fill. Not used

3.5 FILTER FABRIC INSTALLATION

- A. Filter fabric shall be placed as specified herein and at the locations specified or otherwise indicated on the Drawings.
- B. Filter fabric shall be protected from contamination by foreign material and damage. Any contaminated or damaged filter fabric shall be replaced with new filter fabric at no additional cost to the Owner. The fabric shall be covered within 7 calendar days after placement.
- C. The subgrade for placement of filter fabric shall be smooth and free of irregularities and undulations. Filter fabric shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. Type A and B filter fabric shall be overlapped a minimum of 2 feet between adjacent roll ends and adjacent strips.
- D The joints of Type C filter fabric shall be sewn unless otherwise recommended by the manufacturer for the specific application. All seams shall be formed by mating the edges of the filter fabric panels and sewing them together with continuous stitches located a minimum of three inches from the edges. The thread shall be ultraviolet light resistant and manufactured from the same material as the filter fabric. A two-thread, type 401 double-lock stitch shall be used for all sewn work. Sewing methods shall conform to the latest procedures recommended by the filter fabric manufacturer. The Contractor shall demonstrate that the seam efficiency meets the requirements of the specified tabulated properties for the filter fabric as applicable.

- E. All filter fabric placed shall be fixed to the subgrade to prevent filter fabric slippage or movement during placement of subsequent materials. Pins or staples shall not be used to fix the filter fabric to the subgrade when a geomembrane is to be placed on top of the filter fabric.
- F. The Contractor shall exercise care during filter fabric installation to prevent damage to the prepared supporting subgrade surface. The Contractor shall exercise care to prevent the entrapment of rocks, clods of earth or other material which could damage the filter fabric, clog the filter fabric or hamper seaming. Filter fabric damaged or distressed by foreign objects shall be repaired or replaced.
- G. No foot traffic will be allowed on the filter fabric except with approved smooth-sole shoes. The Contractor shall not use the filter fabric surface as a work area or storage area for tools and supplies.
- H. Tracked or rubber tired construction equipment shall not be operated directly upon the filter fabric until a minimum thickness of 6 inches of the cover material is placed over the filter fabric. Turning of construction vehicles shall be minimized to avoid distorting or damaging the filter fabric. All damaged filter fabric shall be replaced at Contractor's expense.

3.6 GEOCOMPOSITE SHEET DRAINS INSTALLATION

A. The prefabricated geocomposite sheet drains shall be placed on buried structure walls as indicated on the Drawings. The fabric shall extend beyond the edges of the core to provide overlap for the adjacent panels. Before beginning the backfilling operations the geocomposite drains shall be permanently secured to the walls by means of an attachment system recommended by the sheet drain manufacturer. Adjacent sheet drain panels shall be joined as recommended by the manufacturer. Terminal edges of the sheet drain to be embedded in the granular drainage material shall have the plastic core exposed by peeling back the fabric a minimum of 3 inches but not so much as to expose the plastic core to intrusion and plugging by soil backfill. Backfill shall be placed and completed within 2 weeks of installation of the sheet drains.

3.7 FINAL GRADING AND PLACEMENT OF TOPSOIL

- A. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Any additional topsoil required to provide the required minimum thickness shall be at no additional cost to the Owner.
- B. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

C. Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris. Seeding shall be in accordance with specification Section 32 92 21.

3.8 DISPOSAL OF EXCAVATED MATERIALS

- A. Suitable excavated materials may be used in fills and embankments as needed. All excess excavated material shall be disposed of off site at the expense of Contractor.
- B. All debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, Contractor.

3.9 SETTLEMENT

- A. Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.
- B. Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section
TEMPORARY EXCAVATION DESIGN CERTIFICATE – Figure 1 – 31 23 11

I, the undersigned professional engineer licensed i	in the state where the earthwork is located, hereby
certify that the temporary excavation for the	(structure name)
excavation at	_ (structure location) has been designed by me, is
appropriate for the	(structure name), as represented to me, and is in
compliance with the Contract Documents (includi	ng protecting adjacent structures, utilities, and other
facilities from damage, and not providing a tempo	rary earth retention design to Contractor that includes
soldier piles with steel plate lagging, slide rail sys	tems, and trench shields).
Name:	State of License:
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Signature:	P.E. Number
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Date:	
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SECTION 31 23 33 - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching; tunneled (trenchless construction) crossings; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other appurtenant work.

1.2 GENERAL

A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed or registered professional engineer, to act upon all pertinent matters of the work of this section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittal Procedures section.

B. Certifications.

- 1. At least 30 days before starting construction on the sheeting and shoring, and in accordance with the OSHA requirements identified above, the Contractor shall ensure that the sheeting and shoring design engineer shall complete and submit to Engineer the Protective System Design Certificate 312333-F2 and the Contractor shall use the sheeting and shoring design. If required by the OSHA requirements identified above or to protect existing facilities, the Contractor shall submit a separate certificate for each unique design. If required for protection of existing facilities or as required by the OSHA regulations identified above, the certificate(s) shall be signed and sealed by the registered professional engineer that designed the protection system.
- C. Filter Fabric Data
 - 1. Complete descriptive and engineering data for the fabric shall be submitted. Data submitted shall include:
 - a. A 12 inch square sample of fabric.
 - b. Manufacturer's descriptive product data.

- c. Installation instructions.
- D. Embedment and Backfill Materials
 - 1. Complete test results covering tests performed by an independent commercial testing laboratory retained by the Contractor for all materials described in the Materials Testing section shall be submitted.

1.4 BASIS FOR PAYMENT

- A. Trench Sheeting
 - 1. No additional payment above the Contract Price will be made for trench sheeting left in place.

1.5 INSURANCE

A. Professional liability insurance shall be provided as specified in the Supplementary Conditions section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Filter Fabric
 - 1. The fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris. All filter fabric shall be in accordance with Article 1080.03 of the IDOT Standard Specifications.
 - 2. Filter Fabric Type A

1)

a.



- Property : Fabric Weight
 - a) Test Method : ASTM D3776
 - b) Unit : oz/yd^2
 - c) Minimum Average Roll Value : 5.7
- 2) Property : Grab Strength
 - a) Test Method : ASTM D4632
 - b) Unit : lb
 - c) Minimum Average Roll Value : 155

- 3) Property : Grab Elongation
 - a) Test Method : ASTM D4632
 - b) Unit : percent
 - c) Minimum Average Roll Value : 50
- 4) Property : Mullen Burst Strength
 - a) Test Method : ASTM D3786
 - b) Unit : psi
 - c) Minimum Average Roll Value : 190
- 5) Property : Apparent Opening Size
 - a) Test Method : CW-02215
 - b) Unit : U.S. Standard Sieve Size
 - c) Minimum Average Roll Value : 70
- 3. Filter Fabric Type B
 - a. Filter fabric Type B shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter fabric Type B shall be a nonwoven fabric consisting of only continuous chains of polymeric filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties (Minimum average roll value in weakest principal direction):
 - 1) Property : Fabric Weight
 - a) Test Method : ASTM D3776
 - b) Unit : oz/yd^2
 - c) Minimum Average Roll Value : 8.0
 - 2) Property : Grab Strength
 - a) Test Method : ASTM D4632
 - b) Unit : lb
 - c) Minimum Average Roll Value : 215
 - 3) Property . Grab Elongation
 - a) Test Method : ASTM D4632
 - b) Unit : percent
 - c) Minimum Average Roll Value : 50
 - 4) Property : Mullen Burst Strength
 - a) Test Method : ASTM D3786
 - b) Unit : psi
 - c) Minimum Average Roll Value : 375
 - Property : Apparent Opening Size
 - a) Test Method : CW-02215
 - b) Unit : U.S. Standard Sieve Size
 - c) Minimum Average Roll Value : 70
- B. Polyethylene Film
 - 1. Polyethylene film beneath concrete slabs or slab base course material shall be Product Standard PS17, 6 mil minimum thickness.
- C. Tunnel Materials. Not used

- D. Backfill Materials
 - 1. Job Excavated Material
 - a. Job excavated material may be used for either uncompacted or compacted trench backfill when the job excavated material is finely divided and free from debris, organic material, cinders, corrosive material, and stones larger than 3 inches in greatest dimension. Masses of moist, stiff clay shall not be used.
 - 2. Inundated Sand Fill
 - a. Sand fill shall be clean. Clean sand shall begradation FA-6 in accordance with Article 1003 of the IDOT standard specifications.
 - 3. Controlled Compacted Fill
 - a. Controlled compacted fill shall be imported crushed limestone aggregate similar in gradation to IDOT CA-6, CA-7.
 - 4. Granular Fill
 - a. Granular fill material shall be crushed rock or gravel. Granular fill shall be free from dust, clay, and trash; shall be hard, durable, and non-friable; and and shall have gradation CA-7 in accordance with Article 1004 of the IDOT Standard Specifications..
- E. Controlled Low Strength Material (CLSM) Fill. Not used
- F. Pipe Embedment Material
 - 1. Pipe embedment material shall be placed as indicated in Figure 1-31 23 33.
 - 2. Granular Embedment
 - a. Granular embedment shall consist of crushed rock and crushed gravel or pea gravel, meeting the quality and gradation per IDOT coarse aggregate gradation specification.
 - 3. Hand Placed Embedment
 - a. Hand placed embedment shall be finely divided job excavated or imported material, free from organic materials, debris, and stones.
 - 4. Compacted Embedment
 - a. Compacted embedment shall be finely divided job excavated material free from debris, organic material, and stones. Graded gravel may be substituted for compacted embedment. Granular embedment may be substituted for all or part of the compacted embedment at the option of the Contractor.

2.2 MATERIALS TESTING

A. Preliminary Review of Materials

- 1. As stipulated in the Quality Control section, all tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of Contractor. Two initial gradation tests shall be made for each type of embedment, fill, backfill, or other material, and one additional gradation test shall be made for each additional 500 tons of each material delivered to the site. In addition, one set of initial Atterberg Limits test shall be made for each fill materials containing more than 20 percent by weight passing the No. 200 sieve. One additional Atterberg Limits test shall be made for each material delivered to the site.
- B. Field Testing Expense
 - 1. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory at the expense of Contractor. Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.
- C. Required Tests
 - 1. For planning purposes, the following guidelines shall be used for frequency of field tests. Additional tests shall be performed as necessary for job conditions and number of failed tests. Test results shall be submitted as specified in the Submittal Procedures section.
 - a. Two moisture density (Proctor) tests in accordance with ASTM D698 (or, when required, ASTM D1557), or two relative density tests in accordance with ASTM D4253 and D4254 for each type of general fill, designated fill, backfill, or other material proposed.
 - b. In-place field density and moisture tests (ASTM D6938) at intervals of 1000 feet maximum along the trench.
 - c. One in-place field density and moisture test (ASTM D6938) for every 200 cubic yards of backfill.
 - d. One in-place density and moisture test (ASTM D6938) whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
 - Additional gradation, Proctor, and relative density tests whenever the source or quality of material changes.

PART 3 - EXECUTION

3.1 CLEARING

A. All clearing shall be performed as necessary for access, stringing of pipeline materials, and construction of the pipeline and appurtenant structures.

3.2 EXCAVATION

- A. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.
- B. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.
- C. Except where exterior surfaces are specified to be damp-proofed, monolithic concrete manholes and other concrete yard structures or parts thereof, which do not have footings that extend beyond the outside face of exterior walls, may be placed directly against excavation faces without the use of outer forms, provided that such faces are stable and also provided that a layer of polyethylene film is placed between the earth and the concrete.
- D. Excavations for manholes and similar yard structures constructed of masonry units shall have such horizontal dimensions that not less than 6 inches clearance is provided for outside plastering. Excavation and Fill for Structures is covered in Section 31 23 11.
- E. Classification of Excavated Materials
 - 1. No classification of excavated materials will be made for payment purposes. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.
- F. Preservation of Trees
 - 1. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from permanent damage by construction operations.
- G. Blasting. Not used
- H. Dewatering
 - 1. Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the yard structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
 - Contractor is responsible for choosing method of groundwater control.
 - 3. If contractor chooses to use deep wells or well points, wells and and well points shall be designed, installed, and operated to prevent removal of in-situ materials.
 - 4. All excavations for concrete yard structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of 24 inches, beneath such excavations. The specified dewatering depth shall be maintained below the prevailing bottom of excavation at all times.

- 5. Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.
- 6. Contractor shall not utilize or connect to existing FRSA stormwater system, piping, and outfalls. Contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes, and all such pipe or conduit shall be maintained to be clean and free of sediment.
- 7. Contractor shall provide all power for dewatering if Contractor requires more than Owner's supply available as specified in Section 01 50 00 Temporary Facilities.
- 8. Contractor is responsible for any required permits for the dewatering system and its operation. Contractor shall obtain from the appropriate agencies and authorities, the dewatering and stormwater discharge permits required to remove and dispose of groundwater, surface water, and any other water used in Contractor's operations. The permits shall be obtained prior to start of construction.
- I. Sheeting and Shoring
 - 1. Except where banks are cut back on a stable slope, excavations for yard structures and trenches shall be supported with steel sheet piling and shoring as necessary to prevent caving or sliding.
 - 2. Sheet piling or other excavation support systems shall be installed as necessary to limit the extent of excavations for deeper yard structures and to protect adjacent structures and facilities from damage due to excavation and subsequent construction. Contractor shall assume complete responsibility for, and shall install adequate protection systems for prevention of damage to existing facilities.
 - 3. Sheeting, shoring and excavation support systems shall be designed by a professional engineer registered in the state where the project is located.
 - 4. Trench sheeting may be removed if the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting. Trench sheeting shall not be pulled after backfilling. Where trench sheeting is left in place, it shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed. Trench sheeting shall be removed unless, in the opinion of Engineer, removal of the sheeting will cause damage to the facility it is protecting or loss of necessary piping support from the piping embedment. If left in place, the sheeting shall cut off 12 inches below finished grade. The design of the support system shall be such as to permit complete removal while maintaining safety and stability at all times.
 - 5. A movable trench support may be used, provided care is exercised in placing and moving the trench box or support bracing to prevent movement of the pipe and bedding and backfill material meets the required compaction without voids.

- J. Stabilization
 - 1. Sub-grades for concrete yard structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.
 - 2. Sub-grades for concrete yard structures or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel as specified for granular fills. The stabilizing material shall be placed in a manner that no voids remain in the granular fill. All excess granular fill with unfilled void space shall be removed. The finished elevation of stabilized sub-grades shall not be above sub-grade elevations indicated on the Drawings.

3.3 TRENCH EXCAVATION

- A. No more trench shall be opened in advance of pipe laying than is necessary to expedite the work. One block or 400 feet, whichever is the shorter, shall be the maximum length of open trench on any line under construction.
- B. Except where tunneling is indicated on the Drawings, is specified, or is permitted by Engineer, all trench excavation shall be open cut from the surface.
- C. Prior to excavation, Contractor shall contact local underground alert hotlines, "Dig Safe" and/or individual utility owners for marking underground utilities. Once utilities are marked, Contractor shall hand dig or pothole to expose the existing utilities. A survey shall be made of the utility size, material, location, and elevation prior to trench excavation and information shall be recorded on the record Drawings maintained by the Contractor.
- D. Alignment, Grade, and Minimum Cover
 - 1. The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the section covering installation of pipe.
 - 2. Where pipe grades or elevations are not definitely fixed by the Drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 24 inches over pipes below paved and graded streets and, of 12 inches over pipes in other locations. Greater pipe cover depths may be necessary on vertical curves or to provide adequate clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation, except where future surface elevations are indicated on the Drawings.
- E. Maximum Trench Widths
 - 1. Maximum trench widths shall be limited as indicated in Schedule 31 23 33for designated conduits. Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment.

However, the limiting trench widths from the bottom of the trench to an elevations 12 inches above the top of installed pipe, and the minimum permissible sidewall clearances between the installed pipe and each trench wall, shall be as indicated in Schedule 31 23 33-S01 or on the Drawings.

- 2. Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances which will be required to the trench excavation or the trench protective system.
- 3. Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits. Slopes shall not extend lower than 12 inches above the top of the pipe.
- 4. If, for any reason, the width of the lower portion of the trench, as excavated at any point, exceeds the maximum permitted, pipe of adequate strength, special pipe embedment, or concrete arch encasement, for the applicable loading conditions and with the concurrence of Engineer, shall be furnished and installed by and at the expense of Contractor.
- F. Minimum Trench Widths
 - 1. Except when maximum trench width is required for certain conduits, trenches shall be excavated to the minimum trench widths indicated in the following table. Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment.
 - a. Nominal Pipe Size : Less than 27 in
 - 1) Minimum Trench Width : Pipe OD plus 24 in
 - 2) Clearance (minimum sidewall clearance): 12 in
 - b. Nominal Pipe Size : Less than 27 in through 60 in
 - 1) Minimum Trench Width : Pipe OD plus nominal pipe size
 - 2) Clearance (minimum sidewall clearance): ID/2
 - 3) ID = Inside Diameter (or span) of conduit
 - c. Nominal Pipe Size : Less than Greater than 60 in
 - 1) Minimum Trench Width : Pipe OD plus 70 in
 - Clearance (minimum sidewall clearance): 30 in

Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances which will be required to the trench excavation or the trench protective system.

Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits.

G. Mechanical Excavation

3.

2)

1. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or

structures above or below ground. In all such locations, hand excavating methods shall be used.

- 2. Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated, that the rough trench excavation bottom elevation can be controlled, and that trench alignment is such that pipe, when accurately laid to specified alignment, will be centered in the trench with adequate sidewall clearance. Undercutting the trench sidewall to obtain sidewall clearance will not be permitted.
- 3. In locations where maximum trench widths are required for designated rigid conduits, mechanical equipment shall be operated so that uniform trench widths and vertical sidewalls are obtained at least from an elevation 12 inches above the top of the installed pipe to the bottom of the trench.
- H. Cutting Concrete Surface Construction
 - 1. Cuts in concrete pavement and concrete base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1-1/2 inches deep along each side of the trench and along the perimeter of cuts for yard structures.
 - 2. Concrete pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6 inches in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than at the top and no undercutting will be permitted. Pavement cuts shall be made to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.
 - 3. Pavement removal for connections to existing lines or structures shall not exceed the extent necessary for the installation.
 - 4. Where the trench parallels the length of concrete walks, and the trench location is all or partially under the walk, the entire walk shall be removed and replaced. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and subsequently replaced between existing joints or between saw cuts as specified for pavement.
- I. Excavation Below Pipe Sub-grade
 - Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, as indicated on Figure 1-31 23 33, to provide for the installation of granular embedment.
 - 2. Bell holes shall provide adequate clearance for tools and methods used for installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

- J. Artificial Foundations in Trenches
 - 1. Whenever unsuitable or unstable soil conditions are encountered, Contractor shall notify Engineer immediately. When authorized by the Engineer, trenches shall be excavated below grade and the trench bottom shall be brought to grade with suitable material. In such cases, adjustments will be made in the Contract Price in accordance with the provisions of the General Conditions.
- K. Over-Excavation
 - 1. Over-excavation carried below the grade, unless authorized by the Engineer, shall be backfilled to the required grade with material acceptable to the Engineer and compacted to the satisfaction of the Engineer, at no additional cost to the Owner.

3.4 PIPE EMBEDMENT

- A. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the requirements indicated on Figure 1-31 23 33 and to the following supplementary requirements.
- B. Embedment material shall contain no cinders, clay lumps, or other material which may cause pipe corrosion.
- C. Embedment Classes.
 - 1. Class A Arch Encasement.
 - a. When arch encasement is indicated on the Drawings, Class A arch encasement shall be used at all locations so indicated.
 - b. When arch encasement is not indicated on the Drawings, Class A arch encasement is not required unless improper trenching or unexpected trench conditions require its use as determined by Engineer.
 - c. Concrete and reinforcing steel for Class A arch encasement shall conform to the requirements of the Cast-in-Place Concrete and Concrete Reinforcement sections.
 - 2. Class B Embedment.

a.

Class B bedding shall be used for all steel, ductile iron, bar-wrapped concrete, and vitrified clay pipelines, and for all other pipelines not otherwise specified.

Class B Special Embedment.

- a. Class B special embedment shall be used for HDPE, PVC, ABS, FRP, GRP, steel or stainless steel pipe where the process fluid design maximum temperature is 140° F or higher such as for pressurized air service, and when recommended by the pipe manufacturer.
- 4. Class C Embedment.
 - a. Class C embedment shall be used for all reinforced concrete and prestressed concrete pipelines.

- D. Embedment for Ductile Iron, Steel, FRP, and PVC Pipelines
 - 1. Granular embedment for polyethlene tube protected ductile iron, coal tar or tape coated steel, FRP, and PVC pipelines shall be pea gravel, crushed rock or crushed gravel with rounded or subrounded particles. Crushed rock or gravel with sharp edges which could cause significant scratching or abrasion of the pipe or damage to the coating or polyethylene tube protection shall not be used unless otherwise approved by Engineer and all damage is repaired to the satisfaction of Engineer.
 - 2. Inundated sand may be used for granular embedment in locations where the use of water will cause no damage to adjacent property and where it can be placed and properly compacted without damage to the pipe.
 - 3. Inundated sand for granular embedment shall be deposited in, or placed simultaneously with the application of water so that the sand is inundated during compaction. During placement, the sand shall be compacted with a mechanical probe type vibrator. Water shall be allowed to escape or shall be removed during vibration, and no ponding shall be allowed to take place. Inundated sand shall be compacted to 70 percent relative density as determined by ASTM D4253 and D4254. If the required density cannot be achieved, placement and compaction methods shall be altered,
- E. Placement and Compaction
 - 1. Granular Embedment
 - a. Granular embedment material shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.
 - b. After each pipe has been graded, aligned, and placed in final position on the bedding material, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof by shovel slicing or other suitable methods to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.
 - c. Placing and compaction of embedment material shall not damage the pipe coating or polyethylene encasement. Embedment material shall not be dumped directly on the pipe or polyethylene encasement unless a suitable temporary isolation layer such as a 60 mil HDPE sheeting, is used to cover the pipe and polyethylene encasement.
 - Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.
 - e. Granular embedment shall be placed in layers not more than 6 inches deep and compacted as specified.
 - f. Each lift of granular embedment material shall be vibrated with a mechanical probe type vibrator or shovel sliced during placement to ensure that all spaces beneath the pipe are filled. Granular embedment shall be placed in maximum lift thickness of 6 inches and compacted. Each lift of embedment material shall be compacted with three passes (round trip) of a platform type vibrating compactor and to at least 70 percent relative density as determined by ASTM D4253 and D4254.

- g. Where indicated on the Drawings or where silt, fine sand, or soft clay soils are encountered below groundwater, migration of soil into the embedment material shall be prevented by installing filter fabric Type A, or by using graded gravel in place of granular embedment. Filter fabric shall be placed on the trench surfaces so that it completely surrounds the embedment material. Joints shall be lapped 12 inches
- h. Unless otherwise indicated on the Drawings, where pipes pass through watercontaining embankments, granular embedment material shall be omitted and the trench bottom shall be graded to provide uniform and continuous support for the pipe. The pipe shall be embedded in embankment material containing no rocks or stones. The embedment material shall be compacted to the same density as the existing embankment or to at least 95 percent relative compaction in accordance with ASTM D698, whichever is higher.
- 2. Compacted Embedment
 - a. Compacted embedment shall be placed in uniform layers not more than 8 inches thick and compacted to not less than 95% maximum density as determined by ASTM D698
 - b. Where Class C embedment is required, compacted embedment shall be placed to the top of the pipe in all areas where compacted trench backfill is specified and around restrained pipe sections. Placing and compaction of embedment shall not damage the pipe or coating.
- 3. Hand Placed Embedment
 - a. Hand placed embedment shall be placed by hand shovels or using methods that prevent dropping the material for more than 24 inches above the pipe. Hand placed embedment shall be lightly tamped using hand equipment. Care shall be taken so as to not damage the pipe or coating.
- 4. Compaction Trench Box Support Systems
 - a. Where trench box support systems are used embedment compaction shall be performed outside the limits of the trench box so that relocating the trench box will not disturb the compacted embedment. Where necessary to protect workers, the compaction may be performed by compaction rollers or other compaction systems that are operated from above the trench and achieve the required compaction.
 - Trench boxes for earth trenches shall be positioned such that the bottom of the trench box is no lower than approximately two feet above the bottom of pipe invert elevation so that initial compaction of the haunch area of the pipe, from within the trench box, extends the full width of trench. Trenches shall be shaped to support the trench box above the bottom of trench.
 - c. When in rock and where it is not practicable to shape the trench to provide the trench box support above the bottom of the trench, initial compaction of the haunch area may be performed within the trench box.
 - d. Final compaction of the haunch area and all other compaction shall be performed outside the limits of the trench box after the trench box has advanced into the next section of trench.

- F. Groundwater Barrier
 - 1. Continuity of embedment material shall be interrupted by low permeability groundwater barriers to impede passage of water through the embedment. Groundwater barriers for sewer lines that contain manholes with cast-in-place bases shall be compacted soil around each manhole, extending through any granular material beneath the manhole, and meeting ASTM D2487 soil classification GC, SC, CL, or ML-CL and shall be compacted to at least 95 percent of maximum density with moisture content within 2 percent of the optimum moisture content (ASTM D698). Material may be finely divided, suitable job excavated material, free from stones, organic matter, and debris.
 - 2. Groundwater barriers for sewer lines that contain manholes with precast (developed) bases and for all other pipelines shall be soil plugs of 3 feet in width, extending the full depth and width of granular material, and spaced not more than 400 feet apart. The soil plugs shall be constructed from soil meeting ASTM D2487 classification GC, SC, CL, or ML, and compacted to 95 percent of maximum density at near the optimum moisture content (ASTM D698).

3.5 TRENCH BACKFILL

- A. All trench backfill above pipe embedment shall conform to the following requirements.
- B. A layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement or concrete thrust blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least 3 days.
- C. Compacted Backfill
 - 1. Compacted backfill will be required for the full depth of the trench above the embedment in the following locations:
 - a. Where beneath pavements, surfacings, driveways, curbs, gutters, walks, or other surface construction or yard structures.
 - b. Where in street, road, or highway shoulders.
 - c. In established lawn areas.

The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than that which is underlying adjoining lawn areas.

Trench backfill material shall be suitable job excavated material and shall be as specified herein.

- 4. Job Excavated Material
 - a. Job excavated materials shall be placed in uniform layers not exceeding 8 inches in uncompacted thickness. Each layer of material shall have the best possible moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as needed and thoroughly mixed to ensure uniform moisture

content and adequate compaction. Increased layer thickness may be permitted for noncohesive material if Contractor demonstrates to the satisfaction of Engineer that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe. Job excavated material shall be compacted to 95 percent of maximum density at a moisture content within 2 percent of the optimum moisture content as determined by ASTM D698when that test is appropriate, or to 70 percent relative density as determined by ASTM D4253 and D4254 when those tests are appropriate.

- 5. Inundated Sand
 - a. Sand shall be deposited in, or placed simultaneously with the application of, water so that the sand is inundated during compaction. During placement, the sand shall be compacted with a mechanical probe type vibrator. Water shall be allowed to escape or shall be removed during vibration and no ponding shall be allowed to take place. Inundated sand shall be compacted to 70 percent relative density as determined by ASTM D4253 and D4254. If the required relative density cannot be achieved, use of inundated sand shall be discontinued.
- 6. Graded Gravel
 - a. Gravel backfill shall be deposited in uniform layers not exceeding 12 inches in uncompacted thickness. The backfill shall be compacted with a suitable vibratory roller or platform vibrator to at least 70 percent relative density as determined by ASTM D4253 and D4254.
 - b. Groundwater barriers specified under pipe embedment shall extend to the top of the graded gravel backfill
- D. Ordinary Backfill
 - 1. Compaction of trench backfill above pipe embedment in locations other than those specified will not be required except to the extent necessary to prevent future settlement. Contractor shall be responsible for backfill settlement as specified.
 - 2. Ordinary earth backfill material to be placed above embedments shall be free of brush, roots more than 2 inches in diameter, debris, cinders, and any corrosive material, but may contain rubble and detritus from rock excavation, stones, and boulders in certain portions of the trench depth.

Backfill material above embedments shall be placed by methods which will not impose excessive concentrated or unbalanced loads, shock, or impact on installed pipe, and which will not result in displacement of the pipe.

- 4. Compact masses of stiff clay or other consolidated material more than 1 cubic foot in volume shall not be permitted to fall more than 5 feet into the trench, unless cushioned by at least 2 feet of loose backfill above pipe embedment.
- 5. No trench backfill material containing rocks or rock excavation detritus shall be placed in the upper 18 inches of the trench, nor shall any stone larger than 8 inches in its greatest dimension be placed within 3 feet of the top of pipe. Large stones may be placed in the

remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

- E. Water-Settled Earth Backfill
 - 1. Settlement or consolidation of trench backfill using water jetting or ponding shall not be performed.
- F. Structure Backfill
 - 1. Backfill around manholes and small concrete vaults shall meet the requirements specified for structure backfill specified in the Excavation and Fill for Structures section 31 23 11.
- G. Controlled Low Strength Material (CLSM). Not used.
- 3.6 TUNNEL EXCAVATION. Not used

3.7 DRAINAGE MAINTENANCE

A. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or watercourses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the trafficway, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other watercourses crossed by the line of trench shall be removed immediately after backfilling is completed, and the original section, grades, and contours of ditches or watercourses shall be restored. Surface drainage shall not be obstructed longer than necessary.

3.8 PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSES

A. Where trenches are constructed in ditches or other watercourses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds 1 percent, or as otherwise required, ditch checks shall be installed. Unless otherwise indicated on the Drawings, ditch checks shall be concrete. Ditch checks shall extend at least 2 feet below the original ditch or watercourse bottom for the full bottom width and at least 18 inches into the side slopes, and shall be at least 12 inches thick.

FINAL GRADING AND PLACEMENT OF TOPSOIL

A. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Topsoil required to provide the minimum thickness shall be imported and placed at no additional cost to the Owner.

- B. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.
- C. Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris.

3.10 DISPOSAL OF EXCESS EXCAVATED MATERIALS

- A. Disposal of excess material from trench excavations on plant and major facility construction sites shall be accomplished as specified in the Excavation and Fill for Structures section of the Specifications for the major construction.
- B. Disposal of excess material from trench excavation sites shall be as follows. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site.
- C. Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be installed in trench backfill, debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site.
- D. Excess earth from excavations located in unimproved property may be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of 6 inches above the original ground surface elevation at and across the trench and sloping uniformly each way. Material thus wasted shall be carefully finished with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road, or highway right-of-way. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing, shall be a subsidiary obligation of Contractor and no separate payment will be made therefore.
- 3.11 RESODDING. Not used.

3.12 SETTLEMENT

- A. Contractor shall be responsible for all settlement of trench backfill which may occur within the correction period stipulated in the General Conditions.
- B. Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section

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PROTECTIVE SYSTEM DESIGN CERTIFICATE – 2

I, the undersigned professional engineer registered in the state where the Project is located, hereby certify that the protection system for _______(trench location) has been designed by me, is appropriate for the (trench location) as represented to me, and is in compliance with the Contract Documents.

	605
Name:	State of Registration:
Signature:	P.E. Number
Date	
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SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SCOPE

- A. This section establishes construction requirements for the control of soil erosion from the construction site and adjacent properties to streams caused by Contractor's construction activities. It is the responsibility of the Contractor to update and maintain an erosion and sediment control plan and water quality protection plan, and to implement those plans throughout the construction period. These plans are be followed throughout construction and maintained and updated in accordance with these Contract Documents and the Illinois general NPDES permit.
- B. Work shall be scheduled to expose areas subject to erosion for the shortest possible time and natural vegetation shall be preserved to the greatest extent practicable. Temporary storage and construction buildings shall be located, and construction traffic routed, to minimize erosion. Temporary fast-growing vegetation or other ground cover, silt fencing, or other measures and devices shall be provided, as necessary, to control runoff and erosion.
- C. Additional requirements for trench dewatering and temporary discharge of stormwater and other water are covered in Section 31 23 33 Trenching and Backfilling.

1.2 STORMWATER POLLUTION PREVENTION PLAN

- A. See the Drawings for Engineer developed project-specific erosion and sedimentation control drawings, notes and details. The Contractor is required to implement, maintain, and update this plan during construction as conditions warrant. The plan shall be updated, submitted, and approved prior to beginning any field construction activities, except for staking and surveying. Modifications to the plan may be required by the Contractor to provide assurance that erosion will be minimized to the greatest extent practicable. The plan on the Drawing includes, but is not limited to, the following:
 - 1. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection requirements that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.



Prior to start of any earthwork, the following permits, authorization, or approvals are required and will be obtained by Owner.

- a. Notice of Coverage under the Illinois Environmental Protection Agency (IEPA) General NPDES Permit for Storm Water Discharges from construction site activities.
- 3. Methods for protection of features to be preserved within authorized work areas. The Contractor shall augment the plan by providing a supplemental list of methods to protect resources needing protection, i.e., trees, shrubs, vines, grasses and ground cover, soil, etc.
- 4. Procedures to be implemented to provide the required erosion control protection. The Contractor shall supplement the plan by setting out the procedures to be followed to correct

erosion due to accident, natural causes, or failure to follow the procedures set out in accordance with the plan.

- 5. Soil erosion monitoring plans for the job site.
- 6. Methods of protecting surface and groundwater during construction activities.
- B. The Contractor shall be responsible for constructing, operating, and maintaining all soil erosion and sediment control measures for the construction areas and any on-site and off-site stockpile areas used by the Contractor. The Contractor shall also remove such measures and restore the sites of erosion and sediment control facilities upon completion of construction,
- C. Implementation
 - 1. Not later than 20 days after receipt of Notice to Proceed and prior to start of construction, the Contractor shall submit in writing an updated copy of the proposed Stormwater Pollution Prevention Plan with supplemental information as required herein. Approval of the Contractor's plan will not relieve the Contractor of its responsibility for adequate and continuing erosion control measures.

1.3 EROSION CONTROL REQUIREMENTS

- A. All disturbances and changes to the earth shall be made in such a manner as to minimize the duration and area of disturbed land exposed and unprotected against the erosive action of wind, ice, precipitation, and the flow of water.
- B. Sediment generated by accelerated soil erosion shall be restricted to a non-polluting minimum as required by the controlling Federal, state, or local regulation.

1.4 EROSION CONTROL MEASURES

A. The Contractor shall provide additional devices and/or measures where field conditions warrant.

Construction Times:

Construction Sequence:

Temporary Stockpiles:

Sediment Control:

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The Contractor shall minimize the duration of the disturbance to the area.

The Contractor shall minimize the area of unstabilized land surface over which stormwater must flow.

Steps shall be taken to minimize erosive loss and resultant off-site sedimentation from stored piles of excavated spoils, topsoil, sand, gravel, and aggregate. Control methods used by the Contractor may include remote storage, covering, temporary stabilization, compacting, diversion ditches, and silt fences, in total or in any combination, as may be dictated by the size, type, location, season and anticipated duration of storage.

The Contractor shall provide suitable sediment control devices/measures and facilities at affected connections to existing or new storm drains, to minimize deposition of sediment in the storm drains during the construction period. Sediment control devices/measures and facilities shall be provided in accordance with the requirements of all laws and

31 25 00 - 2

regulations prior to any significant clearing, grading, or surface disruption of the tributary areas.

- Dewatering: Pumped water from well points, dewatering wells, or excavations shall not be discharged onto unstabilized areas. Such discharge shall be conveyed by pipe, hose, or stabilized channel to a settling basin or other suitable sediment control facility provided by Contractor.
- Vehicle Controls: Where frequent use of improved roads by off-the-road vehicles occurs, appropriate methods shall be used to minimize the transfer of sediment-producing materials from the treads and tracks of the vehicles onto the improved road surface.

1.5 TEMPORARY STORMWATER RUNOFF PROVISIONS

- A. Contractor shall provide for the drainage of stormwater runoff and any water that may be applied or discharged on the site in performance of the Work. Stormwater facilities shall be adequate to prevent damage to the Work, the site, and adjacent property.
- B. Existing drainage channels and conduits shall be cleaned, enlarged, or supplemented as necessary to convey all increased runoff attributable to Contractor's operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect Owner's facilities and the Work, and to direct water to drainage channels or conduits to avoid ponding.

PART 2 - MATERIALS

2.1 EROSION CONTROL DEVICES

- A. Erosion control devices utilized throughout the project shall include, but are not limited to, the following and as indicated on the Drawings:
 - Vegetative Buffer Strips
 - Silt/Sediment Fencing
 - Temporary Seeding
 - Mulching
 - Earth Diversion Dikes
 - Straw Bale Ditch Checks

- Protection of Trees
- Drainage Swales
- Permanent Seeding
- Channel/Slope Riprap
- Area/Curb Inlet Sediment Filters
- Tarp Covers

PART 3 - EXECUTION

- 3.1 EROSION CONTROL MAINTENANCE
 - A. During construction, the Contractor and the Resident Project Representative shall make weekly inspections to assure that the erosion control devices identified in the Stormwater Pollution Prevention Plan are in place and functioning properly. In the event that the devices require repair or maintenance, the Contractor shall make repairs within 2 working days following the inspection.

3.2 FAILURE TO COMPLY

A. In the event that the Contractor fails to properly install and maintain the erosion control devices, the Owner may obtain the services of others. The Owner may back charge the Contractor for all expenses associated with erosion control, including the additional cost of services of another Contractor, additional engineering services, and additional resident inspection services; the Contractor shall be responsible for full reimbursement of all supplemental erosion control measures installed by Owner.

3.3 REMOVAL OF EROSION CONTROL MEASURES

A. Erosion control devices shall remain in place until the construction site has been reestablished with permanent seeding or sodding. The Contractor's obligation for continued maintenance of erosion control devices shall not terminate until Contractor is notified by Owner that the control measures are no longer required. The Contractor is responsible for removal of all remaining erosion control devices when so notified.

3.4 FINAL PAYMENT

A. Final payment and release of retainage may be made upon completion of final inspection of the project regardless of the necessity for continued maintenance of erosion control devices, provided that the Contractor's Surety agrees in writing that in the event the Contractor fails to comply with continued maintenance as stipulated above, all work will be covered under the Contract maintenance bond.

End of Section

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SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SCOPE.

- A. This section covers the furnishing of labor, materials and equipment for the construction of Hotmix asphalt base or binding course, bituminous tack coat, and hot-mix asphalt surface or wearing course for the roadway, driveways and parking area as indicated on the Drawings.
- B. Subgrade preparation shall be as indicated in the Excavation and Fill for Structures section, unless otherwise specified in the governing standards or herein.
- C. Hot-mix asphalt paving shall be constructed to the lines, grades, and cross sections indicated on the drawings. Type of construction shall be as indicated on the Drawings and as specified herein.

1.2 GENERAL.

- A. Governing Standards.
 - 1. Except as otherwise specified or indicated, materials, equipment, details, and construction methods shall comply with the applicable Illinois DOT Standard Specifications for Road and Bridge Construction, Current Edition, including Supplemental Specifications and Recurring Special Provisions and Highway standards.

B. Coordination.

1. Contractor shall coordinate the construction of Hot-mix asphalt paving with the excavation, the construction of concrete curb and gutters and other construction.

1.3 SUBMITTALS.

A. Design Mix Reports.

All submittals of design mix reports including design mix test results and other data, shall be in accordance with the Submittal Procedures section.

- B. Submittal Schedule.
 - 1. Design mix data as specified below.

PART 2 - PRODUCTS

2.1 MATERIALS.

- The sources of materials shall be acceptable to Engineer. Except as modified herein, materials A. shall conform to the requirements of the governing standards. Delivery tickets for all materials delivered to the site shall be submitted to Engineer at the end of each day during the progress of the work.
- B. Hot-mix asphalt materials shall be as follows: Base.

Aggregate for Bituminous Binder

Aggregate for Bituminous Surface.

Asphalt binder.

Prime coat.

Tack coat.

Designation.

Designation.

Rate.

Article 400.06 of the IDOT standard specifications Article 1004.03 for HMA Binder Course, IL-19.0. N50

Article 400.06 of the IDOT standard specifications

Article 1004.03 for HMA Surface Course, IL-9.5

PG 58-28 for binder course PG 64-22 for surface course

Bituminous material meeting one of the types listed in IDOT Standard Specifications, Article 406.02.

Type SS-1H 0.20 - 0.50 gal/ sq yd

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

2.2 DESIGN MIXES

A. A design mix for the asphalt base course and for the surface course, based upon the aggregates to be furnished, shall be determined by an independent testing laboratory at the expense of Contractor and shall be submitted to Engineer for review.

PART 3 - EXECUTION

3.1 EQUIPMENT.

- 505
- A. Equipment and facilities for storage, measuring, mixing, heating, transporting, spreading, compacting, and other operations shall be in accordance with the applicable requirements of the governing standards. Improved or modernized equipment which will produce results equal in quality to those which would result from the specified equipment will be considered for use. All equipment and facilities shall be acceptable to Engineer.

3.2 SUBGRADE PREPARATION.

A. As a minimum, the full depth of the aggregate subgrade shall be compacted to 95 percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing materials are placed. All subgrade and surfacing shall be sloped toward drains or outer edges.

3.3 PAVEMENTS.

- A. Unless otherwise specified, the new pavements to be constructed shall consist of an Hot-mix asphalt base course and an Hot-mix asphalt surface course, each of the thickness indicated on the Drawings. Hot-mix asphalt base course shall be placed in compacted lifts no greater than 4 inches. Hot-mix asphalt surface course shall be placed in compacted lifts no greater than 2 inches.
- B. Grade control shall be maintained by Contractor by means of automatic screed controls on the paving machine and by use of erected and mobile string lines as applicable. The use of the automatically controlled paver may be waived by Engineer on irregular sections. Finished surfaces shall conform to the lines and grades indicated on the Drawings.
- C. Hot-mix asphalt pavements shall be constructed on previously prepared subgrades in accordance with the sections, in compliance with the governing standards.
- D. Asphalt mixtures may be spread and finished by hand methods only where machine methods are impractical as determined by Engineer. Hand placed mixtures shall not be cast or otherwise manipulated in such manner that segregation occurs.

E. Minimum temperatures under which Hot-mix asphalt pavements may be constructed shall be as stipulated in the governing standards.

3.4 **REPAIR OF DEFECTS.**

- Contractor shall remove and replace defective areas by cutting to the full depth of the course. A. Cuts shall be made perpendicular and parallel to the direction of traffic with edges vertical.
- A tack coat shall be applied to all exposed surfaces. The area shall be filled with fresh hot Hot-B. mix asphalt mix in lifts of the same depths as the adjacent area, then compacted by rolling to specified surface density and smoothness.

3.5 CLEANING.

After completion of paving operation, all areas shall be cleaned of excess spilled asphalt A. materials to the satisfaction of Engineer.

3.6 PROTECTION.

- In addition to the requirements for protection stipulated in the governing standards, Contractor Α. shall protect all adjacent concrete and masonry so that no damage will occur as the result of subsequent construction operations. All damage or discoloration shall be repaired to the satisfaction of Engineer before final acceptance by Owner.
- Special care shall be taken to prevent tack or other asphalt materials from spraying or splashing. B. Adjacent construction shall be protected by covering with suitable fabric or paper. d to to to

End of Section

SECTION 32 13 00 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing of labor, materials, and equipment for the construction of portland cement concrete pavements for roadway and parking areas as indicated on the Drawings.

1.2 GENERAL.

- A. Concrete pavement shall be constructed to the lines, grades and cross sections indicated on the Drawings. Type of construction shall be as indicated on the Drawings.
- B. Governing Standards.
 - 1. Except as otherwise specified or indicated, materials, equipment, details, and construction methods shall comply with Illinois DOT Standards.
- C. Coordination.
 - 1. Contractor shall coordinate the construction of concrete paving with excavation, the construction of concrete curb and gutters and other construction.

1.3 SUBMITTALS

- A. Drawings and Data.
 - 1. All submittals of drawings and data, reinforcement bar lists and placement drawings, test data, design mixture reports, field test reports, catalog data sheets; and other data shall be in accordance with the Submittal Procedures section, unless otherwise specified herein.
- B. Certifications.

Contractor shall provide certifications for:

- a. Cement
- b. Fly ash
- c. Admixtures
- d. Membrane curing compound.
- C. Contractor shall provide certifications from the epoxy-coated reinforcement manufacturer verifying that coatings comply with ASTM A775, Annex A1, and that all coated reinforcement complies with ASTM A775 or A884 and with this specification at the time of shipment.

PART 2 - PRODUCTS

2.1 MATERIALS.

A. Except as modified herein, materials shall conform to the requirements of the governing standard. The source of materials shall be acceptable to the Engineer.

Jointing materials	Hot-poured elastic joint sealer
	Preformed fiber expansion joint filler
	Preformed sponge rubber
Fly ash	Class F
Reinforcing steel	Epoxy-coated bars
Air entraining mixture	Permitted
Water – Reducer/plasticizer	Permitted
Water – Reducer/retarder admixture	Permitted
Accelerator	Not permitted
Acceptable curing material	Liquid membrane curing compound,
	Polyethlene sheeting

2.2 CONCRETE MIXTURE REQUIREMENTS.

A. All PCC Pavement shall be class PV concrete in accordance with Article 1020.04 of the IDOT standard specifications.

2.3 LIMITING REQUIREMENTS.

A. Concrete materials shall be selected, and concrete shall be proportioned, batched, mixed, and delivered in a manner that will minimize shrinkage and cracking.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION.

1. As a minimum, the full depth of the aggregate subgrade shall be compacted to 95 percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing materials are placed. All subgrade and surfacing shall be sloped toward drains or outer edges.
3.2 PORTLAND CEMENT CONCRETE PAVEMENT.

- A. Unless otherwise specified, the new pavement shall be constructed to the configuration, and to the lines and grades indicated on the Drawings.
- B. All PCC Pavement shall be finished according to Type B final finish as specified by Article 420.09(e) (2) of the IDOT standard specifications.
- C. The concrete shall be placed on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation. The concrete shall be placed as uniformly as possible to minimize the amount of additional spreading necessary. Concrete shall be placed, vibrated, and finished as specified in the governing standard.
- D. Forms.
 - 1. All forms shall be in good condition, clean, and free from imperfections. Forms shall be in conformance with the Governing Standard.
- E. Reinforcement Placement.
 - 1. Reinforcement shall be placed as indicated on the Drawings and in conformance with the governing standard.
- F. Repair of Epoxy Coating.
 - 1. When epoxy-coated reinforcing bar is specified, before placing epoxy-coated reinforcement in the work, Contractor shall repair all damaged epoxy coatings and shall check the coating for holidays in accordance with the procedures set forth in ASTM A775. All reinforcement shall be free of holidays prior to placement in the work.
 - 2. Damaged epoxy coating shall be repaired as recommended by the manufacturer using patching material provided by the manufacturer and conforming to ASTM A775, Annex A1.
 - 3. Coatings damaged by handling and placing after onsite testing shall be repaired as specified. The maximum amount of damaged coating shall not exceed 0.5 percent of the surface area of each bar.
 - 4. After completion of welding on epoxy-coated reinforcement, when acceptable to Engineer, damage to the coating shall be repaired as specified. All welds and steel splice members, including mechanical connections when used to splice bars, shall be coated with the same material as used to repair coating damage.
- G. Curing and Protection.
 - 1. The finished concrete shall be cured and protected as specified in accordance with governing standard.
 - 2. Traffic shall not be allowed on the newly constructed pavement until it has attained the strength requirements specified in the governing standard, or as otherwise stipulated herein.

- H. Temperature Requirements.
 - 1. Temperature requirements relating to concrete work shall be in accordance with the governing standard.

3.3 JOINTS.

- A. Joints generally shall be formed at right angles to the true alignment of the pavement and to the depths and configuration specified by the Governing Standard or as modified by the Drawings and Specifications.
- B. Expansion, contraction, transverse construction, and longitudinal pavement joints shall be constructed at the locations indicated on the Drawings.
- C. Only longitudinal joints shall be sealed with an approved joint sealer applied in accordance with the manufacturer's directions within a time frame as indicated by the Governing Standard.

3.4 BACKFILL.

A. The time lapse for form removal and backfilling shall be in accordance with the Governing Standard.

3.5 CONTRACTOR'S FIELD CONTROL TESTING.

- A. Field control testing shall be performed in accordance with the governing standard.All QC/QA testing shall be in accordance with Check Sheet #23 IDOT special provision for Quality Control / Quality Assurance of concrete mixers. All testing requirements and frequencies that are specified in this section shall be in accordance with those guidelines.
- B. Field control tests, including aggregate gradation, slump, air content, shrinkage tests, and making compression test cylinders, will be performed by Contractor or Contractor's testing laboratory personnel. Contractor shall provide all facilities and the services of one or more employees as necessary to assist with the field control testing.
- C. As stipulated in the Quality Control section, tests required during the progress of the work shall be made at the expense of Contractor.
- D. The frequency specified herein for each field control test is approximate and subject to change by Engineer.
- E. Engineer may require field testing prior to the addition of superplasticizer at the site to determine compliance with the specifications. Field testing after the addition of superplasticizer shall be conducted as specified and as needed to determine that the concrete is in compliance with the specifications. Air tests shall be conducted whenever field tests are conducted.
- F. Slump.
 - 1. A slump test shall be made for each 50 cubic yards of concrete. Slump shall be determined in accordance with AASHTO T119 (ASTM C143).

- G. Air Content.
 - 1. An air content test shall be made on concrete from one of the first three batches mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with AASHTO T152 (ASTM C231) and verified in accordance with ASTM C138.
- H. Unit Weight.
 - 1. A unit weight test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. Unit weight shall be determined in accordance with ASTM C138.
- I. Concrete Temperature.
 - 1. A concrete temperature test shall be made on concrete from the first batch of concrete mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. Concrete temperature shall be determined in accordance with ASTM C1064.
- J. Water-Soluble Chloride Ion.
 - 1. Water-soluble chloride ion testing shall be performed in accordance with ASTM C1218/AASHTO T260.
- K. Compression Tests.
 - 1. One set of four concrete compression test cylinders shall be made each day when 25 to 50 cubic yards of concrete is placed. One additional set of test cylinders shall be made from each additional 50 cubic yards, or major fraction thereof, placed in any one day. One cylinder of each set shall be tested at an age of 7 days and two cylinders of each set shall be tested at an age of 28 days. The other cylinder of each set shall be tested as directed by the Engineer.
 - 2. Test cylinders shall be 6 inches in diameter by 12 inches high and shall be made, cured, stored, and delivered to the laboratory in accordance with AASHTO T23 (ASTM C31) and tested in accordance with AASHTO T22 (ASTM C39).
 - 3. Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the number of the delivery truck or batch, the air content, the slump, the unit weight, and the concrete temperature.
- Σ . \checkmark Test Reports.
 - 1. Five copies of each test report shall be prepared and distributed by the testing laboratory to the Resident Project Representative (two copies), Engineer, Owner, and Contractor, in accordance with the Quality Control section.

3.6 EVALUATION AND ACCEPTANCE OF CONCRETE PAVEMENT.

- A. Concrete pavement will be evaluated for compliance with all requirements of the specifications. Concrete strength criteria will be used for evaluation and acceptance of the concrete. The results of all tests performed on the concrete and other data and information concerning the procedures for handling, placing, and curing concrete will be used to evaluate the concrete for compliance with the specified requirements.
- B. Compression Test Evaluation.
 - 1. Compressive strength test results will be evaluated for compliance with the specified strength requirements and the specified requirements that relate to durability.
 - 2. Strength. The strength level of the concrete will be considered satisfactory when the averages of all sets of three consecutive strength tests equal or exceed the specified compressive strength, f'_c, and no individual strength test result falls below the specified compressive strength by more than 500 psi.

End of Section

SECTION 32 16 16 - CONCRETE SIDEWALK, CURB, AND GUTTER

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the construction of concrete sidewalks, curb and gutter. This section also covers the reconstruction of concrete sidewalks, curb, and gutter.
- B. Subgrade preparation shall be as indicated in the Excavation and Fill for Structures section, unless otherwise specified in the governing standards or herein.

1.2 GENERAL

- A. All existing sidewalks, and curb and gutters disturbed or damaged during construction of new work or indicated on the Drawings to be demolished and replaced shall be reconstructed to the lines, grades, and cross sections indicated on the Drawings. Damaged curbs, sidewalks and/or gutters shall be to restore to their original locations, cross sections, and style unless indicated otherwise on the Drawings.
- B. Contractor shall be responsible to remove, construct, reconstruct, and adjust as necessary all existing or new manhole tops, curb and gutter, and area drainage structures to match new grades as needed.

C. Governing Standards

- 1. Except as otherwise specified or indicated on the Drawings, materials, equipment, details, and construction methods shall comply with the applicable standards mentioned below:
 - a. ASTM: American Society for Testing and Materials
 - b. AASHTO: American Society of State Highway and Transportation Officials
 - c. CRSI: Concreting Reinforcing Steel Institute
 - d. NCRMA: National Ready Mixed Concrete Association
 - e. IDOT: Illinois Department of Transportation

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Except as otherwise modified herein, materials shall conform to the requirements of the governing standards.
- B. PCC mixtures for all sidewalk and curb and gutter shall be class SI concrete in accordance with Article 1020.04 of the IDOT standard specifications.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. As a minimum, the full depth of the aggregate subgrade shall be compacted to a 95 percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing, curb and gutter, or sidewalk materials are placed. All subgrade and surfacing shall be sloped as indicated on the Drawings, and as needed to achieve a uniform slope between new and existing surfaces. Sidewalks shall slope toward one edge.

3.2 CONCRETE SIDEWALKS

- A. Concrete shall be placed, vibrated, and finished as described in the governing standards.
- B. One-half inch expansion joints shall be provided where sidewalks abut a curb, structure, existing sidewalk, at changes in directions, and at intervals of not more than 40 feet. Expansion joints shall be filled to within 3/4 inch of the surface with bituminous expansion joint material, and then filled flush to the surface with self-leveling caulking in accordance with the Joint sealant section. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.
- C. Concrete sidewalks shall be screeded to the proper elevation and contour. All aggregates shall be completely embedded in mortar. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface. A second floating at the time of initial set shall follow initial floating.
- D. Floated surfaces shall be given a light broom finish, using a horsehair broom, to provide a nonslip surface. Brooming shall be at right angles to the length of the curb, walk, or gutter.
- E. New sidewalks shall be edged to match existing sidewalks.
- F. Sidewalks shall be edged using a 3 to 4 inch wide edging tool with a 1/8 inch corner radius. Edger lap marks at corners of each slab shall be carefully removed. False joints shall be provided at right angles to the length of the walk, using a grooving tool with 1/8 inch radius and a depth of 1.2 inch. The finished edge on each side of the joint shall be the same width as the edging tool used. False joints shall divide each sidewalk into square sections.
- G. The finished surface of all sidewalks shall be neat in appearance, shall be sloped to drain, and shall not pond water.
- H. The finished concrete shall be cured and protected as stipulated in the governing standards.

3.3 CONCRETE CURB AND GUTTER

- A. New concrete curb and gutter shall be as indicated on the Drawings and specified herein. Replacement concrete curb and gutter shall match the existing curb and gutter. Unless otherwise authorized by Engineer, adjacent and enclosed curbs, drainage structures, and gutters shall be placed before placement of pavement sections.
- B. Expansion and contraction joints shall be formed at right angles to the alignment of the curb and/or gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards. One half inch wide expansion joints shall be placed full depth using a premolded expansion joint material, cut to the configuration of the full size of the section, being secured so that they are not moved by depositing, compacting or finishing the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch radius.
- C. Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet.
- D. Contraction joints shall be a minimum of 3 inches deep on all sides, shall be spaced at approximately 15 foot intervals, and shall be formed by a 1/8 inch thick steel template, cut to the configuration of the section. These templates shall be secured so they are not moved by depositing, compacting or finishing the concrete.
- E. Unless otherwise indicated on the drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch.
- F. All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.
- G. Forms
 - 1. Forms shall be in conformance with the governing standards. All forms shall be in good condition, with not more than 1/8 inch variation in horizontal and vertical alignment for each 10 feet in length. Side forms shall have a depth at least equal to the edge thickness of the concrete being formed. The forms shall be set true to line and grade and shall be adequately supported to stay in position while depositing and consolidating the concrete. Forms shall be designed and constructed so as to permit their removal without damage to the concrete.

1.

Expansion and contraction joints shall be formed at right angles to the alignment of the curb and gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards.

a. <u>Expansion Joints</u>. One half inch wide expansion joints shall be placed full depth using a premolded expansion joint material, cut to the configuration of the full size of the Curb and Gutter section, being secured so that they are not moved by depositing and compacting the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch radius.

Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet .

b. <u>Contraction Joints</u>. Contraction joints shall be a minimum of 3 inches deep on all sides, shall be spaced at approximately 15 foot intervals, and shall be formed by a 1/8 inch thick steel template, cut to the configuration of the Curb section. These templates shall be secured so that they are not moved by depositing and compacting the concrete.

Unless otherwise indicated on the Drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch.

2. All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

I. Finishing

1. Curb and gutter shall be finished to the shape indicated on the Drawings. After the forms have been removed, all exposed edges shall be rounded, using an edging tool with a 1/8 inch corner radius. Exposed surfaces shall be float finished and given a light broom finish applied at right angles to the curb at the time of initial set, using a horsehair broom. Mortar or dryer shall not be used to remove imperfections. In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The finished curb shall have a true surface, free from sags, twists, or warps; shall have a uniform appearance; and shall be true to the original lines, grades, and configurations indicated on the Drawings.

3.4 **PROTECTION**

- A. In addition to the requirements for protection set forth in the governing standards, Contractor shall protect all adjacent concrete and masonry so that no damage will occur as the result of subsequent construction operations. All damage or discoloration shall be repaired to the satisfaction of Engineer before final acceptance by Owner.
- B. Special care shall be taken to prevent bituminous materials from spraying or splashing. Adjacent construction shall be protected by covering with suitable fabric or paper.

End of Section

SECTION 32 92 21 - SEEDING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers seeding to be performed after backfilling and final grading are complete. All areas disturbed by construction operations shall be treated as specified herein.

1.2 GENERAL

- A. Governing Standard
 - 1. The governing standard will be Class 1 seed with fertilizer in accordance with Article 250 of the IDOT standard specifications.
- B. Experience
 - 1. All Work shall be performed by a licensed landscaping Contractor who is licensed in the State of Illinois.
 - 2. Work shall be performed by a contractor acceptable to the Engineer, with at least four years seeding experience.

C. Completion

- 1. Seeding Work shall be completed for the planting seasons as follows:
 - a. Spring planting season:
 - 1) Seed: April to June 15
 - b. Fall planting season:
 - 1) Seed: August 1 to November 15
 - c. Dormant Seeding: October 21 to November 15 (Soil at 1"<50 degrees Fahrenheit), seed with cover crop of winter wheat at 100 pounds per acre.
 - d. Perform planting of seed or placement of sod only when weather conditions and soil conditions are acceptable.
 - Planting season limits may be changed when approved by Engineer.
 - At Owner's option, a portion of the final payment not to exceed one (1) percent of the contract price may be retained until an acceptable stand for all grass/ground cover is established. Seeding requirements are as follows:
 - a. Locations to be seeded, all areas disturbed by the Work.

1.3 SUBMITTALS

- A. Soil Test
 - 1. Soil shall be tested to determine nutrient needs by the state Extension Service or an independent agricultural soil testing lab. Composite sample(s) shall be collected and submitted in accordance with lab instructions. Lab report and nutrient recommendations shall be provided to the Engineer.
- B. Invoices and Analysis Labels
 - 1. A copy of supplier's invoices for all seed, mulch, and fertilizer which shows the quantity by weight purchased for the project and representative labels bearing the manufacturer's or vendor's guaranteed statement of analysis shall be submitted to Engineer for review and approval to assure compliance with specified requirements for quality and application rates.
- 1.4 GUARANTEE
 - A. Seeding
 - 1. Contractor shall guarantee a uniform stand of seeding, free of weeds to the extent practical, and acceptable to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.
- B. Prior to use, all products shall be kept dry and in a weatherproof location so that their effectiveness will not be impaired.

PART 2 - PRODUCTS

2.1 MATERIALS

All materials shall conform to the requirements of the Governing Standard, except where otherwise specified.

- B. Starter Fertilizer
 - 1. Fertilizer shall be in accordance with Article 1081.08 of the IDOT standard specifications

- C. Seed
 - 1. The seed shall be Class 1 in accordance with Article 250.07 and Article 1081.04 of the IDOT standard specifications.
 - 2.
 - 2. Weed content shall not exceed 0.25%
- D. pH Adjustment
 - 1. If laboratory soil testing indicates the need for increased soil pH the Contractor shall add agricultural lime as a soil amendment. Addition rate(s) shall be determined by analysis of soil sample(s) subjected to laboratory testing. Addition rate(s) shall be as recommended by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer. If laboratory soil testing indicates the need for decreased soil pH the Contractor shall add agricultural sulfur, aluminum sulfate or iron sulfate as a soil amendment. Addition rate(s) shall be determined by analysis of soil sample(s) subjected to laboratory testing. Addition rate(s) shall be as recommended by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer Service guidelines and/or local horticultural agencies and as approved by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer
- E. Topsoil
 - 1. Topsoil shall be fertile, natural soil, typical of the locality, free from stones, roots, sticks, clay, peat, weeds, and sod, and obtained from naturally well drained areas. It shall not be excessively acidic or alkaline nor contain toxic material harmful to plant growth. Stockpiled topsoil may be used but the Contractor shall furnish additional topsoil at his own expense if required.

F. Erosion control blanket

1. All newly seeded area shall be finished with erosion control blanket in accordance with Articles 251.04 and 1081.10 of the IDOT standard specifications.

PART 3 - EXECUTION

3.1 GENERAL

- A. Execution of seeding Work shall conform to the Governing Standard, or shall be as specified herein, whichever is the most stringent.
- B. Clearing
 - 1. Prior to finish grading, areas to be seeded or sodded shall be cleared to remove stumps, stones larger than 3 inches, roots, cable, wire, debris or other materials that might hinder seeding and future turf maintenance.

- C. Finish Grading
 - 1. Seeding shall not be started until all earthwork has been substantially completed. Backfills and fills shall be allowed to settle, the topsoil spread, and finish grading completed before the Work is started. Finish grading shall result in a surface conforming to the contours indicated on the Drawings.
- D. Application of Fertilizer and pH Adjustment
 - 1. After finish grading, any fertilizer or chemicals for pH adjustment specified shall be applied uniformly to areas to be seeded.
 - 2. Fertilizer application rate shall as follow:
 - a. Before seeding, apply 6-24-24 fertilizer at a uniform rate of 2 lbs/1000 sq. ft.
 - b. After completion of required interim mowing, apply 18-5-9 fertilizer at rate of 15 lbs/1000 sq. ft.
 - 3. Chemicals for pH adjustment shall be applied at a rate based on a soil test for pH. The rate shall be adequate to neutralize the soil.
- E. Final Preparation
 - 1. Following application of additives and/or fertilizers the areas to be seeded and/or sodded shall be tilled to a true depth of 6 inches by disking, harrowing, or other accepted methods to thoroughly incorporate the additives and fertilizer, destroy vegetation, and pulverize the soil. After tilling, the bed shall be smoothed by dragging or floating. The surface shall be cleared of all stones, stumps or other objects larger than 1-1/2 inches in thickness or diameter; roots, wire, grade stakes, and other objects that might hinder future turf maintenance operations.
 - 2. When results are not satisfactory because of drought, excessive moisture or other causes, the Work shall be stopped until such conditions have improved or have been corrected.
 - 3. When possible, operations shall be performed parallel to the contour lines and operations uphill and downhill shall be avoided.
- 3.2 SEEDING

Seed Application

1. Seed shall be applied within 72 hours after preparation of the seedbed. Seed shall be applied with equipment designed to give uniform application. Any method or combination of methods which uniformly distributes the seed directly in contact with the soil, covers the seed, and firms the bed, may be selected. Seed shall be placed approximately 1/4 inch below the surface at a rate of 5 lbs/ 1000 sq ft.

- B. Erosion control blanketing
 - 1. All seeded areas shall be erosion control blanketed within 24 hours following seed application. The operation shall be in accordance with the Governing Standard.

3.3 WATERING

- A. Seeded Areas
 - 1. Watering for seeded areas will not be required.

3.4 REPLANTING

- A. Seeded Areas
 - 1. Unacceptably seeded areas shall be overseeded or completely reseeded as instructed by Engineer. Unless otherwise permitted by Engineer, reseeding shall be performed during the next planting season.

3.5 MAINTENANCE

- A. All areas shall be maintained until final acceptance of the project.
- B. Seeded Areas

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1. Maintenance shall include any necessary reseeding, repair of erosion damage, and replacement of displaced mulch until covered with seedlings. In the event erosion occurs from either watering operations or rainfall, such damage shall be repaired.

End of Section

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SECTION 33 05 14 - MANHOLE AND VAULT COVERS AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the fabrication and erection of iron manhole and vault covers and accessories suitable for installation in manholes, vaults, slabs, electrical handholes, and other applications where a floor access hatch is not required. Manhole steps (suitable for both cast-inplace and epoxy grouted installations) are also included. For floor access hatches and doors see the specification section of the same name.
- B. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1.2 SUBMITTALS

- A. Drawings and Data
 - 1. Complete data, detailed drawings, and setting or erection drawings covering all materials shall be submitted in accordance with the Submittal Procedures section. Each separate piece shall be marked.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Materials shall be stored on blocking and protected from the weather so that no metal touches the ground and water cannot collect thereon.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials work shall be fabricated in conformity with dimensions, arrangements, sizes, and weights or thicknesses as specified or as indicated on the Drawings.

- B. All members and parts shall be free of warps, local deformations, and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. All field connection materials shall be furnished.
- C. The following Owner lettering shall be cast into the covers: FRSA

2.2 DESIGN REQUIREMENTS

- A. Manhole and electrical vault covers and frames shall be cast iron assemblies specifically intended as covers. Manufacturer, product number, and type shall be as specified.
- B. All covers and frames shall be capable of carrying an AASHTO HS-20 street loading unless specifically indicated as light duty. An equivalent heavy duty cover and frame may be substituted for the indicated light duty cover and frame.

2.3 MATERIALS

A. Materials, appurtenances, and finishes used in the manufacturer of manhole and electrical handhole covers and frames shall be as indicated. Unless otherwise required, materials, appurtenances, and finishes shall be the manufacturer's standard for the type of each cover indicated.

Circular Covers and Frames

Light Duty

Heavy Duty (Subject to Vehicular Traffic)

Rectangular Covers and Frames

Light Duty

Square

Rectangular

Heavy Duty (Subject to Vehicular Traffic)

> Square Rectangular

Manhole Steps

Cast iron; Clay & Bailey "2020," Neenah "R-1737," or equal.

Cast iron; Clay & Bailey "2008BV," Neenah "R-1736," or equal.

Cast iron; Neenah "R-6660," or equal.

Cast iron; Neenah "R-6661," or equal.

Cast iron; Neenah "R-6662," or equal.

Cast iron; Neenah "R-6663," or equal.

Steel-Reinforced Plastic Manhole Steps; MeadowBurke "BOWCO No. 93813" or M.A. Industries "PS2-PF" or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prior to installation all loose rust shall be removed from castings and one coat of coal tar epoxy shall be applied to surfaces embedded in concrete. Materials shall be erected and installed in conformity with the dimensions and arrangements specified or indicated on the Drawings and as recommended by the manufacturer.
- B. After erection covers and frames shall be cleaned. Product finishes damaged during erection, shall be repaired as recommended by the manufacturer.

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BV Project No. 411752 12/20/2022 End of Section

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SECTION 33 14 00 - PIPELINE PRESSURE AND LEAKAGE TESTING

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers field hydrostatic pressure and leakage testing of piping. The term "piping" shall be used in this section to refer to piping systems, pipelines, or sections thereof.
- B. Testing of other piping is covered in the Sewer Pipe Installation and Testing section and Miscellaneous Piping and Accessories Installation section. Cleaning and disinfection of piping is covered in the Cleaning and Disinfection of Water Pipelines section.

1.2 GENERAL

- A. Contractor shall coordinate pressure and leakage testing with adjacent work as necessary to preclude work interferences or duplication of effort and to expedite the overall progress of the work.
- B. Contractor shall provide all necessary piping, piping connections, temporary valves, backflow preventers, and all other items of equipment or facilities necessary to complete the pressure and leakage testing.
- C. In all cases where it is necessary to interrupt service, permission of Owner shall be obtained at least two days before the service will be interrupted. In all cases where it is necessary to interrupt service to water customers, permission of the Owner shall be obtained and each customer affected shall be notified of the proposed service interruption and its possible duration in accordance with the Project Requirements section.
- D. Contractor shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of water used for pressure and leakage testing and to identify acceptable locations for disposal of the water. All requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be responsibility of Contractor.
- E. Engineer or Engineer's representative shall be present during testing and shall be notified of the time and place of testing at least 3 days prior to commencement of testing. All testing shall be performed to the satisfaction of Engineer, and in accordance with all governing standards and regulations.
- F. Testing Schedule and Procedure
 - 1. A testing schedule and procedure shall be submitted to Engineer for review and acceptance not less than 21 days prior to commencement of testing. The schedule and procedure shall include, but not be limited to the following information for each pipe section to be tested:

- a. limits of each pipe test section;
- b. proposed time and sequence;
- c. physical locations and set positions of all valves;
- d. locations of temporary bulkheads, stops, caps, restraints, supports, and other temporary equipment needed;
- e. manner of filling and source of water;
- f. method and location of metering volumes;
- g. method and location of gauging pressures; and
- h. method and location of disposal of test water.
- G. Special Testing Requirements
 - 1. Special testing requirements include the following:
 - 2. Water for filling the pipeline from the Owner's existing facilities shall be coordinated with the Owner and may not be available during the Owner's high water demand season from approximately June 15 to September 15.
 - 3. Unless otherwise acceptable to Engineer, the general sequence of work for each pipeline, or valved or bulkheaded section thereof, shall be as follows:
 - a. Initial cleaning and flushing of pipeline.
 - b. Filling pipeline.
 - c. Hydrostatic pressure and leakage testing.
 - 4. Unless otherwise acceptable, during testing of the pipeline, all valves, except for auxiliary hydrant valve(s), shall be in the open position. All auxiliary hydrant valve(s) shall be closed during pressure testing so that the test pressure is not applied to the hydrant valve(s)
 - 5. Unless otherwise acceptable, temporary bulkheads shall be provided during testing so that the test pressure is not applied to existing or new valves and hydrants, or to existing water lines, or to any portion of water lines installed under this Contract that have already been put into service.
 - 6. Unless otherwise acceptable, a temporary pressure gauge shall be installed at each end of the limits of the pipeline to be tested.

Unless otherwise acceptable, tests shall be conducted before connections are made to existing water lines, or to any portion of water lines installed under this Contract that have already been put into service.

- 8. Unless otherwise acceptable, upon completion of testing and disinfection, connections made to existing water lines or to any portion of water lines installed under this Contract that have already been put into service, and any other portion of the pipeline not subject to the pressure test, shall be visually inspected for leakage after placing the water line into service and before backfilling the connection.
- **9.** If testing is permitted against a valve, the maximum differential test pressure across the valve seat (gate) in the closed position shall not exceed the drip-tight rated pressure of the valve.

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- H. Water
 - 1. Water for testing shall be furnished as stipulated in the Temporary Facilities section. Following completion of testing, the water shall be disposed of in accordance with the requirements of regulatory agencies and in a manner acceptable to Engineer.

1.3 **SUBMITTALS**

- Test Procedures and Plans A.
 - Test plans and procedures shall be submitted as outlined in the GENERAL section of this 1. specification.
- Test Results and Reports Β.
 - Test results and reports shall be submitted as outlined in the GENERAL section of this 1. specification. Adins

PART 2 - PRODUCTS

2.1 **TEST EQUIPMENT**

- All necessary connections between the piping to be tested and the water source, together with A. pumping equipment, water meter, pressure gauges, backflow prevention, and all other equipment, materials, and facilities required to perform the specified tests, shall be provided. All required blind flanges, valves, bulkheads, bracing, blocking, and other sectionalizing devices shall also be provided. All temporary sectionalizing devices shall be removed upon completion of testing. Vents shall be provided in test bulkheads where necessary to expel air from the piping to be tested.
- Test pressure shall be applied by means of a force pump sized to produce and maintain the B. required pressure without interruption during the test.
- C. Water meters and pressure gauges shall be accurately calibrated and shall be subject to review and acceptance by Engineer.
- D. Permanent or temporary gauge connections shall be installed at each location where test gauges are connected to the piping during the required test. Drilling and tapping of pipe walls will not be permitted. Upon successful completion of testing, each permanent gauge connection shall be fitted with an isolation valve and a permanent gauge, and each temporary gauge connection, if used, shall be fitted with a permanent sealed plug or cap acceptable to the Engineer.
- E. Permanent or temporary fill and vent connections shall be installed as needed for the required test. Drilling and tapping of pipe walls will not be permitted. Upon successful completion of testing, each permanent fill and vent connection shall be fitted with the permanent fill or vent piping, and each temporary fill and vent connection, if used, shall be fitted with a permanent sealed plug or cap acceptable to the Engineer.

PART 3 - EXECUTION

3.1 FILLING AND VENTING

A. Before filling the piping with water, care shall be taken to ensure that all air release valves and other venting devices are properly installed and operating properly. Hand-operated vent valves shall not be closed until an uninterrupted stream of water is flowing from each valve. The rate of filling the piping with water must not exceed the venting capacity of the installed air vent valves and devices.

3.2 BLOCKING AND BACKFILLING

A. Piping shall be adequately blocked, anchored, and supported before the test pressure is applied. Underground piping identified in the Plant Piping Test Pressure Schedule shall be tested before the joints are covered. All other piping may be tested after backfilling.

3.3 PRESSURE TESTING

- A. After the piping to be tested has been filled with water, the test pressure shall be applied and maintained without interruption within plus or minus 5 psi of test pressure for 2 hours plus any additional time required for Engineer to examine all piping being tested and for Contractor to locate any defective joints and pipe materials. The test pressure shall be in accordance with the requirements specified for pipeline or plant piping.
- B. Plant Piping Test Pressure
 - 1. Piping shall be subjected to the test pressure as indicated in the Plant Piping Test Pressure Schedule.

3.4 PLANT PIPING LEAKAGE TESTING

A. All plant piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

End of Section

Schedule 33 14 00-S01 Plant Piping Test Pressure Schedule

Process Code	Service	Test Pressure
		psig
AGSE	AGS Effluent	20
AGSI	AGS Influent	20
AIR	Air Low Pressure (in-plant and exposed up to reactors)	20
AIR	Air Low Pressure (at reactors)	20
DR	Drain	20
PD	Sump Pump Discharge	20
NPW	Plant Water	100
WAGS	Waste Activated Granular Sludge	20
WLC	Water Level Correction	20
WAGS/WLC	Combined WAGS/WLC Pump Discharge	50
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SECTION 33 39 13 - SANITARY UTILITY SEWERAGE MANHOLES, FRAMES, AND COVERS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of standard and drop sewer manholes. Standard and drop manholes shall be constructed complete with covers, steps, fittings, and other appurtenances, in accordance with the details in the figures at the end of this section.
- B. Where required, special manholes shall be constructed in accordance with the details indicated on the Drawings.
- C. Steps, frames, and covers for structures other than sewer manholes are covered in other sections.

1.2 GENERAL

- A. At the option of Contractor, standard and drop manholes may be constructed with cast-in-place concrete bases or precast concrete (developed) bases as indicated on the figures.
- B. Only manholes which are required to have inside/outside pipe and fittings for dropping sewage into the lower line will be designated as drop manholes. Inside drop manholes where the incoming line discharges directly into the manhole and which do not require special fittings will be considered standard manholes.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Drawings and data covering precast concrete sections and castings shall be submitted in accordance with the Submittal Procedures section.
- B. Manhole Step Submittals



When steel-reinforced plastic manhole steps are specified, data submitted shall include verification of the type and grade of steel used for step reinforcement, typical chemical analysis of the steel, type and classification of the plastic, and reports of acceptance tests performed in accordance with ASTM C478, Section 16, and C497, Section 10.

- C. Corrosion Protection Submittals
 - 1. When corrosion protection systems are specified, data submitted shall include corrosion protection materials, method of application, maintenance requirements, and other pertinent data.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.
- B. Precast concrete sections shall not be delivered to the job until representative concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.
- C. Precast concrete sections shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces.

PART 2 - PRODUCTS

2.1 **MATERIALS**

Precast	Concrete	Manholes	and	ASTM C478, except as modified herein.
Reinforcement				
Cen	nent			Cement type shall comply with ASTM C150,

Type I or II. Water-cementitious materials

materials proposed by Contractor that will provide equivalent corrosion protection and durability may be submitted subject to review

Shape shall be eccentric as required; wall

Materials, handling, forms, finishing, curing, and other work as specified in the cast-in-place

L&M "Crystex", BASF Master Builders

"Masterflow 713 " or "Set Grout", Sauereisen Cements "Grout No. F-100 Level Fill Grout", ,

Butyl rubber compatible with resilient

ASTM C990; Hamilton-Kent "Kent-Seal No.

2", , or Henry Company "Ram-Nek". Crosssectional area as recommended by manhole

or Five Star Products "Five Star Grout".

A-LOK Premium manhole pipe seal.

Alternative

ratio shall not exceed 0.40.

and acceptance by Engineer.

Circular, with shear keys.

concrete section.

connector material.

manufacturer.

Circular, uniform outside diameter.

1/12 of inside diameter, plus 1 inch.

thickness as specified for riser sections.

Riser and Precast Base Minimum Wall Thicknes

Cone

Adjusting Rings Cast-in-Place Concrete Bases

Non-shrinking Grout

Resilient Manhole/Pipe Connectors

Mastic Fill

Gaskets

Mastic

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Rubber	ASTM C361, Section 6.9, except gasket shall be synthetic, with hardness of 40 ± 5 when measured by ASTM D2240, Type A durometer. Natural rubber will not be acceptable.
Rubber Joint Filler	Synthetic.
Hardness	40 ± 5 when measured by ASTM D2240, Type A durometer.
Tensile Strength	1,200 psi minimum.
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300M", or Tnemec "46H-413 Hi-Build Tneme-Tar".
Corrosion Protection System	As specified herein.
Castings	ASTM A48, Class 35B or better.
Manhole Rings and Covers	Clay and Bailey "No. 2032" or Neenah Foundry /"R-1769-A".
Manhole Steps	λO^{μ}
Steel-Reinforced Plastic Manhole Steps	MeadowBurke "BOWCO No. 93813" or M.A. Industries "PS2-PF"; 1/2 inch deformed steel bar ASTM A615 Grade 60 minimum totally

Industries "PS2-PF"; 1/2 inch deformed steel bar, ASTM A615, Grade 60 minimum, totally encapsulated in copolymer polypropylene, ASTM D4101.

2.2 MANUFACTURE

- A. The first riser sections for use with cast-in-place bases shall be provided with horseshoe-shaped boxouts for connecting piping to be grouted in, or with circular openings with continuous, circular, resilient connectors cast into the riser wall. Boxouts for grouting, if used, shall have surfaces grooved or roughened to improve grout bond.
- B. Precast base sections shall be provided with circular openings, with continuous, circular, resilient connectors cast into the wall.
- C. Resilient connectors shall be installed in accordance with the manufacturer's recommendations, except that connectors shall be positioned so that sealing or resealing operations may be accomplished from inside the manhole.
- D. Precast sections may be provided with lifting notches on the inside faces of walls to facilitate handling. Lifting notches shall be not more than 3 inches deep; holes extending through the wall will not be acceptable.
- E. If precast concrete base sections are used, part of the concrete invert fill may be furnished with the precast unit; however, a rough surface shall be provided to improve bond with the final invert fill. At least the top 2 inches of the concrete invert fill shall be installed in the field.

PART 3 - EXECUTION

3.1 INSPECTION

A. Precast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units shall be rejected.

3.2 CONSTRUCTION

A. Bases

- 1. If cast-in-place concrete bases are used, concrete shall be placed on undisturbed earth in accordance with applicable requirements of the Concrete section.
- 2. If precast concrete (developed) bases are used, the subgrade materials shall be excavated to undisturbed earth and to a uniform elevation which will permit at least 4 inches of granular embedment material, as specified in the Excavation and Fill for Structures section, to be installed and compacted. The surface of the granular material shall be carefully graded and the base section accurately set so that connecting pipes will be on proper line and grade. The elevation of the granular material shall be adjusted until proper grade and alignment of the base section has been attained.
- 3. No wedging or blocking under precast concrete bases will be permitted.
- 4. When resilient connectors are used with cast-in-place bases, the concrete fill under the connecting pipe outside the manhole shall be deleted and shall be replaced with granular embedment material to undisturbed earth.
- 5. In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with a radius of curve as large as practicable. All inverts shall be troweled to a smooth, clean surface.
- B. Riser and Cone Sections and Precast Concrete Adjusting Rings
 - 1. Circular precast sections and rings shall be provided with a rubber or mastic gasket to seal joints between sections and rings. Mastic gaskets shall be used only at temperatures recommended by the manufacturer. Lifting notches in manhole walls shall be filled with non-shrinking grout.



Steel-reinforced plastic manhole steps shall be provided. Manhole steps shall be plantinstalled and shall be driven into prepared holes or vibrated into green concrete, in accordance with the recommendations of the step manufacturer.

C. Connecting Piping

- 1. The space between connecting pipes and the wall of precast sections shall be completely filled with non-shrink grout, except where resilient connectors are provided.
- 2. When resilient connectors are used, the connecting pipe shall be carefully adjusted to proper line and grade, and the bedding material shall be compacted under the haunches and to the spring line of the pipe for a distance of at least 6 feet from the manhole wall and to at least the minimum trench width. The pipe shall be installed in the resilient connector prior to backfilling outside the manhole and shall be resealed after completion of the manhole and backfill. All visible leakage shall be eliminated.
- 3. The connecting pipe for installation with resilient connectors shall be plain-end, square cut spigots and shall not protrude more than 1 inch inside the manhole wall. A clear distance of at least 1 inch from the end of each connecting pipe and around the pipe shall be provided when the concrete invert fill is installed. After completion of the manhole, the boxout shall be filled with mastic filler material, completely filling the space beneath the pipe and extending to at least the spring line. The filler material shall provide a smooth, uniform surface between the inside diameter of the pipe and the manhole invert.
- 4. At each special manhole, rubber joint filler shall be provided around connecting piping. The filler shall be securely fastened in place with suitable wires or straps.

3.3 EXTERIOR COATING

- A. Dampproofing
 - 1. Before backfilling is started, the outside surfaces of each manhole shall be coated with one heavy coat of damp proofing as specified in the dampproofing section. Surfaces to receive coating shall be dry. Dampproofing may be applied to precast units in the shop. If the shop coating is damaged during construction, a touchup coat shall be applied and allowed to dry prior to backfilling.
- B. Manhole Encapsulation System. Not used

3.4 CASTING COATING

A. Prior to installation, one coat of coal tar epoxy shall be applied to all castings. Before coating, castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the coating is dry and hard.

3.5 STUBS

A. Stubs for future connections shall be provided in manholes at the locations indicated on the drawings. Stubs shall be not less than 3 feet nor more than 4 feet long and shall terminate in a bell with a plug.

End of Section

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SECTION 40 05 05.11 - MISCELLANEOUS PIPING AND ACCESSORIES INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the installation of piping and accessories as indicated on the Drawings for the following piping sections:
 - 1. Miscellaneous Piping and Accessories
 - 2. Stainless Steel Pipe and Alloy Pipe, Tubing, and Accessories
 - 3. Miscellaneous Steel Pipe, Tubing, and Accessories (SCH 40)
 - 4. Miscellaneous Plastic Pipe, Tubing, and Accessories (PVC, PVC-DWV, CPVC, HDPE)
 - 5. Cast Iron Soil Pipe and Accessories
 - 6. Copper Tubing and Accessories for refrigerant tubing only
- B. Contractor shall furnish all necessary jointing materials, coatings, and accessories that are specified herein.
- C. Pipe supports and anchors shall be furnished by Contractor and are covered in the Pipe Supports section. Pipe trenching and backfilling are covered in the Trenching and Backfilling section.

1.2 GENERAL

- A. Coordination
 - 1. Materials installed under this section shall be installed in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by Engineer.

1.3 SÚBMITTALS

Drawings and Data

- 1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Items requiring submittals shall include, but not be limited to, the following:
 - a. Piping material, class, thicknesses.
 - b. Cleaning procedure for water piping.
 - c. Watertight/dusttight pipe sleeves.
 - d. Materials as specified herein.

- B. Welder Certification
 - 1. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified. Copy of certification and identification stamp shall be submitted for each welder. Qualification tests may be waived if evidence of prior qualification is deemed suitable by Engineer.
- C. Spool Drawings
 - 1. Spool drawings indicating the complete line, showing all welded and assembly items, except for insulation shoes or nonstress-relieved lines, shall be developed and submitted for the following services:
 - a. Aeration air.
 - b. WAGS/WLC piping in WAGS/WLC Wetwell.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications
 - 1. All welding procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be submitted to the Engineer for review.

B. Tolerances

- 1. These tolerances apply to in-line items and connections for other lines.
- 2. The general dimension, such as face-to-face, face or end-to-end, face- or end-to center, and center-to-center shall be 1/8 inch.
- 3. The inclination of flange face from true in any direction shall not exceed 3/64 inch per foot.
- 4. Rotation of flange bolt holes shall not exceed 1/16 inch.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.
- B. Plastic pipe, tubing, and fittings shall be stored between 40°F and 90°F.
- C. Coated Pipe
 - 1. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe
shall be stored off the ground on wide, padded skids. Plastic-coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Pipe, tubing, and fittings covered herein shall be installed in the services indicated in the various pipe sections.

2.2 MATERIALS

- A. Threaded Fittings
 - 1. Anti-Seize Thread Lubricant: Jet-Lube "Nikal," John Crane "Thread Gard Nickel," Never-Seez "Pure Nickel Special," or Permatex "Nickel Anti-Seize."
 - 2. Teflon Thread Sealer: Paste type; Hercules "Real-tuff", John Crane "JC-30", or Permatex "Thread Sealant with Teflon."
 - 3. Teflon Thread Tape: Hercules "Tape Dope" or John Crane "Thread Tape."
- B. Solvent Welded Fittings
 - 1. Solvent Cement for PVC Systems: ASTM D2564.
 - 2. Solvent Cement for CPVC Systems: ASTM F493.
 - 3. Primer for PVC Systems: ASTM F656.
- C. Insulating Fittings
 - 1. Threaded: Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene-lined, zinc plated, Perfection Corp. "Clearflow Fittings."
 - 2. Flanged: Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions." Fittings shall be suitable for the fluid and temperature. Insulating flanges in WAGS/WLC Wetwell shall be suitable for chloride concentrations up to 300 mg/L.
 - Pipe Insulation: See Section 40 42 11 Mechanical Insulation.
- E. Watertight/Dusttight Pipe Sleeves: O-Z Electrical Manufacturing "Thruwall" and "Floor Seals," or Thunderline "Link Seals," with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts.
 - 1. Pipe Sleeve Sealant: Polysulfide or urethane, as specified in the Caulking section or as indicated in the Drawings.

- F. Protective Coatings
 - 1. Tape Wrap: ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils 760 μm; Protecto Wrap "200" or Tapecoat "CT."
 - 2. Primer: As recommended by the tape manufacturer.
- G. Refrigerant copper tubing to ASTM B280 suitable for air conditioning. Refer to Section 23 80 00 Refrigeration Systems.

PART 3 - EXECUTION

3.1 INSPECTION

A. All piping components shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 PREPARATION

1. Field Measurement

a. Pipe shall be cut to measurements taken at the site, not from the Drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3.3 INSTALLATION

- A. General
 - 1. All instruments and specialty items shall be installed according to the manufacturer's instructions and with sufficient clearance and access for ease of operation and maintenance.
 - Flat faced wrenches and vises shall be used for copper tubing systems. Pipe wrenches and vises with toothed jaws will damage copper materials and shall not be used. Bends in soft temper tubing shall be shaped with bending tools.
- B. Pipe Sleeves or Wall Pipe
 - 1. Piping passing through concrete or masonry shall be installed through sleeves that have been installed before the concrete is placed or when masonry is laid or shall be cast into the concrete where indicated on the Drawings. Pipe sleeves installed through floors with a special finish, such as ceramic or vinyl composition tile, shall be flush with the finished

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nsk n floor surface and shall be provided with nickel or chromium plated floor plates. Unless otherwise indicated on the Drawings, in all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch nor more than 2 inches above the floor surface, with the projections uniform within each area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the Drawings indicate future installation of pipe, sleeves fitted with suitable plastic caps or plugs shall be provided.

- 2. Holes drilled with a suitable rotary drill will be considered instead of sleeves for piping which passes through interior walls and through floors with a special finish.
- 3. Unless otherwise indicated on the Drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements.
- 4. Piping shall be made dusttight and gastight with special rubber-gasketed sleeve and joint assemblies; with sleeves sealed with modular rubber sealing elements; or by caulking with oakum and polysulfide or urethane sealant, when passing through the following locations:
 - a. Walls below grade
- C. Pipe Joints
 - 1. Pipe joints shall be carefully and neatly made in accordance with the indicated requirements.
 - 2. Threaded
 - a. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed after threading and before assembly to remove all burrs. Unless otherwise indicated, threaded joints shall be made up with teflon thread tape, thread sealer, or a suitable joint compound.
 - b. Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads. Threaded joints in steel piping for chlorine service shall be made up with teflon thread tape or litharge and glycerine paste applied to all male threads.
 - Solvent Welded
 - a. Solvent welded connections shall only be used for PVC or CPVC pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the setting time recommended by the manufacturer. Pressure testing of solvent welded piping systems shall not be performed until the applicable curing

time, as set forth in Table X2.1 of ASTM D2855, has elapsed. Solvent welding shall be performed by bonding operators who have met the requirements of ASME B31.3 and A328.

- 4. Epoxy and Adhesive Bonded
 - a. Epoxy and adhesive bonded joints shall only be used for FRP pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. After joining, either the pipe or the fitting shall be rotated approximately one-half turn to uniformly distribute adhesive. A slight fillet of adhesive at the bond line is desirable, but all excess adhesive shall be wiped off immediately. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the curing period recommended by the manufacturer.
- 5. Heat Fusion Bonded

2)

- a. Heat fusion bonded joints shall be used for polyethylene pipe with socket and butt fusion fittings. All joint preparation, cutting, jointing equipment, and jointing procedures shall comply with the pipe manufacturer's recommendations. The heating time, temperature, pressure applied to the joint during bonding, and cooling time shall consistently produce leaktight joints as strong as the pipe being joined.
- 6. Flanged
 - a. Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but shall not be torqued less than the minimum value required by the gasket manufacturer. Flange bolts shall not be so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.
 - b. Flange bolt holes shall be oriented as follows, unless otherwise indicated on the spool drawings:
 - 1) Vertical flange face: Bolt holes to straddle the vertical centerline.
 - Horizontal flange face: Both holes shall be aligned with connecting pipe.

Pipe sealants, thread compounds, or other coatings shall not be applied to flange gaskets unless recommended by the gasket manufacturer for the specified service and approved by Engineer.

- d. Welds at orifice flanges shall have internal surfaces ground smooth to the pipe wall.
- e. Slip-on flanges shall be welded inside and outside. There shall be a distance of approximately 1/16 to 1/8 inch between the edge of the fillet weld and the face of the flange. The seal weld shall be applied so that the flange face shall be free of weld spatter and does not require refacing.
- f. Flat-faced flanges shall be used when mating to Class 125 flanges. Full-face gaskets shall be used with flat-faced flanges and ring gaskets shall be used with raised faced flanges.

- g. Weld neck flanges shall be used with butt-weld fittings. The bore of weld neck flanges shall match the pipe wall thickness.
- h. Insulating joints connecting submerged (buried) piping to exposed piping shall be installed above the maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged (buried) metallic piping shall be isolated from the concrete reinforcement. Insulating flanges shall be tested for electrical isolation after installation and bolt-up but prior to introduction of conducting fluid.
- 7. Welded
 - a. Welding shall conform to the specifications and recommendations contained in the "Code for Pressure Piping", ANSI B31.1.
 - b. Weld cross-sections shall be equal to or greater than the pipe wall thickness. Welds shall be smooth and continuous and shall have interior projections no greater than 1/16 inch. Backing strips or rings shall not be used except with specific prior review by Engineer as to use, material, and design. Root gap inserts that are completely melted and consumed in the weld bead are acceptable only when reviewed in advance by Engineer.
 - c. Stainless steel welding shall be inert gas tungsten are (TIG) or the direct current, straight polarity, inert gas metal arc process (MIG). Refer to Section 40 05 23 Stainless Steel Pipe and Alloy Pipe, Tubing, and Accessories for additional stainless steel welding requirements.
 - d. Carbon steel welding shall be made by the shielded metal arc process.
 - e. For socket weld joints, fully engage the two pipe ends, then separate them by 1/16 inch prior to welding to all space for shrinkage.
- 8. Grooved Couplings
 - a. Grooves for grooved couplings shall be cut with a specially designed grooving tool. Grooves cut in steel pipe shall conform to flexible grooving dimensions, as set forth in AWWA C606, and shall be clean and sharp without burrs or check marks.
- 9. Push-on

a.

Gasket installation and other jointing procedures shall be in accordance with the recommendations of the manufacturer. Each spigot end shall be suitably beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

- 10. Rubber-Gasketed
 - a. Rubber-gasketed joints for hub and spigot type cast iron soil pipe shall have plain spigot ends, without beads. Cut ends of all pipe shall be cut square, beveled, and all burrs shall be removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps for hubless cast iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

- 11. Other Pipe Joints
 - a. Coupled joints in tempered glass pipe, plastic joints in vitrified clay pipe, and other proprietary type joints shall be made in accordance with the manufacturer's recommendations and to the satisfaction of Engineer.
- D. Pipe
 - 1. Pipe shall be installed as specified, as indicated on the Drawings, or, in the absence of detail piping arrangement, in a manner acceptable to Engineer.
 - 2. Piping shall be installed without springing or forcing the pipe in a manner which would induce stresses in the pipe, valves, or connecting equipment.
 - 3. Piping shall be supported in conformance with the Pipe Supports section.
 - 4. Piping shall be connected to equipment by flanges or unions as specified in the various piping sections. Piping connecting to equipment shall be supported by a pipe support and not by the equipment.
 - 5. Water, gas, and air supply piping shall be provided with a shutoff valve and union at each fixture or unit of equipment, whether or not indicated on the Drawings, to permit isolation and disconnection of each item without disturbing the remainder of the system. Air supply piping shall be provided with sectionalizing valves and valved air inlet connections as needed for isolation of portions of the system for periodic testing. Gas supply lines to buildings shall be provided with a shutoff valve and union located above grade immediately outside the building. A capped drip leg shall be provided at the bottom of the vertical riser of gas supply piping adjacent to gas-fired appliances.
 - 6. A union shall be provided within 2 feet of each threaded-end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping adjacent to devices or equipment which may require removal in the future and where required by the Drawings or the Specifications.
 - 7. All air piping shall be graded to points of drainage collection where drip legs and drain valves shall be provided. Air piping shall be sized for the service conditions, with the indicated minimum sizes:

Service	Minimum Size
Air supply	1/2 inch OD
Bubbler drop pipes	3/4 inch

- 8. Water supply piping within structures shall be arranged, and facilities provided, for complete drainage. All piping serving metering equipment shall be uniformly graded so that air traps are eliminated and complete venting is provided.
- 9. Stuffing box leakage from water sealed pumps shall be piped to the nearest point of drainage collection.
- 10. Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a ball type shutoff valve.

- 11. Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.
- 12. In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.
- 13. Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.
- 14. Polyethylene piping shall be installed in accordance with the manufacturer's recommendations. A continuous 12 AWG THHN insulated copper tracer wire shall be placed 6 inches above all portions of the buried pipe, but no more than 18 inches below the ground surface. Where the pipe extends above grade, a 2 foot length of wire shall be coiled and attached to the pipe.
- 15. Piping adjacent to flow sensors shall be installed in accordance with the requirements of the manufacturer of the flow sensor and commonly accepted design practices of the appropriate straight pipe runs both upstream and downstream.
- 16. Drains required for operation are shown on the Drawings. However, vents at all high points and drains at all low points in the piping that are required for complete draining for pressure test may not be shown on these Drawings. Contractor shall add such items as found to be necessary during detail piping design and/or piping installation.
- E. Reducers
 - 1. Eccentric reducers shall be installed flat on the bottom for steam, condensate return and digester gas services.
- F. Valves
 - 1. Isolation valves provided with equipment and instruments shall be located in a manner which will allow ease of access and removal of the items to be isolated. Prior to soldering or brazing valves, teflon and elastomer seats and seals shall be removed to prevent damage.

3.4 PIPING ASSEMBLY

A. General

- 1. Contractor shall only use labor that has been qualified by training and experience to capably perform the specified activities required to accomplish the work in a satisfactory manner
- 2. Any deviations from the Specifications or piping locations shown on the Drawings require prior review and approval by Engineer.

- B. Buttwelded Piping
 - 1. The specification and qualification of weld joints and welders for buttwelded piping shall be in accordance with ASME Boiler Pressure Vessel Code, Section IX, Welding and Brazing. Weld procedure specifications (WPS) and procedure qualification reports (PQR) shall be submitted to Engineer for review and validation of joint design, efficiencies and strength before installation begins.
 - 2. Nondestructive examination (NDE) shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination. The minimum level of NDE shall be as follows:
 - a. 100 percent visual examination of welds by a qualified examiner (per ASME B31.1), and
 - b. Radiographic testing (RT) of 10 percent random sampling of welds.
 - 3. If the Contractor wants to use alternative techniques or intends to apply alternative methods considered equivalent to those indicated herein, a proposal on such techniques or methods shall be submitted in writing to Engineer for review and approval at least 14 days before intended date of use.
 - 4. Welding shall not begin until weld joint and welder qualification submittals have been reviewed and approved. NDE shall be performed before the pressure and leakage testing of the piping. Weld acceptance standards shall be in accordance with ASME B31.1, Chapter VI. If a weld fails the NDE, it shall be repaired and the test repeated at no additional cost to the Owner.

3.5 **PROTECTIVE COATING**

- A. Standard weight steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating.
- B. Where specified in the Miscellaneous Steel Pipe, Tubing, and Accessories section, extra strong steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating or a shop applied tape wrap. Where not specified to be shop coated or wrapped in the Miscellaneous Steel Pipe, Tubing and Accessories section, a tape wrap shall be field applied. The exterior surfaces of all fittings, couplings, specials, and other portions of buried piping not protected with plastic coating shall be tape-wrapped in the field.
- C. All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils. Joints in plastic-coated pipe shall be cleaned, primed, and tape-wrapped after installation.
- D. Joints in galvanized steel piping in underground locations shall be field painted with two coats of coal tar epoxy coating.

- E. Inspection
 - 1. All shop-applied plastic coatings and tape wrap on pipe or fittings shall be inspected for holidays and other defects after receipt of the pipe or fitting on the job and immediately before installation. All field-applied tape wrap on pipe, joints, fittings, and valves shall be inspected for holidays and other defects following completion of wrapping. Inspection of plastic coatings after installation of the pipe or fitting in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged during installation. Holidays and defects disclosed by inspection shall be repaired in accordance with the recommendations of the coating or tape wrap manufacturer, as applicable.
 - 2. The inspection shall be made using an electrical holiday detector. The detector and inspection procedures shall conform to the requirements of Section 4.4 of ANSI/AWWA C209.

3.6 PRESSURE AND LEAKAGE TESTING

A. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. The Contractor shall coordinate this section with the Pipeline Pressure and Leakage Testing section. Piping shall be tested at the indicated pressures:

Service	<u>Test Pressure</u>	Test Medium
Water supply	1-1/2 times working pressure but not less than 120 psi	Water
WAGS/WLC piping	1-1/2 times working pressure but not less than 50 psi	Water
Gas supply	1-1/2 times working pressure but not less than 60 psi	Compressed air
Low Pressure Air	13.2 psig	Compressed air with 100 percent of all oil 0.025 micron and larger removed

- B. Compressed air or pressurized gas shall not be used for testing plastic piping unless specifically recommended by the pipe manufacturer.
- C. Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or other positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped as needed during the testing.
- D. Unless otherwise required by the applicable codes, drainage and venting systems shall be water tested. For water testing, the drainage and venting system shall be filled with water to the level of the highest vent stack. For air testing, the system shall be charged with air to a minimum

pressure of 5 psig. Openings shall be plugged as necessary for either type of test. To be considered free of leaks, the system shall hold the water or air for 30 minutes without any drop in the water level or air pressure.

- E. All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor. Contractor shall give Engineer 5 working days advanced notice of scheduled testing.
- F. All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.
- G. Air Pressure Tests
 - 1. Pressure tests shall be performed on all air piping systems as specified herein to conform to ASME B31.1.
 - 2. The test pressure shall be as specified herein and shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, compressors, blowers, or valves, in the system. The pressure in the system shall gradually be increased to not more than one-half of the test pressure, after which the pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure has been reached. The pressure shall be continuously maintained for a minimum duration of 10 min. It shall then be reduced to the blower rated discharge pressure held for such time as may be necessary to conduct the examination for leakage.
 - 3. Examination for leakage detected by soap bubble or equivalent method shall be made at all joints and connections. The piping system, exclusive of possible localized instances at the compressor, blower, or valve packing, shall show no evidence of leaking.
 - 4. Contractor shall be responsible for ensuring that all air piping is free of leaks. All joints which are found to be leaking shall be repaired and the test repeated.

3.7 CLEANING

- A. The interior of all pipe, valves, and fittings shall be smooth, clean, and free of blisters, loose mill scale, sand, dirt, and other foreign matter when installed. Before being placed in service, the interior of all lines shall be thoroughly cleaned, to the satisfaction of Engineer.
- B. Metal anhydrous ammonia, chlorine and sulfur dioxide piping shall be cleaned as recommended by the gas chemical feed system supplier. All surfaces which may come into contact with gas chemical shall be thoroughly dry and free of oil or grease before being placed in service. The recommended cleaning procedures shall be submitted for review in accordance with the Submittals section.
- C. Tin-lined copper tubing for distribution of distilled water shall be flushed and cleaned with distilled water in accordance with the tubing manufacturer's recommendations.

3.8 ACCEPTANCE

Owner reserves the right to have any section of the piping system which he suspects may be A. faulty cut out of the system by Contractor for inspection and testing. Should the joint prove to be sound, Owner will reimburse Contractor on a time-and-material basis as specified in the Contract. Should the joint prove to be faulty, the destructive test will continue joint by joint in

SECTION 40 05 07 - PIPE SUPPORTS

PART 1 - GENERAL

1.1 **SCOPE**

- This section covers the furnishing and installation of pipe hangers, brackets, supports, bracing, A. anchorage, and the design for the pipe support system for pipes 12 inches and smaller. Pipe support systems for pipes greater than 12 inches in diameter are shown in the Drawings. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories. This section also covers the spacing of expansion joints in pipes 12 inches in diameter and smaller. Expansion joint products and materials are covered in the respective piping sections.
- iater. This section covers pipe supports for the following pipe materials: B.
 - 1. Cast or ductile iron
 - 2. Stainless Steel
 - 3. Steel (Process Air)
 - 4. Copper (other)
 - 5. PVC Schedule 40
 - 6. Polypropylene DWY
 - 7. **PVDF DWV**
 - 8. Cast iron soil pipe
- 1.2 GENERAL
 - A. Contractor shall provide pipe supports, anchors, flexible couplings, and expansion joints for all piping systems. The Drawings indicate pipe supports, anchors, flexible couplings, and expansion joints for pipes larger than 12 inches in diameter, and in special cases for pipes that are 12 inches and smaller. Contractor shall design anchors, pipe supports, expansion joints, and flexible couplings not already shown on the Drawings, in accordance with the requirements specified herein.
 - B. Contractor's design shall include pipe supports, bracing, and anchorage adjacent to expansion joints, couplings, valves, in-line devices, equipment, wyes and tees, or changes in direction as required for dismantling piping, removing valves or other in-line devices, disconnecting piping from equipment, and pipe support, in addition to supports in accordance with the maximum spacing specified herein. The pipe support system design by Contractor shall rigidly support pipe so there is no visible movement or visible sagging between supports. The system shall comply with specified piping code requirements.

- C. Contractor shall not delete or relocate the supports, expansion joints, or couplings indicated on the Drawings without written approval of Engineer.
- D. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all supports furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1.3 SUBMITTALS

- A. General Drawings and Data.
 - 1. Complete data, catalog information, and drawings covering fabricated pipe supports, fabricated inserts, and stainless steel, galvanized, and copper-plated and plastic-coated pipe supports shall be submitted in accordance with the Submittal Procedures section.
- B. Intended Use and Location Schedule.
 - 1. Data shall include a listing of the intended use and general location of each item submitted.
- C. Meteorological and Seismic Certification.
 - 1. When a wind and/or seismic design is required, Contractor shall submit confirmation of compliance with the Meteorological and Seismic Design Criteria section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Unless otherwise indicated, all pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69. Materials of construction for fabricated steel supports are covered in the Structural and Miscellaneous Metals section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.
- B. Unless otherwise specified or indicated on the Drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.

Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

- D. Pipe supports shall be manufactured for the sizes and types of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item. Continuously threaded rod is not acceptable for hanger rods over 12 inches in length.
- E. Unless accepted by Engineer, the use of supports which rely on stressed thermoplastic components to support the pipe will not be permitted.

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- F. Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated.
- G. Supports for brass or copper pipe or tubing shall be copper plated or plastic coated.
- H. Stainless steel supports shall be AISI Type 304 or 316 stainless steel, except for stainless steel supports fabricated by welding which shall be AISI Type 304L or 316L. Only Type 316 or 316L stainless steel supports shall be provided in the WAGS/WLC Wetwell and at the AGS Reactor tanks.
- I. For hot air piping, support material shall match pipe material, or an insulating material suitable for the temperature such as Teflon shall be used.
- J. Hot-dip galvanized supports shall be in accordance with ASTM A153 and A385. Galvanized supports shall be provided in Pipe Galleries and AGS Support Facility for non-potable water piping.
- K. Pipe support types and application shall comply with Table 1.

2.2 WIND AND SEISMIC LOADS

A. Wind and seismic loads for worst case conditions of either full, partially full, or empty pipes shall be considered in the design. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Fastening of supports to existing concrete and masonry shall be in accordance with the Anchorage in Concrete and Masonry section.
- B. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as specified to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as needed to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.
- C. When expansion joints are required, pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required where mechanical couplings are permitted as expansion joints. Guides shall be located on both sides of expansion joints, except where anchors are adjacent to the joint. Unless otherwise indicated on the Drawings, one guide shall be within four pipe diameters from the joint and a second guide within 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for

anchoring pipe against longitudinal forces. Pipe guides shall be provided at locations as recommended by the manufacturer.

- Pipe supports for insulated cold piping systems shall be sized for the outside diameter of the D. insulated pipe, and an insulation protection shield shall be installed between the support and the insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields for piping larger than 2 inches or when needed to prevent crushing of the insulation. Inserts shall be of the same thickness as the adjacent insulation and shall be vapor sealed.
- E. Insulated hot piping systems shall be supported by clevises, clamps, support saddles, or rollers. Pipe clamps shall be attached directly to the pipe. Support saddles and rollers shall be sized for the outside diameter of the insulated pipe, and an insulation protection saddle shall be installed at the support.
- When supports for the FRP piping systems are in contact with less than 180 degrees of the pipe F. surface or when the width of the support is less than one-third the nominal pipe diameter (4 inches minimum), an FRP or steel saddle, shaped to the outside diameter of the pipe, shall be bonded to at least the bottom 120 degrees of the pipe.

3.2 TYPES OF SUPPORTS

The products for pipe supports shall be as indicated in Table 1 for the specified type and size of A. support. Where stainless steel is specified for pipe supports but is not available from the name suppliers for the model specified in Table 1, Contractor shall provide a heavier duty support that is available in stainless steel. A

TAB	LE 1 - TYPES OF S	SUPPORTS
Description and Service	<u>MSS SP 69</u> <u>Type (Note 1)</u>	Specification
Hangers	S	-
2-1/2 inch and smaller pipe		
For hot and cold insulated piping	1	
Clevis	1	B-Line "B3100," Anvil "260" Piping Technology & Products Fig. 83.
Other services		
J-style	5	B-Line "B3690," Anvil "67," Unistrut "J Hanger," or Piping Technology & Products Fig. 67.
Clevis	1	B-Line "B3104," Anvil "260," or Piping Technology & Products Fig. 83.
3 Through 12 inch pipe (Note 3)		
For hot insulated piping		
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Description and Service	<u>MSS SP 69</u> Type (Note 1)	Specification
Double bolt	3	B-Line "B3144," Anvil "295," or Piping Technology & Products Fig. 70.
For cold insulated piping		هر
Clevis	1	B-Line "B3100," Anvil "260," or Piping Technology & Products Fig. 83.
For uninsulated cold piping		
Clamp	4	B-Line "3140," Anvil "212," or Piping Technology & Products Fig. 50.
Clevis	1	B-Line "B3100," Anvil "260," or Piping Technology & Products Fig. 83.
Other services	•	<u>S</u>
Clevis	for	B-Line "B3100" or Anvil "260" for steel pipe; B-Line "B3102," Anvil "590," or Piping Technology & Products Fig. 83 C. L. for cast iron pipe.
Concrete Inserts, Steel		
12 inch and smaller pipe	18	Channel 12 ga, galv, 1-5/8 by 1-3/8 inches, min. 8 inches 200 mm long, anchor lugs on 4 inch centers, at least three lugs, end caps, and filler strip.
Beam Clamps, Malleable Iron or Steel, 12 inch and smaller pipe	21	B-Line "3050" and "3055," Anvil "133" and "134," or Piping Technology & Products Fig. 130 and Fig. 130 (SP).
0	28, 29	Anvil "292" or Piping Technology & Products Fig. 140.
	30	B-Line "3054," Anvil "228," or Piping Technology & Products Fig. 140.
Side Beam Bracket	34	B-Line "B3062," Anvil "202," or Piping Technology & Products Fig. 20L.
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TABLE 1 - TYPES OF SUPPORTS

	<u>MSS SP 69</u>	
Description and Service	Type (Note 1)	Specification
Wall Supports and Frames, Steel, 12 inch and smaller pipe (Note 2)		
Brackets	32	B-Line "B3066," Anvil "195," or Piping Technology & Products Fig. 76.
	33	B-Line "B3067," Anvil "199," or Piping Technology & Products Fig. 76.
Prefabricated channels		12 ga , galv, 1-5/8 inches , with suitable brackets and pipe clamps.
Offset pipe clamp, 1-1/2 inch and smaller pipe		Galv, 1-1/4 by 3/16 inch steel, with 3/8 inch bolts.
Offset pipe clamp, 2 to 3-1/2 inch pipe		Galv, 1-1/4 by 1/4 inch steel, with 3/8 inch bolts.
Floor Supports, Steel or Cast Iron		
6 inch and smaller pipe	37 (with base)	B-Line "B3090," Anvil "259" or Piping Technology & Products Fig. 48.
8 through 12 inch pipe	38	B-Line "B3093," Anvil "264" or Piping Technology & Products Fig. 46.
Pipe Alignment Guides		B-Line "B3281" through "B3287," Anvil "255," or Piping Technology & Products Fig. 6.
Turnbuckles Steel	13	B-Line "B3202," Anvil "230," or Piping Technology & Products Fig. 30.
Hanger Rods, Carbon Steel, Threaded Both Ends, 3/8 inch minimum size		B-Line "B3205," Anvil "140," or Piping Technology & Products Fig. 128.
Weldless Eye Nut, steel	17	B-Line "B3200," Anvil "290," or Piping Technology & Products Fig. 40.
Insulation Protection Saddle	39	B-Line "B3160 Series," Anvil "160 Series," or Piping Technology & Products Fig. 184.

TABLE 1 - TYPES OF SUPPORTS

TABLE 1 - TYPES OF SUPPORTS

Description and Service	<u>MSS SP 69</u> Type (Note 1)	Specification
Insulation Protection Shield	40	B-Line "B3151," Anvil "167," or Piping Technology & Products Fig. 183.

Table 1 Notes:

- 1. MSS SP-69 supports and hangers are illustrated on Figure 1-40 05 17.13.
- 2. Pipe clamps or other devices which rely on the application of a clamping force to the supported pipe in order to maintain the clamp position or location in a prefabricated channel or track will not be acceptable for use with nonmetallic pipe or tubing.
- 3. Alternatively, pipe hangers for 12 inch pipe may be saddle type as indicated on the Drawings.

3.3 SUPPORT SPACINGS

Pipe supports and expansion joints shall be spaced in accordance with Tables 2, 3, 4, and 5. The A. types of pipes to be supported are as specified herein. Table 2 covers spacings for the standard operating conditions specified for each pipe material. Tables 3 and 4 cover PVC and FRP pipe spacings where operating conditions are in excess of the temperature and specific gravity requirements covered in Table 2. Table 5 covers PVC and FRP pipe which carries air or liquids with a specific gravity other than 1.0. Spacing in the tables is the maximum spacing considering gravity loads. Where Contractor's design includes lateral and longitudinal forces due to seismic loads, wind loads, and other forces, the spacing requirement may be less than that indicated in the tables.

TABLE 2 - MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES
AND SERVICES

	Pipe Support Max Spacing	<u>Max Run</u> <u>Without</u> <u>Expansion Joint,</u> <u>Loop, or Bend</u> <u>(Note 1)</u>	Expansion Joint Max Spacing (Note 2)	<u>Type of</u> Expansion
<u>Type of Pipe</u>	feet	teet	teet	Joints
Cast iron or Ductile	15	80	80	Note 6
Steel, for other services				
1-1/4 inch and smaller	7	30	100	Note 3
1-1/2 to 4 inch	10	30	100	Note 3
Over 4 inch	15	80	80	Note 6
Stainless steel				
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		Pipe Support Max Spacing	<u>Max Run</u> <u>Without</u> <u>Expansion Joint,</u> <u>Loop, or Bend</u> <u>(Note 1)</u>	Expansion Joint Max Spacing (Note 2)	<u>Type of</u> Expansion
Type	e of Pipe	feet	feet	feet	<u>Joints</u>
	1-1/4 inch and smaller	7	30	100	Note 3
	1-1/2 to 4 inch	10	30	100	Note 3
	Over 4 inch	15	80	80	Note 3
Cop	per, for services othe	er than hot water ((refrigerant)		
	1 inch and smaller	5		6-2	Note 7
	Over 1 inch	7	50	100	Note 3
Poly	ypropylene DWV	6	~ ~ ~		Note 7
PVI	DF DWV	6			Note 7
Cas	t iron soil pipe	10			Notes 7, 8
PV0 spec	C, Schedule 40, for s cific gravity of 1.0.	ervices at a maxin	mum temperature of	100° F , and a	maximum
	1/8 and 1/4 inch	Continuous Support	20	60	Note 3
	1/2 inch	3-1/2	20	60	Note 3
	3/4 and 1 inch	4	20	60	Note 3
	1-1/4 and 1-1/2 inch	4-1/2	20	60	Note 3
	2 inch	5	20	60	Note 3
	2-1/2 inch	5-1/2	20	60	Note 3
	3 inch	6	20	60	Note 3
~	4 inch	6-1/2	20	60	Note 3
$ \rightarrow $	6 inch	7-1/2	20	60	Note 3
Y	8 inch	8	20	60	Note 3
	10 inch	8-1/2	20	60	Note 3
	12 inch	9-1/2	20	60	Note 3

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

		Max Run		
		Without	Expansion	
		Expansion Joint,	Joint Max	
	Pipe Support	Loop, or Bend	Spacing	Tuna of
	Max Spacing	<u>(Note 1)</u>	(Note 2)	Expansion
Type of Pipe	feet	feet	feet	Joints

Table 2 Notes:

- 1. Unless otherwise acceptable to Engineer, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.
- 2. Unless otherwise acceptable to Engineer, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.
- 3. Expansion joint fittings are specified in the respective piping sections.
- 4. At least two properly padded supports for each pipe section.
- 5. At least one support for each pipe section.
- 6. Expansion joints shall be mechanical couplings.
- 7. No expansion joints are required.
- 8. Supports for 5 and 10 foot long pipe sections shall be located within 18 inches of each joint. Supports shall be positioned to maintain the piping alignment and to prevent the piping from sagging.
- 9. References to specific gravity refer to liquid specific gravity and are referenced to water which is assumed to have a specific gravity of 1.0.
- B. Specific Gravity Adjustments for PVC and FRP Pipe
 - 1. PVC and FRP pipe shall have the maximum spacing indicated in Table 2 adjusted in accordance with the following table when the specific gravity of the liquid is greater than 1.0. (Note: Specific gravities listed are liquid specific gravities referenced to water which is assumed to have a specific gravity of 1.0.) Table 5 shall not apply to PVC pipe containing alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution, as these services are specifically covered in Table 2.

Table 5 shall be used for Indicate service and specific gravity.

> TABLE 5 – MAXIMUM SUPPORT SPACING CORRECTION FACTORS	FOR	PVC
AND FRP PIPE		

Specific Gravity	Correction Factor
1.0	1.00
1.1	0.98
1.2	0.96

Specific Gravity	Correction Factor	
1.4	0.93	
1.6	0.90	
2.0	0.85	
2.5	0.80	
Air	1.40	~
INSTALLATION	~00 ⁵	

TABLE 5 – MAXIMUM SUPPORT SPACING CORRECTION FACTORS FOR PVC AND FRP PIPE

A. General

3.4

- 1. All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, and adjacent to flexible couplings. Pipe supports and hangers shall not be installed in equipment access areas.
- 2. Where horizontal piping is arranged with two or more parallel lines, trapeze hangers may be used in lieu of individual hangers. Trapeze assembly shall consist of structure attachments as previously specified with rod size dependent upon total weight supported. Spacing of assemblies shall be determined by the minimum pipe size included in the group supported. Trapeze horizontal assemblies shall be structural angle or channel section of sufficient size to prevent measurable sag between rods when pipes are full. All lines shall be attached to the horizontal with intermediate pipe guides and U-bolts or one-hole clamps. Pre-engineered support equipment may be used when selected and installed in accordance with the manufacturer's recommendations.
- 3. Where copper pipe is installed on a support system of dissimilar metal with other pipes, the copper pipe shall be galvanically isolated from the support using Neoprene strips or other material acceptable to Engineer.
- 4. No piping shall be supported from the pipe above.
 - Horizontal piping hanger support rods shall attach to steel beams with center-loading I-clamps, or welded beam clips. Hanger support rods shall attach to concrete slabs or beams with inserts.

Anchorage shall be provided to resist both lateral and longitudinal seismic forces.

B. Inserts

6.

5.

1. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Fastening of supports to existing concrete and masonry shall be in accordance with the Anchorage in Concrete and Masonry section. Reference building structural concrete Drawings for concrete inserts. When not provided as part of the building

concrete structure, provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- 2. Where concrete slabs form finished ceilings, provide inserts flush with the slab surface.
- 3. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. NDE (Non-Destructive Evaluation) shall be used to locate existing reinforcing before drilling.
- C. Pipe Hangers and Supports
 - 1. Install hangers to provide a minimum 1/2 inch space between finished covering and adjacent work.
 - 2. A hanger shall be placed within 18 inches of each horizontal elbow, and on both sides of all piping accessories and valves weighing 20 lbs or more.
 - 3. Hangers shall have 1-1/2 inches minimum vertical adjustment.
 - 4. Support horizontal cast iron, ductile iron and no-hub piping systems adjacent to each joint.
 - 5. Support vertical piping at every floor using riser clamps.
 - 6. Support riser piping independently of connected horizontal piping.
 - 7. Hanger and hanger components shall be sized specifically for the pipe size it is to be used on.

3.5 PLACEMENT

- A. The maximum spacing for pipe supports and expansion joints shall be as indicated in Tables 2 and 5.
- B. Rubber hose and flexible tubing shall be provided with continuous angle or channel support.
- C. Unless otherwise indicated on the Drawings or acceptable to Engineer, piping shall be supported approximately 1-1/2 inches out from the face of walls and at least 3 inches below ceilings.

End of Section





SECTION 40 05 19 - DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of ductile iron pipe. Ductile iron pipe shall be furnished complete with all fittings, specials, adapters, closure pieces, blowoffs, outlets, caps and plugs, temporary bulkheads, access manholes, jointing materials, pipe hangers and supports, anchors, blocking, encasement, appurtenances, and accessories specified and indicated on the Drawings, and as required for proper installation and functioning of the piping.
- B. The size, service, and locations of ductile iron pipelines are covered in the Ductile Iron Pipe Schedule.
- C. Piping furnished hereunder shall be complete with all joint gaskets, bolts, nuts and other jointing materials required for installation of any valves and equipment furnished by others for installation under this Contract.
- D. Pipe hangers and supports, pressure and leakage testing and cleaning and disinfection are covered in other sections. Cast iron soil pipe is covered in the Cast Iron Soil Pipe and Accessories section. Pipe trenching, embedment, and backfill are covered in the Trenching and Backfilling section.

1.2 GOVERNING STANDARDS

A. Except as modified or supplemented herein, all ductile iron pipe, fittings, and specials shall conform to the applicable requirements of the following standards and other standards named in this section:

А	NSI/AWWA	
<u>S</u> 1	tandards	Title
	C151	Ductile-Iron Pipe, Centrifugally Cast, For Water
	C600	Installation of Ductile Iron Water Mains and Their Appurtenances
~	M41	Ductile Iron Pipe and Fittings - Manual of Water Supply Practices
\rightarrow	C104	Cement Mortar Lining for Ductile Iron Pipe and Fittings
	C105	Polyethylene Encasement for Ductile Iron Pipe Systems
	C110	Ductile-Iron and Gray-Iron Fittings
	C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

ANSI/AWWA <u>Standards</u>	Title
C115	Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
C153	Ductile-Iron Compact Fittings

1.3 PIPE MANUFACTURER AND FIELD SERVICES

- A. All ductile iron pipe, fittings, specials, bolts, gaskets, other jointing materials, and appurtenances shall be fabricated, lined, coated, and furnished under the direction and management of one pipe manufacturer. The pipe manufacturer responsibilities, which shall include, at a minimum; coordinating and furnishing all pipe materials, gaskets, bolts, and other jointing materials, and pipe appurtenances (except for furnished coupled joints and other similar products by a specified manufacturer) for a complete piping system that meets the specified test pressures and service conditions; ensuring and certifying that all pipe, fittings, specials, and other pipe materials, pipe gaskets and bolts specified herein, are being manufactured in full accordance with the Contract Documents; preparing and submitting all submittal information and shop drawings; and making any corrections that may be required to submittal information and shop drawings.
- B. The pipe manufacturer's minimum required experience qualifications shall include manufacture of interior and buried plant piping of similar diameters of at least two water or wastewater plants with joints, linings, and coatings suitable for the same or higher pressure rating, which has performed satisfactorily for the past 5 years.
- C. All ductile iron pipe shall be installed in accordance with the pipe manufacturer's recommendations.
- 1.4 SUBMITTALS
 - A. General Submittals.
 - 1. Drawings, details, specifications, and installation schedules covering all ductile iron pipe and accessories shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the submittals listed in this section.
 - B. Experience Certification.
 - 1. Certification of pipe manufacturer's experience requirements
 - C. ANSI/AWWA Certification.
 - 1. Certification by manufacturer (affidavit of compliance) for each item furnished in accordance with the ANSI/AWWA Standards.

- D. Restrained joints details.
- E. Field Services Certification.
 - 1. Certification of pipe manufacturer's field services, including a copy of the initial services, and all subsequent inspection reports.
- F. Gasket Certifications.
 - 1. Certification of gaskets by pipe manufacturer, certifying that gasket material is suitable for test pressures and services intended.
- G. Certification of Joint Lubricant.
- H. Joint Test Certification.
 - 1. Certification of proof-of-design tests for joints, including restrained joints.
- I. Ground Elevation and Utility Locations.
 - 1. Prior to preparation of the pipe laying schedule, Contractor shall verify the existing ground elevation and the location and depth of all underground utilities using centerline stakes set at no more than 100 feet intervals. Contractor shall carefully locate and excavate utility, survey, document and submit this information to the Engineer.
 - 2. Engineer will review this information and if necessary make adjustment to the pipeline profile. Any plans sheets that are modified by the Engineer will be reissued to the Contractor.
- J. Encasement Samples.
 - 1. Two samples of the polyethylene encasement, each sample clearly identified as required by the Governing Standards and test results from an independent third party laboratory of the requirements specified in ANSI/AWWA C105/A21.5.
- K. Deflection Measurement.
 - 1. The method that the Contractor proposes to use for measuring deflection of pipe joints.
- L. Other Data.

Submittal data shall clearly indicate the country of origin of pipe, fittings, flanges, restraining devices, and accessories. When requested by Engineer, certified copies of physical and chemical test results as outlined in ANSI/AWWA C151/A21.51 shall be submitted for the materials to be provided.

1.5 SHIPPING, HANDLING, AND STORAGE

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section, and as specified herein.

- B. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes or other abrasive tools shall not be permitted to come into contact with polyethylene lining if such lining is specified.
- C. Pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired.
- D. Contractor shall repair any damage to pipe coatings and linings before the pipe is installed.

PART 2 - PRODUCTS

2.1 PIPE CLASS

A. The class of ductile iron pipe shall be as indicated in the Ductile Iron Pipe Schedule. The specified class includes service allowance and casting allowance.

Pipe Size (inches)	ANSI/AWWA Pressure Class
64 thru 30	150
24	200
20 thru 14	250
12 and smaller	350

B. Pipe wall thickness for grooved and threaded end pipe shall be increased if necessary to comply with the following minimum thickness:

Pipe Size	<u>Minimum</u>	Thickness Class
(inches)	<u>Threaded Ends (1)</u>	Grooved Ends (2)
4-16	53	53
18	53	54
20	53	55
24	53	56
30-54	53	
60 and 64	350 (3)	

2.2 MATERIALS					
Pipe	Ductile iron, ANSI/AWWA C151/A21.51				
Gaskets – All Joint Types Synthetic rubber unless otherwise specified; natural rubber will not be acceptable. All gaskets shall be furnished by the pipe manufacturer unless another manufacturer's product is indicated. Pipe manufacturer shall submit certificates of gasket suitability certifying that the gasket materials are compatible with the joints specified, are recommended for the specified field test pressure and service conditions. Gaskets for treated or potable water service shall be certified for chlorinated and chloraminated potable water. Gas and oil-resistant gaskets shall be made of Nitrile (NBR [Acrylonitrile Butadiene]) rubber. The name of the material shall be permanently marked or molded on the gasket. Gaskets shall also be certified as suitable where soils may be contaminated with gas and oil products.					
Joint Lubricant Vegetable-based lubricant recommended by the pipe manufacturer. Petroleum or animal- based lubricants will not be acceptable. Lubricants that will be in contact with treated or potable water shall be certified as being in compliance with ANSI/NSF 61.					
Fittings ANSI/AWWA C110/A21.10 (except shorter laying lengths will be acceptable for U.S. Pipe), or ANSI/AWWA C153/A21.53, minimum working pressure rating as follows, unless indicated otherwise on the Drawings.					
<u>Fitting Size,</u> inches <u>Ma</u>		<u>Material</u>	Туре		Min. Working <u>Pressure Rating</u> , psi
4 to 24 DI Mechanical and Push-on joints		on joints	350		
4 to 24 DI Flanged joints		Flanged joints		250	
30 to 48 DI		DI C	All joints		250
54 to 64 DL All joints			150		
All fittings shall be ductile iron and suitable for the rated working pressure plus a surge or test pressure allowance of 100 psi or 1.5 times rated working pressure, whichever is less, without leakage or damage.					
Push-on Joints ANSI/AWWA C111/A21.11			WA C111/A21.11		
Restrained Push-on Joints, gaskets with stainless steel gripping segments, 4 inch through 12 inch, working pressure rating 350 psi.		American "Fast Grip." U.S. Pipe "Field Lok 350 Gasket", or McWane Sure Stop 350 Gasket.			
Restrained Push-on Joints, locking wedge type, 4 inch through 24 inch, working pressure rating 350 psi for 4 through 16 inch and at least 250 psi for 18 through 24 inch.			EBAA Iro U.S. Pipe Star Pipe I or Americ without ex	n "Megalug" Series 1700; "TR Flex Gripper Ring"; Products "StarGrip 3100P"; an "Field Flex Ring", cception.	

Restrained Push-on Joints, positive locking rings, 4 inch through 24 inch, working press psi.	American "Flex-Ring,"; U.S. Pipe or McWane "TR Flex."		
Restrained Push-on Joints, positive locking segments and/or rings, 30 inch through 48 inch, working pressure rating at least 250 psi.		American "Flex-Ring," or "Lok Ring"; U.S. Pipe or McWane "TR Flex"; U.S. Pipe HP LOK.	
Restrained push-on joints shall be suitable for rated working pressure plus 100 psi .	a test or working	pressure plus surge pressure of the	
Flanged Joints ANSI/AWWA C		2115/A21.15	
Flanges	2		
Class 250 (Where identified on the Drawings)	Ductile iron, flat faced, with ANSI/ASME B16.1, Class 250 diameter and drilling.		
All others	Ductile iron, Class 125, ANSI/AWWA C115/A21.15.		
Flanges	All flanges shall be suitable for test pressure of 1.5 times rated pressure without leakage or damage.		
Bolts	ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch beyond outer face of nut.		
Nuts	ASTM A563, hexagonal, ANSI/ASME B18.2.2, heavy semifinished pattern.		
Gaskets	ASTM D1330, G thick unless other and accepted by submit certificati above under Gas	Grade I rubber, full face type, 1/8 inch rwise required by pipe manufacturer Engineer. Pipe manufacturer shall on of gaskets furnished as indicated kets - All Joint Types.	
Insulated Flanges			
Flanges	As specified here as needed to acce	ein, except bolt holes shall be enlarged ept bolt insulating sleeves.	
Insulation Kits	As manufactured by Advanced Products or Pipeline Seal and Insulator, Inc.		
Insulating Gaskets	Type E, G-10, 1/ sealing element f sealing elements otherwise require by Engineer. Pipe certification of ga under Gaskets - A	8 inch thick, with Nitrile or EPDM for water and air service and Viton for wastewater service unless ed by pipe manufacturer and accepted e manufacturer shall submit askets furnished as indicated above All Joint Types.	

Bolt Insulating Sleeves	G-10, 1/32 inch thick.	
Insulating Washers	G-10, 1/8 inch thick, two for each flange bolt.	
Backing Washers	Steel, 1/8 inch thick, two for each flange bolt.	
Mechanical Joints	ANSI/AWWA C111/A21.11, with ductile iron glands	
Restrained Mechanical Joints (factory prepared spigot), 4 inch through 48 inch, working pressure rating at least 250 psi.	American "MJ coupled Joints," or Griffin U.S. Pipe "Mech-Lok." (thru 36" size only)	
Restrained Mechanical Joints, (field cut spigot), 4 inch through 24 inch, working pressure rating 350 psi for 4 through 16 inch and at least 250 psi for 18 through 24 inch.	EBAA Iron "Megalug" Series 1100, Sigma "One Lok" SLDE series, or Star Pipe Products "StarGrip 3000" without exception.	
Restrained mechanical joints shall be suitable for a test or working pressure plus surge pressure of the rated working pressure plus 100 psi		
Wall Pipes or Castings	Mechanical joint with water stop and tapped holes; single casting or fabricated ductile iron pipe; holes sized in accordance with the details on the Drawings and provided with removable plugs.	
Mechanical Joints with Tie Rods	As indicated in the Drawings.	
Tie Rods	ASTM A307.	
Steel Pipe	ASTM A53, Schedule 40 or 80 as indicated on the Drawings.	
Washers	ANSI/ASME B18.22.1, plain steel.	
Threaded Connections	ANSI/ASME B1.20.1, NPT; with boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4- thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.	
Mechanical Couplings		
Couplings	Dresser "Style 38"; Smith-Blair "411 Steel Coupling"; or Romac "Style 400" or "Style 501"; without pipe stop.	

Gaskets	Oil-resistant synthetic rubber gaskets shall be as recommended by the coupling manufacturer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Restrained Mechanical Couplings	American Pipe "Restrained Coupling Gland Joint" coordinated with mechanical couplings furnished.
Grooved End Joints	AWWA C606.
Pipe Ends (rigid joints)	Grooved, with dimensions conforming to AWWA C606, Table 3.
Pipe Ends (flexible joints)	Shouldered, with dimensions conforming to AWWA C606, Table 4.
Couplings (non-shouldered pipe)	Tyco/Grinnell "Figure 772," or Victaulic "Style 31."
Couplings (shouldered pipe)	Victaulic "Style 41" or "Style 44."
Flanged Coupling Adapters	. 20
Restrained 4 inch through 12 inch. Unless otherwise indicated on the Drawings, flanged coupling adapters shall be restrained.	Smith-Blair "Type 912" or Romac "Style FCA501", with anchor studs of sufficient size and number to withstand test pressures.
Unrestrained 14 inch and larger.	Smith Blair "Type 913" or Romac "Style FC400."
Dismantling Joints	
Restrained 3 inch and larger Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.	Romac "DJ400"; Dresser "Style 131 Dismantling Joint" or Viking Johnson. For use in potable water systems, coating to be in accordance with NSF-61.
Tapping Saddles	Ductile iron, with stainless steel straps and synthetic rubber sealing gasket, 250 psi pressure rating.
Watertight/Dusttight Pipe Sleeves	GPT " Link-Seal", insulating type with modular rubber sealing elements, nonmetallic pressure plates, and stainless steel bolts and nuts.
Shop Coating and Lining	
Cement Mortar Lining with Seal Coat	ANSI/AWWA C104/A21.4.
Universal Primer	Manufacturer's standard. If in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61.
Asphaltic Coating	Manufacturer's standard.
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Zinc Coating	ISO 8179.
Coal Tar Epoxy	Manufacturer's standard.
Liquid Epoxy	ANSI/AWWA C210, non-coal tar modified, or when in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Bostik/Never-Seez "Pure Nickel Special" or Permatex "Nickel Anti-Seize."
Corrosion Protection	
Polyethylene Encasement	Seamless, ANSI/AWWA C105/A21.5; LLDPE - 8 mil or HDCLPE - 4 mil.
Heat-shrinkable Coating and Primer (Shrink Sleeve)	ANIS/AWWA C216, cross-linked polyethylene sheeting precoated with adhesive; minimum 80 mils; type and recovery as recommended by Shrink Sleeve manufacturer; Canusa-CPS or Berry Plastics Water Wrap.
Wax Tape and Primer	ANSI/AWWA C217, cold-applied petroleum wax primer and cold-applied petroleum wax tape; Trenton Wax-Tape and Primer.
Medium Consistency Coal Tar	Carboline "Bitumastic 50" or Tnemec "46 465 H.B. Tnemecol."

2.3 OUTLETS

- A. Where a 12 inch or smaller branch outlet is indicated and the diameter of the parent pipe is at least twice the diameter of the branch, a tee, a factory welded-on boss, or a tapping saddle will be acceptable.
- B. Where a 4 inch or larger branch outlet is indicated on the Drawings and the diameter of the branch pipe for a given diameter of parent pipe is less than or equal to the maximum diameter listed herein, a factory welded-on outlet fabricated from centrifugally cast ductile iron pipe will be acceptable.

Parent Pipe Diameter Versus Maximum Branch Pipe Diameter for Welded-On Outlets

Parent Pipe Diameter, inches	Max Branch Pipe Diameter, inches	Parent Pipe Diameter, inches	Max Branch Pipe Diameter, inches
8	4	30	20
10	6	36	24

Parent Pipe Diameter, inches	Max Branch Pipe Diameter, inches	Parent Pipe Diameter, inches	Max Branch Pipe Diameter, inches
12	8	42	30
14	8	48	30
16	10	54	36
18	12	60	36
20	14	64	36
24	16		-07

Parent Pipe Diameter Versus Maximum Branch Pipe Diameter for Welded-On Outlets

- C. All 30 inch and smaller branch pipe diameter welded-on outlets shall be rated for a working pressure of 250 psi, 36 inch branch diameter welded-on outlets shall be rated for a working pressure of 200 psi, and all outlets shall have a minimum factor of safety of 2.0. The pipe manufacturer shall provide test data and certification of proof of design. It is not necessary that these tests be performed on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design.
- D. Welded-on outlets may be provided as a radial (tee) outlet, a tangential outlet, or a lateral outlet fabricated at a specific angle to the parent pipe (in 15 degrees increments between 45 degrees and 90 degrees from the axis of the parent pipe), as indicated on the Drawings. The fillet weld dimensions for welded-on outlets shall be as specified herein. Parent pipe and branch pipe shall meet hydrostatic test requirements in accordance with ANSI/AWWA C151/A21.51 prior to fabrication.

Welded-on Outlet Fillet Weld Dimensions for Specified Outlet Configurations

Radial and Lateral Outlets			,	Tangential Outlet	S
Parent Pipe Diameter, inches	Branch Pipe Diameter, inches	Weld Fillet Size, inches	Parent Pipe Diameter, inches	Branch Pipe Diameter, inches	Weld Fillet Size, inches
24 and smaller	24 and smaller	1 x 1	8-30	24 and smaller	1-1/4 x 1-1/4
30-48	24 and smaller	1-1/4 x 1-1/4	36-54	24 and smaller	1-1/2 x 1-1/2
54-64	24 and smaller	2-1/4 x 2-1/2	60-64	24 and smaller	2-1/2 x 2-1/2
42-64	30	2-1/2 x 2-1/2	42-54	30	2-1/2 x 2-1/2
54-64	36	2-3/4 x 2-3/4	60-64	30	2-3/4 x 2-3/4

E. All joints on welded-on branch outlets shall be made in accordance with the latest revision of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15, as applicable. All outlets shall be fabricated from centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured and tested in accordance with ANSI/AWWA

C151/A21.51. Ni-Rod FC 55[®] electrodes manufactured by International Nickel Corporation (or an electrode with equivalent properties) shall be used in the manufacture of the fillet welds. Carbon steel electrodes will not be acceptable. Special Thickness Class 53 pipe shall be used for all branch pipe and parent pipe in 4 to 54 inch sizes. Pressure Class 350 pipe shall be used for 60 inch and 64 inch parent pipe. After welding, each fabricated outlet shall be subjected to a 15 psi air test. A soap and water solution shall be applied during the testing procedure to inspect the weld for leakage. Any welds that show air seepage shall be refabricated and retested.

- F. Welded-on outlets shall be fabricated by the pipe manufacturer at its production facilities. Manufacturers of welded-on outlets shall have at least 5 years of satisfactory experience in the manufacture and performance of these products. The manufacturer shall have a documented welding quality assurance system and shall maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall also maintain appropriate welding procedure specifications (WPS) and procedure qualification (PQR), and welder performance qualification (WPQR) records.
- G. The type of pipe end for the branch outlet shall be as specified or indicated on the Drawings. The maximum size and laying length of the welded-on branch outlet shall be as recommended by the pipe manufacturer and shall be acceptable to Engineer for the field conditions and the connecting pipe or valve.
- H. At locations acceptable to Engineer, drilling and tapping of the pipe wall for 2 inch and smaller pipe connections will also be acceptable, provided that the wall thickness, minus the casting allowance, at the point of connection equals or exceeds the wall thickness required for 4-thread engagement in accordance with Table A.1, Appendix A of ANSI/AWWA C151/A21.51.

2.4 JOINTS

- A. Joints in buried and tunnel locations shall be mechanical or push-on type unless otherwise indicated on the Drawings or where required to connect to existing piping or to valves. Bells on wall castings and wall sleeves shall be mechanical joint type, with tapped holes for tie rods or stud bolts. All other joints shall be flanged unless otherwise indicated on the Drawings.
- B. Certification of joint design shall be provided in accordance with ANSI/AWWA C111/A21.11, Performance Requirements, as modified herein. The joint test pressure shall be not less than 2 times the working pressure rating of the joint. The same certification and testing shall also be provided for restrained joints. For restrained joints, the piping shall not be blocked to prevent separation and the joint shall not leak or show evidence of failure. It is not necessary that such tests be made on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design. Any new proof-of-design testing to meet the requirements for this project shall be independently verified and the Owner shall be given the opportunity to witness the testing.
- C. Unless otherwise indicated on the drawings or acceptable to the Engineer, field closure pieces shall be located away from the bends or dead ends beyond the length over which joints are to be restrained.
- D. The length of pipe having restrained joints shall be as indicated on the drawings or specified. All vertical bends and eccentric reducers shall have restrained joints.

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- E. Where acceptable to Engineer, grooved couplings may be used instead of flanges, provided that rigid grooving is used to preclude longitudinal pipe movement and angular deflection at joints. Fittings, valves, and equipment installed using grooved couplings shall be adequately supported and blocked or restrained to prevent rotation.
- F. Flanged Joints
 - 1. Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.
- G. Flanged Coupling Adaptors
 - 1. Flanged coupling adapters shall be provided for restrained couplings 12 inch and smaller where indicated on the Drawings and as specified herein. Unless indicated otherwise on the Drawings, all flange coupling adapters 12 inch and smaller shall be restrained. Flange coupling adapters 14 inch and larger may only be used in unrestrained pipe applications.
 - 2. The inner and outer surfaces of couplings, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be shop coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.
- H. Dismantling Joints
 - 1. Dismantling joints shall be provided for restrained couplings 6 inch and larger piping where indicated on the Drawings and as specified herein. Dismantling joints shall comply with AWWA C219 and shall be restrained flange by flange couplings manufactured as a single unit. Unless otherwise indicated on the Drawings, dismantling joints shall be restrained. The inner and outer surfaces of dismantling joints, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be shop coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.
- I. Mechanical Couplings

1.

The piping layout for mechanical couplings shall provide a space of at least 1/4 inch, but not more than 1 inch, between the pipe ends.



- 3. A ductile iron pipe factory spacer shall be provided for the piping where indicated on the drawings. The spacer shall be shop lined and coated with 16 mils of liquid epoxy. Piping surfaces within the coupling shall be shop coated with 16 mils of liquid epoxy.
- 4. Tie bolts shall be provided to restrain mechanical coupling connections where indicated on the Drawings. The connecting pipe shall be furnished with welded retainer rings as

recommended by pipe manufacturer. The pipe manufacturer shall also coordinate the restrained connection with the pressure rating, length, and diameter dimensions of the mechanical coupling being furnished to assure proper clearance is provided for completing the restrained coupling installation.

- J. Grooved-End Couplings
 - 1. Grooved-end couplings shall not be used in the following applications: chemical service, except lime slurry piping, flammable liquid or flammable gas piping, compressed air or compressed gas piping operating at pressures above 25 psig, toxic gas piping, hot liquid with operating temperatures above 120°F, or steam piping.

2.5 REDUCERS

A. Reducers shall be eccentric or concentric as indicated on the Drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

2.6 BLOWOFFS

A. Each blowoff shall be located and arranged as indicated on the Drawings.

2.7 ACCESS OPENINGS

A. Access openings shall be installed at the locations indicated on the Drawings. Access openings shall be 36 inch diameter outlets for 36 inch and larger diameter pipe and the same size as the pipe for 24 and 30 inch diameter pipe. Access openings shall be provided with either flanged outlets with blind flange cover or mechanical joint outlets with restrained mechanical joint plugs. Unless otherwise indicated on the Drawings or acceptable to the Engineer, covers shall be designed for the same external loads and internal pressures as the adjacent pipe. Covers shall be fabricated from steel plate and shall have two handles fabricated from 1 inch diameter rod or shall be manufacturer's standard blind flange with integrally cast lifting devices, either one in the center or two or more symmetrically located around the perimeter of the cover. At the option of the Contractor, and if acceptable to the Engineer, reinforced or dished covers of lighter weight and equal strength may be provided.

2.8 WALL AND FLOOR PIPES

Wall and floor pipes shall be installed where ductile iron pipes pass through concrete walls or floors, unless otherwise indicated on the Drawings.

- 2. Where a flange and mechanical joint pipe piece is to connect to a mechanical joint wall pipe or casting, the bolt holes in the bell of the wall pipe or casting shall straddle the top centerline of the horizontal pipe or casting and shall align with the bolt holes in the flange and mechanical joint piece. The top centerline shall be marked on the wall pipe or casting at the foundry or fabrication shop.
- 3. In vertical piping, the bolt holes of flanged and mechanical joint floor pipes or castings shall be aligned with the bolt holes of the flange or mechanical joint connecting piece. The Four Rivers Sanitation Authority

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required centerline alignment and orientation of the floor pipe or casting shall be marked on the floor pipe or casting at the foundry or fabrication shop.

2.9 WALL AND FLOOR SLEEVES

- A. Wall and floor sleeves shall be installed where indicated on the Drawings and shall be installed where ductile iron pipe passes through concrete walls and floors or masonry walls, unless otherwise noted. To minimize sleeve size, piping on either side of the sleeve shall be provided with a screw-on flange, grooved coupling, or mechanical coupling with anchor studs to allow the pipe to pass through the sleeve. Where required, sleeves in masonry walls may be enlarged enough for flange or other joint restraint to pass through the sleeve.
- B. Where specified or indicated on the Drawings, one or two sets of modular casing seals shall be installed at the face of walls to seal against soil or provide a dust or water tight seal. Contractor shall coordinate the diameter of wall or floor sleeves with the modular casing seal manufacturer. When soil may be present at wall sleeves, two sets of modular casing seals shall be installed, one at each face of the wall. Unless otherwise indicated on the Drawings, modular casing seals shall not be used in submerged conditions unless the hydrostatic pressure is less than 20 feet and piping is less than 24 inch size.

2.10 SHOP COATING AND LINING

- A. The interior of all pipe and fittings, unless noted otherwise, shall be cement mortar lined.
- B. Lining for pipe and fittings for gravity sewers and wastewater facilities services shall be as specified in the Ductile Iron Pipe Schedule
- C. The exterior surfaces of all pipe and fittings which will be exposed in both interior and exterior locations shall be shop primed. Field painting of exposed exterior surfaces is covered in the Protective Coatings section. Flange faces shall be coated with a suitable rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.

PART 3 - EXECUTION

3.1 INSPECTION

Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; pipe ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site.

3.2 PROTECTION AND CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign material prior to installation and shall be kept clean until the work is completed. Before jointing, all joint contact surfaces shall be wire brushed if necessary and wiped clean.

- B. Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.
- C. Whenever pipe laying is stopped, the open end of the pipe shall be closed to prevent entry of dirt, mud, rodents, and other material. All water in the trench shall be removed prior to removing the closure.

3.3 CUTTING PIPE

- A. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or a power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.
- B. All field cutting of existing gray cast iron pipe shall be done with mechanical pipe cutters, except where the use of mechanical cutters would be difficult or impracticable.
- C. Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be acceptable. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be acceptable.
- D. Contractor shall use factory prepared pipe ends unless a field cut is required for connections.

3.4 ALIGNMENT AND GRADE

- A. Buried piping shall be laid to the lines and grades indicated on the Drawings and as specified. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the values stipulated for full-length push-on joint pipe for full-length mechanical joint pipe of AWWA C600, unless specially designed bells and spigots are provided. Contractor shall submit his proposed methods to measure deflection of deflected joints in accordance with the Submittal section.
- B. Whenever deflections would exceed the values stipulated in AWWA C600, either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the Drawings and as acceptable to the Engineer.
- C. Unless otherwise specified or acceptable to Engineer, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.
- D. Additional requirements for alignment and grade are covered in the Project Requirements and Trenching and Backfilling sections and on the Drawings.

- E. Tolerances
 - 1. Each section of pipe shall be laid to the alignment and grade indicated on the Drawings and pipe laying schedule with pipe ends within the following tolerances;
 - a. +/-0.10 foot in grade at any point
 - b. +/-0.20 foot in alignment at any point
 - 2. In addition, piping shall be visually straight or on a smooth curve between the points of defection or curvature indicated on the Drawings. Stricter tolerances than specified above shall be used as necessary to maintain minimum cover, to maintain required clearances, to make connections to existing pipe, to maintain the correct slope to avoid high or low points along the pipeline other than at locations indicated on the Drawings, or to meet other restrictions as required or directed by the Engineer.

3.5 LAYING PIPE

- A. Buried pipe shall be protected from lateral displacement by placing the specified pipe embedment material installed as specified in the Trenching and Backfilling section. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions. Pipe embedment material and trench backfill shall be placed and compacted under and around each side of outlets and fittings to hold the pipe in proper position and alignment during the subsequent pipe jointing, embedment, and backfilling.
- B. Pipe shall be laid with the bell ends facing the direction of laying, except where reverse laying is specifically acceptable to Engineer.
- C. The pipe laying schedule shall be annotated during the progress of the work to show all changes made during construction for record documentation. Upon completion of the installation of the piping, the annotated pipe laying schedule shall be submitted to Engineer in accordance with the Submittals Procedures section.

3.6 JOINTS

A. Each joint, including restrained joints, shall be checked by Contractor as recommended by the pipe manufacturer to verify that the joint and the restraints are installed properly. Restrained joints shall be extended after they are assembled to minimize further take-up.

3.7 MECHANICAL JOINTS

A. Mechanical joints shall be carefully assembled in accordance with the pipe manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Over tightening of bolts to compensate for poor installation practice will not be acceptable.

B. The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top centerline for horizontal piping.

3.8 PUSH-ON JOINTS

- A. The pipe manufacturer's instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with a soap solution provided by the pipe manufacturer immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.
- B. Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer's recommendations.

3.9 FLANGED JOINTS

- A. When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually in a crisscross pattern and at a uniform rate, to ensure uniform compression of the gasket around the entire flange. All flange joint bolting procedures shall be in accordance with the pipe manufacturer's recommendations.
- B. Special care shall be taken when connecting piping to any pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported to obtain accurate matching of bolt holes and uniform contact over the entire surface of flanges before any bolts are installed in the flanges.
- C. Pump connection piping shall be free to move parallel to its longitudinal centerline while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe, so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping.
- D. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts shall then be loosened and the process repeated until no movement is observed.
- E. Insulated Flanged Joints
 - 1. Insulated flanged joints shall be installed where indicated on the Drawings. In addition to one full-faced insulated gasket, each flange insulating assembly shall consist of one full-length sleeve, two insulating washers, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch less than the ID of the flange in which it is installed.

The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the insulating kit manufacturer.

3.10 FLANGED COUPLING ADAPTERS

A. Flange coupling adapters shall be installed in accordance with the coupling manufacturer's recommendations. After the pipe is in place and bolted tight, the locations of holes for the anchor studs shall be determined and the pipe shall be field-drilled. Holes for anchor studs shall be drilled completely through the pipe wall. Hole diameter shall be not more than 1/8 inch larger than the diameter of the stud projection. Unless indicated on the Drawings, all flange coupling adapters shall be restrained.

3.11 DISMANTLING JOINTS

A. Dismantling joints shall be installed in accordance with the coupling manufacturer's recommendations.

3.12 MECHANICAL COUPLINGS

1. Mechanical couplings shall be installed in accordance with the coupling manufacturer's recommendations. A space of at least 1/4 inch, but not more than 1 inch, shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

3.13 GROOVED-END JOINTS

A. Grooved-end joints with rigid type grooving shall be installed in accordance with the coupling manufacturer's recommendations. Completed joints shall be rigid and shall allow no angular deflection or longitudinal movement. Except for closure pieces, field grooving of pipe will not be acceptable.

3.14 GAS AND OIL-RESISTANT GASKETS

Gas and oil-resistant gaskets shall be installed where specified, indicated on the Drawings, or directed by Engineer where jointing gaskets may be subject to permeation when piping passes through areas where soil may be contaminated with gas or petroleum (oil) products or organic solvents or their vapors.

3.15 CORROSION PROTECTION

A. Polyethylene Encasement

- 1. All buried pipe including all straight pipe, bends, tees, adapters, closure pieces, and other fittings or specials, shall be provided with at least one wrap of polyethylene encasement. Other locations where ductile iron pipe and accessories shall be double wrapped with polyethylene encasement shall be as specified herein. Where ductile iron pipe is also embedded or encased in concrete, including in locations beneath structures, the polyethylene encasement shall be installed around the pipe for 5 feet extending into each end of the concrete encasement.
- 2. Where the ductile iron pipe is embedded within a concrete structure wall, floor or footing, the polyethylene encasement for the pipe shall end at the outside faces of the structure. Ductile iron pipe embedded within concrete structures shall not be wrapped with polyethylene encasement.
- 3. All buried flanged valves, mechanical joint couplings with tie rods, mechanical couplings, restrained mechanical couplings and other pipe harness assemblies at valves or structure walls shall be provided with two wraps of polyethylene encasement in addition to other corrosion protection coatings as specified herein.
- 4. Polyethylene tube protection shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Preparation of the pipe shall include, but shall not be limited to, removal of lumps of clay, mud, cinders, etc., prior to installation.
- 5. The terms "polyethylene tube protection" and "polyethylene encasement" are interchangeable and shall have the same meaning in these Contract Documents.
 - a. Inspection and Testing
 - 1) Tests for preliminary acceptance of polyethylene encasement materials as required in the submittal paragraph shall be made at the expense of the Contractor.
 - 2) At the Owner's expense, the Owner may obtain samples from the material supplied in the field and have test conducted of the requirements specified in ANSI/AWWA C105/A21.5 by an independent third-party laboratory.
- B. Mechanical Joint Couplings with Tie Rods
 - 1. The mechanical joint tie rods, bolt studs, pipe spacers and washers of buried mechanical joint couplings as detailed on the Drawings shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.



- C. Flanged Joints
 - 1. The flange bolts and nuts on buried flanges, including valve flanges, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as

recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

- 2. Following application of the wax tape protection, the entire flanged joint shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement on each side of the joint.
- D. Valves
 - 1. Buried portions of the valve and the actuator to the wrench nut shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the valve.
- E. Mechanical Couplings
 - 1. The tie bolts and nuts on all buried mechanical couplings shall be coated with two coats of medium consistency coal tar.
 - 2. After the protective coating has been applied to the tie bolts, the entire mechanical coupling shall be encapsulated with a shrink sleeve. The shrink sleeve shall extend a minimum of 6 inches on to the pipe on each side of the coupling. A primer shall be applied to the piping on each side of the coupling prior to installing the shrink sleeve. The application of the shrink sleeve shall be in accordance with ANSI/AWWA C216 and as recommended by the shrink sleeve manufacturer. There shall be no bare or unprotected ferrous metal surfaces. Following installation of the shrink sleeve, the entire assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.
- F. Restrained Mechanical Couplings
 - 1. The corrosion protection for the mechanical coupling and its tie bolts and nuts of all buried restrained mechanical coupling assemblies shall be protected with two coats of medium consistency coal tar and shrink sleeve as specified herein for buried mechanical couplings.
 - 2. The tie rods and bolts of the coupling assembly shall be protected by wrapping them with wax tap in accordance with ANSI/AWWA C217 and as detailed on the Drawings. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.
 - Following the application of the wax tape, the entire restrained mechanical coupling assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.
- G. Other Assemblies
 - 1. All ferrous metal clamps, tie rods, bolts, and other components of buried joint harnesses, tapping saddles, or pipe reaction anchorages in contact with earth or other fill material and

not encased in concrete, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

- 2. Following the application of the wax tape, the entire assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.
- H. Surfaces Exposed in Manholes and Vaults
 - 1. Unless otherwise specified, all uncoated surfaces exposed in manholes and vaults shall be cleaned and coated with two coats of medium consistency coal tar. The first coat shall be dry and hard before the second coat is applied. There shall be no unprotected, bare, or uncoated ferrous metal surfaces.

3.16 PROVISIONS FOR CATHODIC PROTECTION SYSTEMS

- A. An electrical bond shall be provided across all pipeline joints except where insulated joints are shown on the Drawings or specified.
- B. Electrical Bond Across Rubber-Gasketed Joints
 - 1. Two electrical bonding cables shall be provided across each mechanical coupling and each rubber-gasketed bell-and-spigot joint. Before applying the field joint coating to mechanical couplings, two small areas of the metal surface shall be exposed on each side of the coupling, on the middle ring, and on each follower ring. Each exposed area shall be thoroughly cleaned, and two cathodic protection cables shall be connected to the top of the pipe at least 12 inches apart, one end of each on either side of the joint, and to the middle ring and follower rings of mechanically coupled joints, using the thermite process. The completed connections and exposed metal surfaces shall be coated as specified for field repair of coatings.
 - 2. Joint bond cables shall contain at least 6 inches of slack wire to compensate for pipe movement and backfill settlement.
- C. Electrical Bond Across Valves and Flanges

1. Two electrical bonding cables shall be provided across valves and flanged connections other than insulating flanges in the same manner as specified for rubber-gasketed joints.

D. Bonding Cables

1. Bonding cable and test lead wires shall be at least 8 AWG, Type CP copper cathodic protection cable, with low density, high molecular weight polyethylene insulation.

3.17 CONNECTIONS WITH EXISTING PIPING

A. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and

under conditions which will least interfere with service to customers, and as authorized by Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from dewatered lines and excavations without damage to adjacent property.

3.18 CONCRETE ENCASEMENT

A. Concrete encasement shall be installed where indicated on the Drawings. A pipe joint shall be provided within 12 inches of each end of the concrete encasement. Concrete and reinforcing steel shall be as specified in the Cast-in-Place Concrete section. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.19 PRESSURE AND LEAKAGE TESTS

- After installation, pipe and fittings shall be subjected to a pressure test and a leakage test in A. accordance with the Pipeline Pressure and Leakage Testing section.
- After installation, pipe and fittings shall be subjected to a pressure test and a leakage test. The B. Contractor shall provide all necessary pumping equipment; piping connections between the piping and the nearest available source of test water; pressure gauges; and other equipment, materials, and facilities necessary for the tests. The minimum test pressure shall be as indicated in the Pipeline Pressure and Leakage Testing section or as indicated on the Drawings
- All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall C. be removed and replaced with new and acceptable materials, and the affected portion of the piping shall be retested by and at the expense of Contractor.
- All joints shall be watertight and free from visible leaks. Any visible leak which is discovered D. within the correction period stipulated in the General Conditions shall be repaired by and at the Lot to be USE expense of Contractor.

End of Section

Schedule 40 05 19-S01 Ductile Iron Pipe Schedule

Size	Service	Location	ANSI/AWWA Class	Lining Material
in.				Ś
All	AGS Effluent (AGSE)	Buried	150	Cement Mortar
All	AGS Influent (AGSI)	Buried; In-Plant	150, 200	Cement Mortar
All	Waste Activated Granular Sludge (WAGS)	Buried; In-Plant	350	Cement Mortar
All	Water Level Correction (WLC)	Buried; In-Plant	350	Cement Mortar
All	WAGS/WLC	Buried; In-Plant	350	Cement Mortar

End of Schedule

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SECTION 40 05 23 - STAINLESS STEEL PIPE AND ALLOY PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of stainless steel pipe and alloy pipe, tubing and accessories through 24" diameter for the services as indicated herein. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS

- A. Drawings and Data
 - 1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:
 - a. Name of Manufacturer
 - b. Type and model
 - c. Construction materials, thickness, and finishes
 - d. Pressure and temperature ratings

B. Gasket Material Certifications.

- 1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.
- C. Welding Procedures and Qualifications.
 - 1. All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be in written form and submitted to the Engineer for review.
- D. Compliance Data.
 - Pipe for liquid chemical service shall comply with ASME B31.3. Pipe for all other services shall comply with ASME B31.1.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless steel pipe and alloy pipe materials shall be as specified herein.

B.	Material Classification SS-2		
	SS-2 – Schedule 10S with Beveled	Pipe	ASTM A312 or ASTM A778 with
	Ends.	Fittings	longitudinal seams only TP304L.
			Buttwelded, ASTM A403 WP-W or A774,
	Blower inlet piping.		wrought stainless steel, grade equivalent to
	Non-submerged AGS reactor air		pipe. Fittings shall conform to
	piping, including outdoor blower		ANSI/ASME B16.9, Schedule 10S with
	discharge air pipe.		beveled ends.
	2-1/2 inch and larger.		
С	Material Classification SS-7		6 X
0.	SS-7 - Schedule 40S with Plain	Pipe	ASTM A312 Grade TP304L
	Ends.	Fittings	Socket welded, ASTM A182, F304L.
		8-	Fittings shall conform to ANSI/ASME
	Gauge piping in stainless steel	•	B16.11, Class 3000.
	piping systems.		
			7
	2-inch and smaller with socket	x	
	welded ends.		
р	Material Classification SC 12		
D.	SS 12 Durlay Stainlage Steel	Dina	ASTM A 700 Crode S21802 (Allow 2205)
	Schedule 10S	Fipe	ASTWIA 790, Orade S51805 (Alloy 2205)
	Schedule 103.	Fittings	Scamess. Buttwelded ASTM A182 182M Grade F51
	Submerged AGS reactor air nining		(\$318803)
	(by AGS system supplier).		(5510005)
	WAGS and WLC piping, in		
	WAGS/WLC wetwell.		
	XO		
	Submerged AGS reactor drain		
	piping.		
	2-1/2 inch and larger.		

- E. Accessory Materials
 - Accessory materials for the stainless steel pipe systems shall be as indicated. Flanges shall be flat faced for water service and shall be raised face for air or gas service except when connecting to flat face equipment or valve flanges. Flanges

SS-1, SS-2 and SS-3 Pipe Stainless steel plate, AISI Type 304 or 316 to match **Backing Flanges** fittings. Provide stub ends or angle face rings with material and thickness to match fittings. The angle or radius between the angle face ring or stub end and the pipe shall match the angle or radius of the backing flange for proper seating. Flanges shall conform with ANSI/ASME B16.5, Class 150 diameter and drilling; with the following thicknesses: Nominal Pipe Size Flange Thicknes inches inches 1/2-81/210-16 5/8 18-20 3/424-30 36 SS-12 Pipe Flanges Flanged, ASTM A182, 182M, Grade F51 (S318803). Flanged fittings shall conform to ANSI/ASME B16.5, Class 150 or 300 with beveled ends. ASTM A193 Class 2, AISI Type 316, ANSI B18.2.1, Flange Bolts heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. Flange Nuts ASTM A194, AISI Type 316, ANSI/ASME B18.2.2, heavy hex pattern. Washers shall be installed under the nuts. Flange Gasket Process air **Raised Face Flanges** Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces, rated for 275°F service; Garlock "IFG 5507." Premium Grade, EPDM, full face type, 1/8 inch thick, Flat Faced Flanges rated for 275°F service; Garlock "8314." Garlock "Multi-Swell 3760 Ring Gaskets," 1/16 inch WAGS/WLC Piping. thick to match required flange dimensions. All other services. Flexitalic "Style CG," spiral wound, AISI Type 304 stainless steel, non-asbestos filler, 3/16 inch nominal thickness, with compression ring 1/8 inch thick to match required flange dimensions.

Elbows	Except for elbows 14 inches and sma which the laying le	in chemical service, elbows in lines aller shall be long radius type for ength is 1.5 times the pipe diameter.
Expansion Joint	ts	
Process air	Expansion joints s and shall be Merce retaining rings and The number of arc Drawings. The cor maximum pressure temperature of 275 following minimu	hall be the elastomeric, arched type er "Type 450" with "Type 500" I Kevlar reinforcement, or equal. thes shall be as indicated on the nnection shall be suitable for a e of 15 psig and maximum 5°F . Expansion joints shall have the m ratings:
	Size	16 inches
	Number of Arc	thes:
	Face-to-face le	ngth: 8 inches
	Axial Spring ra	ite: 1377 lbs/inch
	Lateral Spring	rate: 1672 lb/inch
	Axial Compres	sion: 2-1/8 inches
	Size	16 inches
	Number of Arc	thes: 2
	Face-to-face les	ngth: 12 inches
	Axial Spring ra	ate: 688 lbs/inch
	Lateral Spring	rate: 836 lb/inch
	Axial Compres	sion: 4-3/8 inch
Insulation	All blower inlet, b be insulated and ja Mechanical Insula	low-off and discharge piping shall acketed. Refer to Section 40 42 11 – tion for requirements.
Insulating Fittin	ıgs	
Threaded	Dielectric steel pip polypropylene line "Clearflow Fitting	be nipple, ASTM A53, Schedule 40, ed, zinc plated; Perfection Corp. gs."
Flanged	Epco "Dielectric F "Insulating Flange for the fluid and te WAGS/WLC Wet concentrations up	Flange Unions" or Central Plastics 9 Unions." Fittings shall be suitable 9 emperature. Insulating flanges in 9 well shall be suitable for chloride 10 to 300 mg/L.

- 2. Branch Connections
 - a. Branch connections 2-1/2 inches and smaller shall be made with welding fittings. Welded outlets shall be used. Where the exact outlet size desired is in doubt, but is known to be less than 1 inch, a 1 inch outlet shall be provided and reducing bushings used as needed.

- b. Branch connections sized 3 and larger shall be made with pipe nipples or with welding fittings with welded outlets. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as needed to meet design and testing requirements. The pressure rating of branch and branch connections shall equal or exceed the pressure rating of the main pipe it is connected to.
- c. Small branch connections shall be so located that they will not interfere with joints, supports, or other details, and shall be provided with caps or plugs to protect the threads during shipping and handling.
- 3. Duct and Transition Fittings
 - a. Three (3) ducts shall be provided at the blower inlet piping as shown on the Drawings. Each duct shall be stainless steel to match the blower inlet pipe material (SS-2) specified herein. Each duct shall have an opening of 30 inch by 30 inch and shall be installed with a bird screen. Duct shall have 18 gauge thickness minimum.
 - b. A transition fitting shall be provided between each duct and inlet pipe as shown on the Drawings and shall be constructed of stainless steel. One end shall be circular to match the size of the intake pipe as specified herein. The other end shall be square to match the size of the duct as specified herein. Fitting shall be welded to the air inlet piping and the duct.

2.2 WELDING OF STAINLESS STEEL AND ALLOYS

- A. Filler metal for welding austenitic stainless steel and alloys, P-number 8 base materials shall be in accordance with the following:
 - 1. Material Type/Grade 304 shall use Type 308 filler metal.
 - 2. Material Type/Grade 304L shall use Type 308L filler metal.
 - 3. Material Type/Grade 316, shall use Type 316 filler metal.
 - 4. Material Type/Grade 316L shall use Type 316L filler metal.
 - 5. Material Type/Grade Duplex 2205 shall use Type 2205 filler metal.
- B. The following requirements shall apply when fabricating austenitic stainless steel and alloy components.
- C. Grinding shall be by aluminum oxide, zirconium oxide, or silicon carbide grinding wheels that shall not have been used on carbon or low alloy steels. Hand or power wire brushing shall be by stainless steel brushes that shall not have been used on carbon or low alloy steels for stainless steel pipe. Hand or power wire brushing shall be by Carpenter 20 brushes that shall not have been used on carbon or low alloy steels for Carpenter 20 pipe. Hand or power wire brushing shall be by Hastelloy C276 brushes that shall not have been used on carbon or low alloy steels for Carpenter 20 pipe. Hand or power wire brushing shall be by Hastelloy C276 brushes that shall not have been used on carbon or low alloy steels for Hastelloy C276 pipe. All tools used in fabrication shall be protected to minimize contact with steel alloys or free iron. Grinding wheels and brushes shall be identified and controlled for their use on these materials only to ensure that contamination of these materials does not occur.

- D. Antispatter compounds, marking fluids, marking pens, tape, temperature indicating crayons, and other tools shall have a total halogen content of less than 200 parts per million.
- E. Heat input control for welding shall be specified in the applicable WPS and shall not exceed 55,000 joules per inch as determined by the following formula:

Heat Input
$$(J/_{in.}) = \frac{\text{Voltage x Amperage x 60}}{\text{Travel Speed }(^{in.}/_{min.})}$$

- F. Complete penetration pressure retaining welds shall be made using the Gas Tungsten Arc Welding (GTAW) process for the root and second layer as a minimum.
- G. Austenitic stainless steel instrument tubing shall be welded using only the GTAW process.
- H. Socket welds or butt welds in all austenitic stainless steel instrument tubing lines shall require an inert gas backing (purge) using argon during welding to avoid oxidation.
- I. The application of heat to correct weld distortion and dimensional deviation without prior written approval from the Engineer is prohibited.
- J. Unless otherwise approved in writing, the GTAW process shall require the addition of filler metal.
- K. The maximum preheat and interpass temperature for austenitic stainless steel shall be 350° F. The minimum preheat temperature shall be 50° F.
- L. Complete joint penetration welds welded from one side without backing, weld repairs welded from one side without backing, or weld repairs in which the base metal remaining after excavation is less than 0.1875 inch from being through wall, which are fabricated from austenitic stainless steel ASME P-number 8 base metal or unassigned metals with similar chemical compositions, shall have the root side of the weld purged with an argon backing gas prior to welding. Backing gas (purge) shall only be argon. The argon backing gas shall be classified as welding grade argon or shall meet Specification SFA-5.32, AWS Classification SG-A. The backing gas (purge) shall be maintained until a minimum of two layers of weld metal have been deposited.

2.3 SHOP CLEANING AND PICKLING OF STAINLESS STEEL PIPING AND WELDS

- A. All stainless steel piping shall be thoroughly cleaned and pickled at the mill in accordance with ASTM A380.
- B. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication including welded areas shall either be mechanically cleaned or repickled or passivated in accordance with ASTM A380. Materials that have been contaminated with steel alloys or free iron shall not be used until all contamination is removed. When cleaning to remove steel or iron contamination is required, it shall be performed in accordance with ASTM A380, Code D requirements. Mechanical cleaning is not an acceptable cleaning method for oxygen or ozone piping. All stainless steel surfaces shall be adequately protected during fabrication, shipping,

handling, and installation to prevent contamination from iron or carbon steel objects or surfaces. Particulate matter shall be removed from piping and welds. Labels shall be affixed to the piping sections to indicate shop cleaning has been performed. Welds shall be either mechanically cleaned or pickled or passivated on the exterior of the pipe.

2.4 INSULATING FITTINGS

A. In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

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SECTION 40 05 24.43 - MISCELLANEOUS STEEL PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of miscellaneous steel pipe, tubing and accessories that for pipe diameters 24 inches and smaller. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.
- B. Steel pipe for potable and non-potable water conveyance are covered in the Steel Pipe section.

1.2 GENERAL

- A. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1.3 SUBMITTALS

A. Drawings and Data

- 1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:
 - a. Name of Manufacturer
 - b. Type and model
 - c. Construction materials, thickness, and finishes
 - d. Pressure and temperature ratings

B. Gasket Material Certification



Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

- B. Coated Pipe
 - 1. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 STEEL PIPE

- A. Steel pipe materials and service shall be as specified herein.
- B. Material Classification CS-3 CS-3 – Standard Weight Steel with

Buttwelded Fittings.Indoor blower discharge air piping.Blower blow-off air piping.8-inch AGS Reactor in-wall basin drain
valve underdrain piping.

2-1/2 inch and larger.

C. Accessory Materials

1. Accessory materials for the miscellaneous steel pipe and tubing systems shall be as indicated.

Pipe

Nipples

Unions (Malleable Iron)

Flanges

Standard Weight Pipe

Flange Bolts and Nuts

ASTM A733, seamless, extra strong (Schedule 80); "close" nipples will be permitted only by special authorization in each case.

ASTM A53/A106, Type S,

ends.

weight.

standard weight, Grade B; beveled

Buttwelded. Fittings shall conform

to ANSI/ASME B16.9, standard

Fed Spec WW-U-53l, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe.

ANSI/ASME B16.5, Class 150, flat faced when connected to flat faced flanges; otherwise, raised face.

ASTM A193, Grade B7 with ASTM A194 Grade 2H nuts. Length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.

Flange Gaskets	
For Process Air Service	
Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces, rated for 275°F service; Garlock "IFG 5507".
Flat Faced Flanges	Premium Grade, EPDM, full face, 1/8 inch thick, rated for 275°F service; Garlock "8314"
For Water Service	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch thick.
For Other Services	
Flat Faced Flanges	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces.
Raised Face Flanges	Continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch ± 0.005 inch.
Expansion Joints	See Section 40 05 23 for requirements.
Insulation	All blower inlet, blow-off and discharge piping shall be insulated and jacketed. Refer to Section 40 42 11 – Mechanical Insulation for requirements.

2.2 COATINGS

- A. Standard weight steel pipe in buried locations, except hot piping such as aeration air piping, shall have exterior surfaces protected with a shop applied plastic coating. Coatings for hot piping shall be as specified.
- B. All surfaces to be tape-wrapped in the shop shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils.
- C. Shop applied coatings shall be as follows:
 - 1. External Coatings
 - a. Plastic: Liberty Coating Company "Pritec" or Bredero-Shaw "Entec." The products of other manufacturers will not be acceptable.

- Tape Wrap: ANSI/AWWA C209, except single ply tape thickness shall not be less b. than 30 mils; Protecto Wrap "200" or Tapecoat "CT."
- High temperature epoxy for aeration and process air piping: Shop or field applied c. high solids epoxy; suitable for protection at continuous pipe wall temperatures up to 300 F. Coating shall be abrasion resistant. The finished coating shall have a minimum total film thickness of 10 mils. The surface shall be prepared in accordance with SSPC-SP7 as a minimum unless otherwise recommended by the coating manufacturer. The coating shall be Carboline "Thermaline 450," Ameron "Amerlock 400 with Amercoat 880 Additive," or approved equal.

PART 3 - EXECUTION

3.1 **INSTALLATION**

ner Materials furnished under this section will be installed in accordance with the Miscellaneous A.

SECTION 40 05 32 - MISCELLANEOUS PLASTIC PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous plastic pipe, tubing, and accessories. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, jointing materials and other necessary appurtenances.

1.2 SUBMITTALS

- A. Drawings and Data
 - 1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:
 - a. Name of Manufacturer
 - b. Type and model
 - c. Construction materials, thickness, and finishes
 - d. Pressure and temperature ratings

B. Gasket Material Certifications.

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

B. Pipe, tubing, and fittings shall be stored between 40°F and 90°F.

PART 2 - PRODUCTS

2.1 PVC PIPE MATERIALS

A. PVC pipe materials and services shall be as specified herein.

B. Material Classification PVC-6

PVC-6 – PVC Underdrain	Pipe	ASTM F758, perforated wall, Cell
Pipe	_	Classification 12454 or 12364, Type PS 46.
-	Fittings	ASTM D3034, Cell Classification 12454,
AGS Reactor Underdrain		wall thickness SDR 35, with elastomeric
Piping		gasket joints.

- C. Accessory Materials
 - 1. Accessory materials for the PVC Pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to
	ANSI/ASME B16.5, Class 150.
	Schedule 80 for DWV systems.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after
	installation, the bolts will project 1/8 to 3/8 inch
	beyond outer face of the nut.
	Stainless steel for DWV and chemical feed systems,
	galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain. Same material as bolts and nuts.
Flange Gaskets	Full face, 1/8 inch thick, chemical-resistant elastomeric
C C	material suitable for the specified service.

2.2 PE PIPE MATERIALS

- A. PE pipe materials and services shall be as specified herein.
- B. Material Classification PE-5

PE-5 – Corrugated	Tubing and	AASHTO M252 and ASTM F405, with solid
Polyethylene Drainage	Fittings	wall.
Tubing.		
Support Facility ST Yard		
Piping		

C. Accessory Materials

Accessory materials for the PE Pipe systems shall be as indicated.

Flanges

Flange Bolts and Nuts

Schedule 80 PVC; diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.

ANSI B18.2.1, ASTM A193, AISI Type 304, heavy hex head, length such that after installation the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. ASTM A194, AISI Type, ANSI/ASME B18.2.2, heavy hex pattern. Fittings and Flange Adapters

Molded or manufactured from the pipe; cell classification of material and pressure rating same as for pipe.

PART 3 - EXECUTION

3.1 **INSTALLATION**

Materials furnished under this section will be installed in accordance with the Miscellaneous

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SECTION 40 05 41 - MISCELLANEOUS PIPING AND PIPE ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous piping and pipe accessories. Miscellaneous piping shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS

- A. Drawings and Data
 - 1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:
 - a. Name of Manufacturer
 - b. Type and model
 - c. Construction materials, thickness, and finishes
 - d. Pressure and temperature ratings

B. Gasket Material Certifications

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Miscellaneous piping materials shall be as specified herein.

Service	Material
Sanitary drainage, vent, inside the building, above/below ground, storm water piping, sump pump discharge	PVC, Class 150 to AWWA C900 Cast Iron to ASTM A74 and ASTM A888
Domestic Water/W4 Service inside building	PVC, CPVC to ASTM D2564, F493 PVDF to ASTM D3222
Natural Gas above ground Natural Gas below ground	Steel SCH 40, ASTM A53 av HDPE 4710 to ASTMD 2513
Refrigerant	ACR copper, to ASTM B280
	6

PART 3 - EXECUTION

3.1 **INSTALLATION**

Materials furnished under this section will be installed in accordance with the Miscellaneous Α. Piping and Accessories Installation section.

End of Section

SECTION 40 05 51.13 - VALVE INSTALLATION

PART 1 - GENERAL

1.1 **SCOPE**

- This section covers the installation of new valves and actuators purchased by Contractor as part A. of this Work or purchased by others under the valve specifications. The equipment to be furnished by others for installation by Contractor is identified in the applicable valve schedules.
- Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in B. other sections.
- C. The following specification sections are applicable to valves to be installed: s bi ot bildine

Title

- 1. Industrial Butterfly Valves
- 2. Check Valves
- 3. Plug Valves
- 4. **Basin Valves**
- AWWA Butterfly Valves 5.
- Eccentric Plug Valves 6.
- 7. Resilient-Seated Gate Valves
- 8. Knife Gate Valves
- 1.2 GENERAL
 - Equipment installed under this section shall be erected and placed in proper operating condition A. in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
 - Any valves and actuators that are identified as being provided by others will be furnished B. complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

- C. Coordination
 - 1. When manufacturer's field services or installation check services are provided by the supplier, Contractor shall coordinate the services with the supplier. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services.
 - 2. Flanged, push-on, and grooved connections to valves including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section. Valve ends shall match piping. purpose

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 **INSPECTION**

All valves and accessories shall be inspected for damage and cleanliness before being installed. A. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 **INSTALLATION**

- A. General
 - Valves shall be installed with sufficient clearance for proper operation of any external 1. mechanisms, and with sufficient clearance to dismantle the valve for in-place maintenance. Installation shall be in accordance with the valve manufacturer's recommendations.
 - 2. Unless otherwise indicated on the Drawings or specified, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of piping having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation, as reviewed by Engineer.
- Installation Checks B.
 - When specified in the valve sections, the valve manufacturer will provide installation 1. checks. For installation checks, the manufacturer's field representative will inspect the valve installation immediately following installation by Contractor. The manufacturer's

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representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

- 2. Contractor shall perform no work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.
- C. AWWA Butterfly Valves
 - 1. Butterfly valves shall be installed with the shaft horizontal unless otherwise necessary for proper operation or as acceptable to Engineer.
 - 2. Whenever an actuator must be removed to permit installation of a valve, the actuator shall be promptly reinstalled and shall be inspected and readjusted by a representative of the valve manufacturer.
- D. Check Valves
 - 1. Lift Check Valves
 - a. Horizontal lift checks shall be installed in a level horizontal position so that the internal parts rise and fall vertically, unless the valve is spring loaded. Angle pattern lift checks shall be installed in vertical pipe with flow upward from beneath the disc.
 - 2. Swing Check Valves
 - a. Install valves oriented for the correct flow direction. Only valves designed for vertical installation shall be installed in vertical piping.
 - 3. Low Pressure Air Service Check Valves
 - a. Dual disc wafer check valves installed in the discharge piping of centrifugal blowers shall be positioned with the valve hinge perpendicular to the impeller shaft of the blower.
- E. Plug Valves



Plug valves shall be installed with the shaft horizontal and the plug in the upper half of the valve body. Valves in horizontal wastewater, sludge, or scum lines shall be installed with the seat on the upstream end. Valves in all vertical piping shall be installed with the seat at the upper end of the valve.

- F. Resilient Seated Gate Valves
 - 1. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendices to ANSI/AWWA C509 and C515 and with the recommendations of the manufacturer.

- G. Air Release and Combination Air Valves
 - 1. The exhaust from each valve shall be piped to a suitable point acceptable to Engineer. Air release valve exhaust piping leading to a trapped floor drain shall terminate at least 6 inches above the floor.
- H. Hydrants
 - 1. Yard Hydrants
 - a. A concrete slab 18 inches square and 4 inches thick shall be provided around the top of each 3/4 inch and 1-1/2 inch yard hydrant. Hydrants shall be installed plumb. Hydrant drainage shall be provided by installing below each hydrant at least 1 cubic foot of gravel or crushed stone.
 - Each 4 inches yard hydrant shall be set on a reinforced concrete foundation at least 18 inches square and 6 inches thick. Each hydrant shall be anchored in place or adequately blocked to prevent the hydrant from blowing off the supply connection. Hydrant drainage shall be provided by installing at least 7 cubic feet of gravel or crushed stone around the hydrant and below the top of the hydrant supply pipe.
 - c. An operating wrench shall be provided for each yard hydrant.
- I. Valve Boxes
 - 1. Valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After each valve box is placed in proper position, earth fill shall be placed and thoroughly tamped around the box.

3.3 VALVE ACTUATORS

A. Valve actuators and accessories shall be factory mounted on the valve, calibrated, and tested by the valve or actuator manufacturer.

3.4 FIELD QUALITY CONTROL

A. Field Testing

1. After installation, all valves shall be tested in accordance with the Pipeline Pressure and Leakage Testing section.

Pressure Tests

- a. Pressure testing shall be in accordance with the Pipeline Pressure and Leakage Testing section.
- 3. Leakage Tests
 - a. All valves shall be free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at

the expense of Contractor. This requirement applies whether pressure testing is required or not.

3.5 ADJUSTING

enter

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SECTION 40 05 51.16 - GATE INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the installation of new gates and actuators purchased by Contractor as part of this Work.
- B. The following specification sections are applicable to gates to be installed under this contract:
 - 1. Stainless Steel Slide Gates

1.2 GENERAL

- A. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Any gates and actuators identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.
- C. Coordination
 - 1. When installation check services are provided by the gate manufacturer, Contractor shall coordinate the services with the gate manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's installation check services.
 - 2. Submittals for equipment furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials shall be as follows:
 - 1. Grout As specified in the Grouting section.

PART 3 - EXECUTION

3.1 **INSPECTION**

- All gates and accessories shall be inspected for damage and cleanliness before being installed. A. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use. nost
- 3.2 INSTALLATION.
 - A. General
 - Gates and appurtenances shall be installed with sufficient clearance for proper operation 1. of any external mechanisms, and with sufficient clearance to dismantle the gate for Installation shall be in accordance with the manufacturer's maintenance. recommendations and the requirements specified herein.
 - All bolts shall be tightened and all items requiring lubrication, including pivot pins, shall 2. be lubricated. Anti-seize thread lubricant shall be liberally applied to the threaded portion of stainless steel anchor bolts during the installation and tightening of nuts. Excess lubricant shall be thoroughly removed following final tightening.
 - The threaded portion of each plastic stem cover shall be wrapped in at least two layers of 3. teflon thread tape, and the threaded portion of steel pipe stem covers shall be coated with teflon thread sealer immediately prior to installation of the cover on the actuator.
 - Each gate shall be adjusted so that it does not bind or leak in excess of specified 4. requirements. After installation, each gate shall be operated through at least two complete open-close cycles, re-adjusted and re-operated as necessary, and left in a condition acceptable to Engineer.
 - Installation Checks B.
 - When specified in the gate sections, the gate manufacturer will provide installation 1. checks. For installation checks, the manufacturer's field representative will inspect the gate installation immediately following installation by Contractor. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.
 - Contractor shall perform no Work related to the installation or operation of materials or 2 equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.

- C. Fabricated Stainless Steel Slide Gates
 - 1. Each fabricated stainless steel slide gate shall be carefully installed and adjusted for proper operation. Care shall be taken to avoid warping the gate frames and to maintain tolerances between seating faces.
 - 2. Wall thimbles, if required, shall be accurately positioned and supported to prevent shifting during placement of surrounding concrete. Square or rectangular thimbles shall be carefully braced both horizontally and vertically to prevent distortion.
 - 3. Gates mounted directly on the vertical face of concrete walls shall be adjusted and grouted in place with non-shrinking grout in accordance with the manufacturer's recommendations.
 - 4. Gates shall be installed so that frame members and anchor bolts do not rest upon or contact steel reinforcing bars. Anchor bolts shall be set using a template.
 - 5. Grout fill shall be placed in the pit in front of each flush bottom closure gate after the gate has been adjusted.
 - 6. Each actuator shall be accurately set and plumbed and shall be in proper alignment with the gate and stem before the actuator is grouted in place. Operating stems shall be installed in proper alignment and shall not bind in the lift nut or stem guides.

3.3 GATE ACTUATORS

A. Gate actuators and accessories shall be installed in accordance with the equipment manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

- A. Field Testing
 - 1. After installation, all gates shall be pressure tested for leakage at the hydrostatic heads specified. Leakage exceeding the specified limits which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.
- B. Fabricated Stainless Steel Slide Gates
 - For the maximum seating and unseating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.

3.5 ADJUSTING

A. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic, or electric actuated gate.

End of Section

Not to be used for bidding pumposes

SECTION 40 05 57 - VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing manual and powered valve and gate actuators and accessories as specified herein.

1.2 GENERAL

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standards

- 1. Except as modified or supplemented herein, cylinder and vane type actuators shall conform to applicable requirements of ANSI/AWWA C541.
- 2. Except as modified or supplemented herein, electric motor actuators shall conform to applicable requirements of ANSI/AWWA C542.
- 3. Except as modified or supplemented herein, actuators for butterfly and eccentric plug valves shall conform to the applicable requirements of ANSI/AWWA C504.



Except as modified or supplemented herein, manual actuators for ball valves shall conform to the applicable requirements of ANSI/AWWA C507.

- 5. Except as modified or supplemented herein, actuators for cast-iron slide gates shall conform to the applicable requirements of ANSI/AWWA C560.
- 6. Except as modified or supplemented herein, actuators for open channel slide gates and weir gates shall conform to the applicable requirements of ANSI/AWWA C513.
- 7. Except as modified or supplemented herein, actuators for stainless steel slide gates shall conform to the applicable requirements of ANSI/AWWA C561.

- 8. Except as modified or supplemented herein, actuators for composite slide gates shall conform to the applicable requirements of ANSI/AWWA C563.
- E. Power Supply
 - 1. Power supply to electric actuators will be as indicated in the valve and gate schedules.
- F. Marking
 - 1. Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.
- G. Temporary Number Plates
 - 1. Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve or gate by number or service as indicated in the valve or gate schedule.

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1.3 SUBMITTALS

- A. Drawings and Data General
 - 1. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.
- B. Drawings and Data Electrical and Wiring Diagrams
 - 1. Submittal drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.
- C. Network Valve Actuator Data
 - 1. For networked valve actuators, information on the available input and output assemblies shall be submitted for the protocol(s) specified to be provided. The submittal shall identify the version of the selected network protocol for which the device has been tested and certified.
- D. Testing Certifications and Results
 - 1. For electric or cylinder actuators, certified copies of reports covering proof-of-design testing of the actuators as set forth in Section 5 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, together with an affidavit of compliance as indicated in Section 6.3 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, shall be submitted to Engineer before the actuators are shipped.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

- A. General
 - 1. Actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective valve and gate sections.
 - 2. Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.

B. Valve Actuators

- 1. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential across the valve and maximum velocities through the valve where indicated in the respective valve schedules.
- 2. Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the Drawings or directed by Engineer.
- 3. When valves are to be buried, submerged, or installed in vaults; the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective valve schedules but not less than 20 feet .
- C. Gate Actuators
 - 1. Actuators shall be sized to produce the torque or thrust required to operate the gate when subject to the seating and unseating operating heads as indicated in the respective gate schedules.
 - 2. Both the design head and the operating head shall be measured from the surface of the liquid to the center line of the gate.

2.2 MATERIALS

A

Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of the applicable governing standard(s).

2.3 VALVE MANUAL ACTUATORS

A. General

1. Manual actuators of the types listed in the valve specifications or schedules shall be provided by the valve manufacturer.

- 2. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.
- 3. The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.
- 4. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.
- 5. Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.
- 6. Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.
- 7. Actuators shall produce the required torque with a maximum pull of 80 lbs on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs on the handwheel or chainwheel or an input of 300 foot-lbs on the operating nut.
- B. Handwheels
 - 1. Handwheel diameters shall be at least 8 inches but not more than 24 inches for 30 inch and smaller valves and not more than 30 inches for 36 inch and larger valves.
 - 2. Chainwheels. Unless otherwise specified in the valve schedules, all valves with center lines more than 7'-6" above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized or zinc plated carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.
- C. Levers
 - Levers shall be capable of being locked in at least five intermediate positions between fully open and fully closed. In any building or structure containing lever operated valves, at least two operating levers shall be provided for each size and type of lever operated valve.

- D. Chain Levers
 - 1. Suitable actuator extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.
- E. Wrench Nuts
 - 1. Unless otherwise specified in the valve schedules or on the Drawings, wrench nuts shall be provided on all buried valves and on all valves that are to be operated through floor boxes. Unless otherwise directed by Owner, all wrench nuts shall comply with Section 4.4.13 of ANSI/AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

2.4 GATE MANUAL ACTUATORS

- A. General
 - 1. Manual actuators of the types listed in the gate schedules shall be provided by the gate manufacturer. Unless otherwise specified, actuators shall conform to ANSI/AWWA C560.
 - 2. All bearings and gears shall be totally enclosed in a weathertight housing having a sufficient number of fittings to permit periodic lubrication of all internal moving components without partial or total disassembly of the mechanism. The pinion shaft of crank-operated mechanisms shall be supported by roller bearings or needle bearings.
 - 3. The direction of rotation of the wheel, crank, or wrench nut to open the gate shall be to the left (counterclockwise).
 - 4. Actuators for rising stem self-contained gates shall be designed for mounting directly on the frame yoke.
 - 5. When indicated in the gate schedules, crank-operated actuators shall be suitable for operation with a portable actuator specified herein. A suitable adapter coupling shall be furnished with each crank actuator to couple the portable actuator to the crank actuator pinion shaft as required.
- B. Remote Actuators

Remote actuators shall be operated by a frame-mounted handwheel and chain drive. An extension shaft suitable for connection to the pinion shaft of the benchstand shall be provided complete with a roller chain, shaft couplings, support bearings, and a roller chain sprocket keyed or bolted to the end of the shaft. A handwheel with bearing housing and sprocket shall be bolted to the side frame approximately 48 inches above the operating floor. Removable aluminum or stainless steel weathertight covers shall be provided to protect the extension shaft, drive chain, and sprockets. Handwheel and sprocket diameters shall be selected to operate the gate under the maximum specified seating pressure with an effort of not more than 40 lbs applied to the rim of the

handwheel. Handwheels and sprockets shall be able to withstand a 100 lb effort without damage.

- C. Dual Actuators
 - 1. Dual actuators shall be provided where indicated in the gate schedules. Dual actuators shall be interconnected by a cross shaft complete with required couplings so both stems move at the same rate. Each cross shaft shall be protected by a full length removable aluminum or stainless steel cover attached to the yoke beam or actuator.
- D. Floorstands
 - 1. Floorstands shall be designed to transfer operating thrusts to the supporting structure. Each floorstand shall be designed to position the crank or the handwheel approximately 36 inches above the frame yoke, supporting surface, or adjacent operating floor or platform.

2.5 INTELLIGENT ELECTRIC ACTUATORS

- A. General
 - 1. Intelligent electric actuators as listed in the valve and gate schedules shall be provided by the valve or gate manufacturer.
 - 2. Intelligent electric actuators with torque output requirements of 750 ft-lbs and less for butterfly valves and eccentric plug valves shall be quarter-turn type and shall be Auma "AUMATIC SQBV 05.1 through SQBV 12.1", or Rotork "IQT Series" without exception.
 - 3. All other intelligent electric actuators for open-close service shall be multi-turn type and shall be Auma "AUMATIC AC SABV 07.2 through SABV 16.2", or Rotork "IQ Series" without exception.
 - 4. Intelligent electric actuators for modulating service shall be Auma "AUMATIC AC SARBV 07.2 through SARBV 16.2", or Rotork "IQ Series" without exception.
 - 5. Intelligent electric actuators for explosion proof service shall be Auma "AUMATIC AC SAExBV/SARExBV 07.2 through SAExBV/SARExBV 16.2", or Rotork "IQ Series" without exception.

6.

Intelligent electric actuators produced by other manufacturers are not acceptable.

- 7. Intelligent electric actuators shall be capable of non-intrusive configuration without requiring removal of any actuator covers. Configuration of actuator functions shall be by use of a hand held infrared linked device, laptop or PDA with compatible wireless communication capability, or by local control switches and 32-character LCD display mounted on the actuator housing. The display language shall be English.
- 8. Each intelligent electric actuator shall be furnished complete with a motor, gearing, handwheel, configurable output relays, torque sensors, lubricants, wiring, and terminals.

Each actuator shall be constructed as a self-contained unit with a ductile iron or aluminum alloy housing, of a type as indicated in the valve and gate schedules, and shall be integrally assembled on the applicable valve or gate by the valve or gate manufacturer. Housings shall have two O-ring seals, one on the controls compartment and one on the terminal cover.

- 9. Actuators shall be designed to cycle the valve or gate from the fully open to the fully closed position or the reverse in approximately 60 seconds or as indicated in the valve and gate schedules.
- 10. Actuator motors may be mounted horizontally adjacent to or vertically above the reduction gearing. All gearing shall be oil or grease lubricated.

B. Motors

- 1. Motors shall be totally enclosed, high torque design made expressly for valve and gate actuator service, capable of operating the valve or gate under full differential pressure for two complete strokes or one complete cycle of travel without overheating. Motors shall be designed in accordance with NEMA standards and shall operate successfully at any voltage within 10 percent above or below rated voltage. Motor bearings shall be permanently lubricated. Motors shall be capable of indicating phase loss. Motors for open-close service shall be rated for a minimum of 60 starts per hour and motors for modulating service shall be rated for a minimum of 1,200 starts per hour.
- C. Power Gearing
 - 1. Power gearing shall consist of hardened steel spur or helical gears and alloy bronze or hardened steel worm gear, all suitably lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter. Steel gears shall be hardened to at least 350 Brinell. Planetary or cycloidal gearing, aluminum, mild steel, or nonmetallic gears will not be acceptable. Gearing shall be designed to be self-locking so that actuation of a torque switch or electronic torque protection device by a torque overload condition will not allow the actuator to restart until the torque overload has been eliminated. If a secondary gearbox is required, it shall be designed to withstand the locked rotor torque of the actuator.
- D. Handwheel Mechanism



The handwheel shall not rotate during motor operation. During handwheel operation the motor shall not affect the actuator operation. The actuator shall be responsive to electrical power and control at all times and, when under electrical control, shall instantly disengage the handwheel. The handwheel shall rotate counterclockwise to open the valve. An arrow indicating the opening direction and the word "Open" shall be cast on the handwheel. The force required to operate the handwheel shall not exceed 80 lbs . The handwheel shall have a padlockable declutch lever.

- E. Torque Sensing
 - 1. Torque and thrust loads in both closing and opening directions shall be limited by a torque sensing device. Torque settings shall be adjustable and shall be indicated locally. The adjustment shall permit a variation of 40 to 100 percent of rated torque.
- F. Terminal Facilities
 - 1. Terminal facilities for connection to motor leads, switches, and control and indication signals shall be provided in a readily accessible terminal compartment. The terminal compartment shall have at least two openings for external electrical conduits, one sized at least 3/4 inch and the other at least 1-1/4 inches. Each terminal compartment shall be large enough to allow easy routing and termination of fifteen 12 AWG conductors.
- G. Controls Compartment
 - 1. Each actuator shall be furnished with a sealed compartment containing a reversing controller, multi tap transformer, electronic controls, and monitoring and protection modules. Reversing controllers shall be both mechanically and electrically interlocked and provided with the necessary direct-operated auxiliary contacts for required interlocking and control. The multi tap transformer shall provide power for all internal circuits, and shall provide 120 VAC supply for remote controls as indicated in the valve and gate schedules, or in the schematics on the Drawings.
 - 2. Where not networked, actuators for valves or gates listed for modulating service in the valve and gate schedules shall be provided with a control module for position modulating type service. The control module shall be mounted within the controls compartment. The module shall accept a standard 4-20 mA dc analog input signal with a load impedance of not greater than 400 ohms. The control module shall contain adjustments for span, zero, gain, and deadband. Non-networked modulating actuators shall have a 4 to 20 mA output signal proportional to valve or gate position.
- H. Local Controls
 - 1. Each actuator shall have controller devices mounted on the actuator as indicated in the valve and gate schedules.
- I. Remote Indication and Controls



- a. Valve or gate opening, closing, or moving.
- b. Thermostat tripped, phase loss.
- c. Motor tripped on torque in mid travel, motor stalled.
- d. Remote mode selected.

- e. Local mode selected.
- 2. Valve or gate control commands and actuator status indication for networked valves shall be communicated over the network. The actuator shall accept remote controls through the network to open, close, and stop the actuator and shall also accept a position setpoint. Hardwired signals to the actuator shall prevent or allow the actuator to operate as indicated on the Drawings. A hardwired permissive, inhibit or emergency stop interlock(s) shall override commands transmitted through the network.
- 3. At a minimum, the actuator shall transmit the following status information through network:
 - a. Valve opening, closing, or moving.
 - b. Valve full open, full closed.
 - c. Thermostat tripped, phase loss.
 - d. Motor tripped on torque in mid travel, motor stalled.
 - e. Remote mode selected.
 - f. Local mode selected.
 - g. Valve position.
 - h. Valve torque.
- J. Remote Electric Actuator Control Station
 - 1. Each actuator shall be furnished with a remote control station as indicated in the valve schedules and on the Drawings. The control station shall include red and green indicating lights for valve position status, and Local-Off-Remote and Open-Close selector switches for control,
 - 2. Power for the remote control station shall be provided from its respective actuator unit. The remote control station shall be rated NEMA 4X. Each device mounted on the remote control station shall have an engraved label or escutcheon plate indicating its respective function. The remote control station shall have an engraved tag indicating the tag number or description of the respective actuated valve or gate.

2.6 ACTUATOR ACCESSORIES

- A. Extension Stems
 - Extension stems and stem guides shall be furnished when indicated in the respective valve schedules, indicated on the Drawings, or otherwise required for proper valve operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the actuator shaft. Extension stems shall be connected to the actuator with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.
 - 2. At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet, whichever is smaller. The top stem guide shall be designed to carry the weight of the

extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.

- 3. Extension stems for chemical resistant butterfly valves located in drainage sumps shall be the two-piece type with stainless steel stem, PVC housing, wall support, and collar. Unless otherwise indicated on the Drawings, the length of the stem extension shall be as necessary to position the valve operator 12 inches above the maximum liquid level in the immediate area.
- 4. Extension stems for buried valve actuators shall extend to within 6 inches of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.
- 5. Extension stems for buried valve actuators shall be provided with position indicators as specified in the valve schedules.
- B. Position Indicators
 - 1. Where specified, each valve actuator shall be provided with a position indicator to display the position of the plug or disc relative to the body seat opening.
 - 2. For quarter turn plug, ball, or cone type valves installed in interior locations, the indicating pointer shall be mounted on the outer end of the valve operating shaft extension and shall operate over an indicating scale on the operating mechanism cover. Where the shaft passes through the cover, a suitable stuffing box or other seal shall be provided to prevent the entrance of water.
 - 3. Each actuator for butterfly valves, except where located in manholes, buried, or submerged, shall have a valve disc position indicator mounted on the end of the valve shaft. A disc position indicator shall also be provided on each operating stand or the actuator mounted thereon.
- C. Valve Boxes
 - Each valve buried to a depth of 4 feet or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches in inside diameter, shall be at least 3/16 inch thick, and shall be provided with suitable cast iron bases and covers.



Each valve buried deeper than 4 feet shall be provided with a valve box consisting of a cast iron cover and a 6 inch Cast Iron Pipe section. The cover shall be Clay & Bailey "No. 2193". The pipe shaft shall extend from the valve to 5 inches inside the valve box cover.

- 3. All parts of valve boxes, bases, and covers shall be shop coated with manufacturer's standard coating.
- 4. Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2.7 SHOP PAINTING

- A. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.
- The following surfaces shall be painted: B.

Polished or Machined Surfaces

Other Surfaces

Actuators and Accessories

Rust-preventive compound. 19050

Universal primer.

Epoxy.

PART 3 - EXECUTION

3.1 **INSTALLATION**

Actuators will be installed on the valves in accordance with the Valve Installation section and A. on gates in accordance with the Gate Installation section.

3.2 FIELD QUALITY CONTROL

Installation Supervision A.

- The equipment manufacturer shall furnish installation supervision services when 1. indicated in the Equipment Schedule section.
- Installation Check B.
 - The equipment manufacturer shall provide a certificate of proper installation when 1. indicated in the Equipment Schedule section.
- Functional Testing. С.

The equipment manufacturer shall provide functional testing assistance when indicated in 1. the Equipment Schedule section.

Performance and Other Testing

The equipment manufacturer shall provide performance and other testing services when 1. indicated in the Equipment Schedule section.

3.3 NETWORK SETUP

A manufacturer's representative for the intelligent electric actuator manufacturer shall inspect А. all network terminations for conformity with the manufacturer's recommended methods of

terminating the network to each actuator, and shall notify the Contractor of any wiring modifications required. The manufacturer's representative shall also set addresses for each valve and prove communication over the network. The valve manufacturer shall furnish the required information to the control system supplier that will allow the specified control and monitoring for each intelligent electric actuator.

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SECTION 40 05 59.23 - STAINLESS STEEL SLIDE GATES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing stainless steel slide gates and actuators as specified herein and as indicated in the Stainless Steel Slide Gate Schedules. Slide gates shall be furnished complete with frames, actuators, stem guides, operating stems, and appurtenances as specified herein and as indicated in the schedules. Operators shall be in accordance with the Actuators for Process Valves and Gates section.

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.
- B. Gates and actuators shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest product of a manufacturer regularly engaged in the production of slide gates.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- D. Governing Standard
 - 1. Except as modified or supplemented herein, all slide gates shall conform to the applicable requirements of ANSI/AWWA C561.
- E. Minimum Metal Thickness



Where so indicated in the governing standard, the design safety factors pertaining to tensile, compressive, and shear strength of materials used shall be observed. In addition, unless otherwise acceptable to the Engineer, all portions of submerged components of each gate, exclusive of stem guide wall brackets, shall have a metal thickness of at least 1/4 inch.

F. Tagging

1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

- G. Identification
 - 1. Gates shall be identified in accordance with the Equipment and Valve Identification section.
- H. Shop Testing
 - 1. All gates shall be completely assembled in the shop to ensure that all parts fit together properly.

1.3 SUBMITTALS

- A. Complete drawings, construction details, and specifications covering the slide gates, and appurtenances shall be submitted in accordance with the Submittal Procedures section. Each drawing shall be identified with the corresponding gate designation.
- B. Drawings shall include separate wiring diagrams for each electrically operated gate and related electrical control equipment.

1.4 DELIVERY, STORAGE, AND HANDLING.

- A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.
- B. In addition, frames shall be provided with corner bracing, plywood sheet backing, or other means to hold the frames in proper alignment during shipment and installation. The bracing or backing shall be factory applied and will not be removed until after the frames have been installed in the structures.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. One stainless steel slide gate will be provided in the existing Distribution Chamber to isolate the WAGS/WLC Pump discharge.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Slide gates shall be designed for the conditions and requirements indicated in the Stainless Steel Slide Gate Schedules.
- B. Design
 - 1. Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one third of the yield point or one fifth of the ultimate strength of each material.

2. Gates shall be designed for the design seating and unseating heads indicated in the gate schedule. Both the design head and the operating head shall be measured from the surface of the liquid to the invert of the gate. Gates shall be designed to fit into the structures indicated on the Drawings.

2.3 ACCEPTABLE MANUFACTURERS

- Α. The fabricated stainless steel slide gates furnished under this section shall be manufactured by: nose
 - 1. **RW** Gate Company
 - 2. Whipps
 - 3. or equal.
- This listed equipment is part of the Base Bid as indicated on the Bid pages and will be B. considered as establishing the type, function, appearance, and quality required as defined in the General Conditions.
- C. The drawings and specifications were prepared based on the named manufacturers. Contractor shall include in the Bid and shall be responsible for the cost of any changes, including engineering changes, to accommodate the other Base Bid equipment, including but not limited to structural, mechanical and electrical work.
- D. Contractor may provide Alternative Bids for equipment from other manufacturers by writing their name into the blank(s) provided on the Bid form. Contractor shall comply with all provisions regarding substitute items and shall include in the Bid and be responsible for the cost of any changes to accommodate substitute equipment including but not limited to structural, mechanical, and electrical work. Contractor shall also pay costs of engineering services for review of substitutes and for revisions of drawings and/or specifications by Engineer to accommodate substitutes.

2.4Frames Yokes

ASTM A240, Type 316L stainless steel.

ASTM A240, Type 316L stainless steel.

Flush Bottom Closure Seal

Hollow Bulb J-Seals

Compressible neoprene.

Compressible neoprene.

Seal Retainer Bar

Slide Seats and Bearing Bars

Mounting

Handwheel

Lifting Nut

Lifting Stem and Stem Guides

edf

Stem Covers

Stainless Steel Surface Finishes

Accessories

Thimbles

Stainless Steel, ASTM B276, Type 316L

UHMW polyethylene

ASTM A240, Type 316L stainless steel.

Cast aluminum or epoxy coated steel.

Bronze or Brass. Furnish great fitting, roller bearings, ball bearings, or polymer bearing pads above and below lifting nut and for pinion shaft support

ASTM A276, Type 316 stainless steel.

Provide rising stem gates with clear butyrate, polycarbonate or methacrylate plastic covers, capped, vented, and of a length to allow full travel of gate.

Mill finish. All welds shall be passivated in accordance with ASTM A380 for a uniform finish.

ASTM A276, Type 316 stainless steel.

ASTM A240, Type 316L stainless steel.

2.5 FRAMES

- A. Each frame shall be an integral unit of extruded or welded structural shapes having a thickness of not less than 1/4 inch. Gate frames shall be of the configurations listed in the Stainless Steel Slide Gate Schedules. Frames shall be designed for embedment in concrete or installation on the face of concrete walls or thimbles as required in the Stainless Steel Slide Gate Schedules. Embedded frames shall be recessed, or seals shall be mounted, so that the waterway is not obstructed.
- B. Guides shall be provided on each side of each frame. Guides shall be sufficiently strong so that no further reinforcing will be required where the guides extend above the operating floor. Guides shall support the entire height of the slide in all positions.
- C. Full-length plastic slide seats or bearing bars shall be provided on both sides of the slide. Seats and bars shall be securely held in the guides by permanent mechanical fasteners evenly spaced along the height of the guides.
- D. All self-contained gates shall be equipped with a yoke, shop welded to the top of vertical frame members to support the actuator. Yokes shall be fabricated from a pair of formed or rolled extruded channels or angles and shall be designed for deflection of not more than 1/720 of the span when the gate is operated at the specified maximum seating or unseating pressure. Each yoke shall be designed to permit vertical removal of the slide. Actuators shall be mounted so that no eccentric loads are transmitted to the yoke.
- E. Where indicated on the Drawings, self-contained gate frames shall be designed at adequate height to prevent interference of handwheel with existing guardrail.

2.6 SLIDES

- A. Slides shall be at least 1/4 inch thick and shall be provided with welded stiffeners to limit deflection to 1/360 under the maximum seating or unseating head indicated in the Stainless Steel Slide Gate Schedules. Slides shall be adequately reinforced to withstand, without permanent distortion, the maximum thrust which can be transmitted by the operating stem. Each slide shall have a reinforced pocket or an internally threaded nut welded to the slide for connection of the stem. The pocket or nut shall be designed to withstand the maximum thrust which can be transmitted by the operating stem.
- B. Each slide of non-rising stem gates shall be provided with a socket located at the top of the gate so that the stem cannot protrude into the waterway when the slide is fully raised.

2.7 SEALS/SEATING FACES

A. All gates shall be provided with a self-adjusting seal system to restrict leakage in accordance with the requirements listed in this specification. All seats and seals shall be mechanically fastened to the frame and field replaceable without the need to remove the gate from the installed position. A compression load pad or cord shall be set behind the UHMW seal to allow for a self-adjusting seal system. UHMW polyurethane seat/seal extruded shape shall fit into a dovetail grove in the guide section, and shall seal on both upstream and downstream sides of the

slide. The seat/seal system shall act as both a bearing surface and as a seal, and the seal system shall be self-adjusting. The seat/seals shall be easily replaced without removing the gate from the wall. For flush bottom application, the invert shall have a replaceable resilient neoprene seal mounted on the frame invert.

B. Wedges, wedge bars and pressure pads or similar are not acceptable. Rubber J-seals are acceptable. Each J seal shall be provided with a full length retainer bar which shall compress the seal and prevent leakage between the seal and the frame member. The method of attachment of J seals to frame members shall permit replacement of the seals without disassembling or removing the gate.

2.8 OPERATING STEMS

- A. Operating stems shall conform to the requirements of the governing standard. Operating stems shall have a minimum diameter of 1-1/2 inches. Operating stems shall be of sufficient size to withstand, without damage or permanent distortion, the tensile and compressive stresses resulting from the application of 250 foot lbs of torque on the pinion shaft of geared actuators by means of a crank or a handwheel, on the lift nut of nongeared, handwheel operated lift mechanisms, on the wrench nut, and 1.5 times the output thrust of the electric actuator in the stalled motor condition.
- B. Contact surfaces of threads shall be rolled or machined to a 63 microinch finish, or smoother. Each stem shall be securely attached to the slide. The stem shall be threaded to allow full travel of the slide unless the travel distance is otherwise shown on the Drawings. Stems of more than one section shall be joined by stainless steel or bronze couplings bolted to the stems.

2.9 STEM GUIDES

A. Stem guide angles or wall mounted brackets with bronze split type stem collars shall be provided per manufacturer's recommendations. Stem guides will be spaced at intervals to provide adequate stem support, not exceeding an L/r ratio of 200.

2.10 CLOSURE

A. The bottom of each slide gate frame shall be recessed so that the waterway is not obstructed. A compressible seal shall be securely attached to the bottom of the slide or to the frame invert. The seal shall be of sufficient length to seal the bottom corners of each slide. Slide gates that incorporate a flush-bottom seal shall be mechanically fastened to the bottom frame invert member. The seal shall be of the materials shown above. Seals attached to the slide or "press fit seals" are not acceptable.

2.11 STAINLESS STEEL

A. All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to

detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication including welded areas shall be repickled or passivated in accordance with ASTM A380 as needed to remove all traces of iron contamination. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2.12 ACTUATORS

- A. Actuators and their accessories shall be the type as indicated in the Stainless Steel Slide Gate Schedules and as specified in the Actuators for Process Valves and Gates section.
- B. Stem covers for manual actuators shall be UV resistant clear plastic, polycarbonate, or steel pipe as indicated in the Stainless Steel Slide Gate Schedules and as specified in the Actuators for Process Valves and Gates section.

2.13 SHOP TESTING

A. Gates shall be completely assembled in the shop to ensure that all parts fit together properly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Gates shall be installed in accordance with the Gate Installation section.

3.2 FIELD QUALITY CONTROL

- A. Requirements for manufacturer's field quality control services shall be installed in accordance with the Gate Installation section.
- B. Installation Supervision.
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check.
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- D. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.

- Performance and Other Testing. E.
- 1. The equipment manufacturer shall provide performance and other testing services when Notto be used for bilding punpose indicated in the Equipment Schedule section.

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

Schedule 40 05 59.23-S01 Stainless Steel Slide Gates Schedule

Tag Number	Location (1)	[ype of Service (2)	Vominal Size WxH	Maximum Head of Water (seating) Nbove Invert Gate	Maximum Head of Water (unseating) Nbove Invert Gate	nvert Elevation	Dperating Floor Elevation	Type of Mounting 3)	Type of Operating stem (8)	Type of Closure (4)	Jual Stems Required	Suitable for use Vith an electric Oortable actuator	Suitable for use Vith a portable Jydrauic actuator	Type of Electric Actuator(5)	[ype of Housing(6)	Dperating Time	Power for Electric Actuator Motor	lastic Stem Cover	Actuator Provides 20 VAC For emote controls	Number of Limit Switch Assemblies 9)
Tug Tunior	I		(in)	(ft)*	(ft)*	(ft)	(ft)	E			I	<u> </u>	NPE			(s)	V/PH	H	1	
GSD-1651	6	Ι	8 x 8	16	26	686.92	703.80	PF	RS	FB	No	No	No	IE	WP	60	460/3	Yes	Yes	ELSCH
													- Ġ							
* Units are in	feet of	head																		
					200															
Four Rivers Sa	anitation	n Autho	ority					40 05	29.23 -	S01 -	1							E	SV Project I	No. 41175

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge Phase I This Page Interiorally Left Blank This Page Interiorally Left Blank Hitting Control of the second se

Notes:

(1) Abbrevia	tions for locations are as indicated:						
6	Return Sludge Pump Station						
8	Aeration Basins						
19	Chlorine Contact Tanks						
26	Mixing Basins						
98	Yard Structures						
20							
(2) Abbreviat	tions for services are as indicated:						
Ι	Isolation						
TS	Throttle Service						
(3) Abbrevia	tions for wall thimbles are as indicated:						
ER	"E" shape, rectangular						
EC	"E" shape, circular						
ECSP	"E" shape, circular, for connection to steel pipe						
FR	"F" shape, rectangular						
FC	"F" shape, circular						
FMJ	Flange and mechanical joint						
PF	Attach gate frame to pipe flange; wall thimble not required						
(4) Abbrevia	tions for frame types and shapes are as indicated:						
FB	Flush bottom						
FBJS	Flush bottom with hollow bulb J-seals						
WS	Weir service, downward opening, with hollow bulb J-seals						
(5) Abbrevia	tions for electric actuator types are as follows:						
ŠÉ	Standard Electric						
IE	Intelligent Electric						
NE	Networked Electric						
(6) Abbreviations for electronic or electric actuator housing.							
WP	Weatherproof						
SUB Submersible [xx = depth of submergence](SUBxx)							
EXP Explosion proof							
(7) Abbreviations for control devices are as indicated.							

Table 1: Control Devices									
	Open-Close	Open-Stop-	Hand-Off-	Red and Green					
Abbreviations	Selector	Close Selector	Remote	Indicator Lights					
А	Required		Required	Required					
В	Required		Required						
С		Required	Required	Required					

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge-Phase I

D		Required	Required	
E		Required		
F	Required			
G	Required			Required
Н		Required		Required
(8) Abbrev RS NRS (9) Abbrevi	viations for types of ope Rising stem Non-rising stem ations for limit switche	erating stems are s on manual and	e as indicated: 1 cylinder operat	ed valves.
EOT PSS ELSCH	End of travel (open - Pump start - stop (tw See electrical schema	close) o intermediate p atics	positions)	PUTT
	toe	JSed F	orbid	

SECTION 40 05 61.23 - RESILIENT-SEATED GATE VALVES

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers furnishing resilient-seated AWWA gate valves for clear water service and as indicated in the Resilient-Seated Gate Valve Schedule. Resilient-seated gate valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the valve schedule, and as specified in the Valve and Gate Actuator section.

1.2 GENERAL.

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.
- C. General Equipment Stipulations.
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard.

- 1. Except as modified or supplemented herein, all resilient-seated gate valves shall conform to the applicable requirements of ANSI/AWWA C509.
- E. Temporary Number Plates. Not used.
- F. Identification.
 - 1. Resilient seated gate valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS.

- A. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section.
- B. All valves shall be tested in accordance with Section 5 of the governing standard. Certified copies of the results of all tests, together with an affidavit of compliance as indicated in Section 6.3 of the governing standard, shall be submitted to Engineer before the valves are shipped.

PART 2 - PRODUCTS

- 2.1 MATERIALS.
 - A. Except as modified or supplemented herein, materials used in the manufacture of resilientseated gate valves shall conform to the requirements of the governing standard.
 - B. Bronze Components.
 - 1. All bronze valve components in contact with liquid shall contain less than 16 percent zinc. All aluminum bronze components in contact with liquid shall not contain less than 79 percent copper.
 - C. Gaskets.
 - 1. Gaskets shall be free of asbestos and corrosive ingredients.
 - D. Shop Coatings.

Epoxy for Liquid Service other than in PPG potable water facilities Carbol

PPG Amercoat "Amerlock 385 Epoxy", Carboline "Carboguard 890", Sherwin-Williams "Macropoxy 646" or Tnemec "Series N69 Hi-Build Epoxoline II".

Rust-Preventive Compound

Universal Primer

As recommended by manufacturer. As recommended by manufacturer

- 2.2 VALVE CONSTRUCTION.
 - A. Ends.
 - 1. Valve ends shall be compatible with connecting piping and shall be as indicated in the Resilient-Seated Gate Valve Schedule. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of the governing standard.
 - 2. Flanges shall be finished to true plane surfaces within a tolerance limit of 5 mils. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per inch of flange diameter.
 - B. Stem Seals.
 - 1. The type of stem shall be as indicated in the Resilient-Seated Gate Valve Schedule. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems.
 - C. Rotation.
 - 1. The direction of rotation of the handwheel or the wrench nut to open the valve shall be to the left (counterclockwise).

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- D. Shop Coatings.
 - 1. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. Except as specified below, the valve manufacturer's standard fusion-bonded coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating.

Epoxy.

2. Surfaces shall be coated as follows:

Unfinished S	Surfaces
--------------	----------

Interior Surfaces

Exterior Surfaces of All Other Valves

Universal primer.

Polished or Machined Surfaces

Flange Faces

Other Surfaces

Rust-preventive compound.

3. Alternatively, the manufacturer's standard coating may be used and the interior surfaces of each valve shall be subjected to a nondestructive holiday test in accordance with ASTM G62, Method A, and shall be electrically void-free.

Epoxy

4. Interior coatings shall comply with ANSI/AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating

Minimum Dry Film Thickness

Epoxy

10mils.

Universal Primer

3 mils.

2.3 VALVE ACTUATORS.

Requirements for valve actuators shall be as specified in the Valve and Gate Actuator sectionand as indicated in the Resilient-Seated Gate Valve Schedule.

2.4 ACCESSORIES.

А.

A. When the Drawings or the Resilient-Seated Gate Valve Schedule indicate the need for extension stems, stem guides, position indicators, floor boxes, valve boxes, or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

nosec

3.1 INSTALLATION.

- A. Gates shall be installed in accordance with Section 40 05 51.13 Valve Installation.
- B. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check
 - 2. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- D. Functional Testing.
 - 3. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- E. Performance and Other Testing
 - 4. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

End of Section
Schedule 40 05 61.23 - S01 **Resilient Seated Gate Valves Schedule**

Tag Number	Size	Application	Type of Installation(1)	Ends(2)	Stem(3)	Type of Manual Actuator(4)	Extension Stems	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands
1	2	3	4	5	6	7	8	9	10	11
	(in)									
VG-1120	6	AGS Reactor Drain	IP	F	OS&Y	HW	No	No	No	No
VG-1220	6	AGS Reactor Drain	IP	F	OS&Y	HW	No	No	No	No
VG-1320	6	AGS Reactor Drain	IP	F	OS&Y	HW	No	No	No	No
VG-1420	6	AGS Reactor Drain	IP	F	OS&Y	HW	No	No	No	No
VG-1620	6	WAGS/WLC Wetwell Drain Isolation	IP	F	OS&Y	HW	No	No	No	No

Notes:	JILY
(1)	Abbreviations for installation types are as follows:
B4 B20 B SV20 SV IP	Buried, depth of 4 feet or less Buried, depth greater than 4 feet but 20 feet or less Buried, depth greater than 20 feet Submerged or vaulted, depth greater than 20 feet In plant
(2)	Abbreviations for types of ends:
F MJ P	Flanged Mechanical joint Push-on joint
(3)	Abbreviations for types of stems:
NRS OS&Y	Non-rising stem Outside screw-and-yoke
(4)	Abbreviations for types of manual actuators:
WN HW	Wrench nut Handwheel
	End of Schedule

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SECTION 40 05 61.43 - KNIFE GATE VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing all Knife Gate Valves as required by the Work and as indicated in the Knife Gate Valve Schedule. Knife Gate Valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Section 40 05 57 - Valve and Gate Actuators.

1.2 GENERAL

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Gates shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.
- C. General Equipment Stipulations
 - 1. Section 01 61 00 General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.
- D. Governing Standard
 - 1. The publications referred to hereinafter form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this section and the listed references, the requirements of this section shall prevail.



J	Reference	Title
	ASME B16.5	Pipe Flanges and Flanged Fittings
	MSS SP-135	High Pressure Knife Gate Valves

- E. Identification
 - 1. Knife Gate Valves shall be identified in accordance with Section 01 68 00, Equipment and Valve Identification.

- 1.3 Submittals
 - A. The following information shall be submitted for review in accordance with Section 01 33 00 -Submittal Procedures.
 - 1. A copy of this specification section, with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.
 - 2. Manufacturer's product data.
 - 3. Certified factory leakage tests.

PART 2 - PRODUCTS

- 2.1 ACCEPTABLE PRODUCTS
 - A. Knife Gate Valves shall be manufactured by DeZURIK (Hilton Valve), Pratt, or approved equal.

2.2 MATERIALS

A. Materials used in the manufacture of Knife Gate Valves shall be as indicated:

Body

Bonnet

Wetted interior parts and fasteners

Gate

Stem and stem coupling Packing gland and follower

Yoke Resilient Seats Fabricated Steel.

Fabricated Steel.

Stainless Steel, Type 316. Body cladding and face rings shall be welded to the body.

Stainless Steel, Type 316, polished to minimum surface finish of 32 micro-inch/inch RMS.

Stainless Steel, Type 316.

Stainless Steel, Type 316.

Fabricated Steel.

EPDM.

2.3 VALVE CONSTRUCTION

A. General

1. Knife Gate Valves shall be bi-directional resilient seated with a pressure-retaining bonnet that fully encloses the gate. Bonnetless Knife Gate Valves are not acceptable. The bonnet shall be rated at the same pressure as the valve body and shall not include any type of internal gate packing or gate wiper. A packing gland shall be located at the top of the bonnet to provide a tight seal around the stem.

- 2. A bevel gear operator with 2-inch nut shall be provided with each Knife Gate Valve. Operators shall be oriented on the valve yoke.
- 3. Except for the resilient seats, all wetted parts of the body and bonnet shall be 316 SS, including fasteners. Exterior flanges and stiffeners shall be cast or fabricated carbon steel.
- 4. All valves shall be capable of zero leakage shutoff in either flow direction where required and dead end isolation service with the downstream pipe flange removed.
- B. Valve Body
 - 1. Knife Gate Valves shall have fabricated steel bodies conforming to the general requirements of MSS SP-135. Valves shall be provided Class 125 flanges conforming to ANSI B16.1.
- C. Shaft Coupling
 - 1. A shaft coupling shall be provided between the valve bonnet and the top of the yoke to allow separate removal of upper portion of stem, yoke and operator prior to removal of valve from the valve vault. The yoke and shaft shall be extended as necessary to accommodate the shaft coupling while allowing normal operation from fully open to fully closed and to meet the dimensional requirements for locating the operator as shown on the drawings.
- D. Seats
 - 1. The resilient seats shall be EPDM, installed in a self-retaining groove that is cut into the 316 SS seat ring, and shall be replaceable without removing the valve from the pipeline.
- E. Lining
 - 1. The 316 body cladding and face rings shall be fully welded to the carbon steel body "floating" body liners are not acceptable.
- F. Packing
 - 1. The valve bonnet shall be sealed against external leakage by Teflon impregnated synthetic fiber packing with an adjustable packing gland. The bottom of the gland shall be machined to mate with the machined stem back-seating ring, to allow the packing to be replaced with the valve pressurized. The back-seating ring shall also include a Teflon O-ring for improved sealing.

1. The gate shall be beveled and machined to evenly match the seating area in the valve body.

2.4 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified herein, as indicated in the Knife Gate Valve Schedule, and as specified in Section 40 05 57, Valve and Gate Actuators. Valve actuator types shall be as indicated on the Drawings.

G. Gate

- B. Manual valves located above operator level shall be provided with chain driven operators.
- C. Supplier shall provide a portable handheld electric operator that is suitable for opening and closing the valves. Portable handheld electric operator shall be Wachs Pow-R-Drive II, or equal.

2.5 OPERATING DATA

A. Knife Gate Valves shall be suitable for the conditions described in the Valve Schedule..

2.6 SHOP PAINTING

A. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is compatible with the specified field painting system per Section 09 96 11, Protective Coatings.

2.7 LUBRICATION

A. Valves shall be designed so that all required lubrication can be completed externally with the valve installed in the pipeline.

2.8 WELDING

A. All stainless steel welds exposed to the process fluid shall be pickled and passivated.

2.9 TESTING

- 1. Valves shall be factory tested and certified for zero leakage, as follows:
 - a. Shell Test Each valve body and bonnet shall be hydrostatically pressure tested at 1.5 times the rated design pressure with no visible leakage allowed (leakage through the packing shall not be cause for rejection, as long as there is no leakage at the rated design pressure). Valves shall be tested with the flanges and body unconstrained to confirm the integrity of the design.



- Gate/Seat Test Each valve shall be hydrostatically pressure tested at 1.1 times the maximum operating pressure in both directions of closure with no visible leakage through the gate material and with drip tight seat leakage.
- c. Operational Test Each valve shall be operated from full closed to full open and back to full closed, two times. Operation shall be smooth, with no unusual noise or vibration.
- 2. Additionally, valves shall be tested for proper alignment, balancing, and smooth operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Gates shall be installed in accordance with Section 40 05 51.13, Valve Installation.
- B. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- D. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- E. Performance and Other Testing

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1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

End of Section

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Schedule 40 05 61.43-S01 Knife Gate Valves Schedule

Tag Number	Size	Rated Working Pressure	Maxımum Differential Pressure Across Valve	Type of Service	Application(1)	Type of Installation(2)	Type of Manual Actuator(4)	Electrical Actuator	Ends(3)	High Pressure Side of Plug(5)
	(in)	(psi)	(psi)						S	
VKG-1000	0.4		0	TT 7	0.0	ID	CIU) T		
VKO-1000	24	2	9	Wastewater	0-0	IP	CW	No (F	U
VKG-1000 VKG-1001	24 24	2 2	9	Wastewater Wastewater	0-C 0-C	IP IP	CW CW	No No	$\frac{F}{F}$	U U
VKG-1000 VKG-1001 VKG-1110	24 24 30	2 2 2	9 9 9	Wastewater Wastewater Wastewater	0-C 0-C 0-C	IP IP IP	CW CW CW	No No No	F F F	U U U
VKG-1000 VKG-1001 VKG-1110 VKG-1210	24 24 30 30	2 2 2 2 2	9 9 9 9	Wastewater Wastewater Wastewater	0-C 0-C 0-C	IP IP IP IP	CW CW CW	No No No	F F F F	U U U U
VKG-1000 VKG-1001 VKG-1110 VKG-1210 VKG-1310	24 24 30 30 30	2 2 2 2 2 2	9 9 9 9 9 9	Wastewater Wastewater Wastewater Wastewater	0-C 0-C 0-C 0-C	IP IP IP IP IP	CW CW CW CW CW	No No No No	F F F F F	U U U U U
VKG-1000 VKG-1001 VKG-1110 VKG-1210 VKG-1310 VKG-1410	24 24 30 30 30 30	2 2 2 2 2 2 2	9 9 9 9 9 9 9	Wastewater Wastewater Wastewater Wastewater Wastewater Wastewater	0-C 0-C 0-C 0-C 0-C 0-C	IP IP IP IP IP IP	CW CW CW CW CW	No No No No No	F F F F F F	U U U U U U

Aot to be the to

Notes:

(1) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(2) Abbreviations for installation types are as follows:

- B4 Buried, depth of 4 feet [1.2 m] or less
- B20 Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
- Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet(Bxx) В
- **SV20** Submerged or vaulted, depth 20 feet [6.1 m] or less
- dine purposes Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of SV xx feet(SVXX)
- IP In plant
- (3) Abbreviations for valve ends are as indicated:
- F Flanged
- Mechanical joint MJ
- Ρ Push-on joint
- (4) Abbreviations for manual actuator types are as indicated:
- WN Wrench Nut LVR Lever
- CW ChainWheel
- HandWheel HW
- (5) Abbreviations for high pressure side of plug are as indicated:
- S Seating (plug shaft side)
- U Unseating (plug seat side)
- (6) Abbreviations for limit switches on manual and cylinder operated valves.
- End of travel (open close) EOT
- PSS Pump start - stop (two intermediate positions)
- ELSCH See electrical schematics
- (7) Abbreviations for electronic or electric actuator housing.
- WP Weatherproof
- Submersible [xx = depth of submergence](SUBxx) SUB
- EXP Explosion proof

(8) Abbreviations for control devices are as indicated.

Table 1: Control Devices								
	Open-Close	Open-Stop-Close	Hand-Off-	Red and Green				
Abbreviations	Selector Switch	Selector Switch	Remote	Indicator Lights				
А	Required		Required	Required				
В	Required		Required					
С		Required	Required	Required				
D		Required	Required					
Е		Required			0			
F	Required			Ċ				
G	Required			Required	$\overline{\mathbf{v}}$			
Н		Required		Required)			
(10) Abbreviations	for electric actuat	or types are as follo	we.					
SF Standard	Flectric	or types are as tono	ws.					
IF Intelliger	nt Electric							
NF Network	ed Electric							
(11) Abbreviations f	for remote control	station types:	•					
CS Control S	Station without in	dicating lights.						
CIS Control S	Station with indic	ating lights.	20	1				
			•					
		End of Schedule						

- SE Standard Electric
- IE Intelligent Electric
- Networked Electric NE

- CS Control Station without indicating lights.
- CIS scheder schede Control Station with indicating lights.

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SECTION 40 05 62.13 - PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of manually operated or remote activated two position (open-close) plug valves.
- B. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in the Valve and Gate Actuator section.

1.2 GENERAL

- A. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

- A. Drawings and Data.
 - 1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Valves VP-1

VP-1	Rating	175 WOG
	Code	AGA Approved
Natural gas,	Body	Cast iron
propane service	Trim	

	Plug Seal	Hycar
2-1/2 inch and	Plug	Bronze or nickel plated cast iron
smaller pipe	Stem Seal	Buna
	End Connection	Threaded
	Temp. Limitations	-20 to 180°F
	Valve Operator	Lever
	Manufacturers	Key Port "Fig 425-RS51"

B. Valves VP-2

VP-2	Rating	175 WOG
	Code	AGA Approved
Natural gas,	Body	Cast iron
propane service	Trim	
	Plug Seal	Hycar
3 and 4 inch pipe	Plug	Bronze or nickel plated cast iron
	Stem Seal	Buna
	End Connection	Flanged, ASME B16.1, Class 125
	Temp. Limitations	-20 to 180°F
	Valve Operator	Lever
	Manufacturers	Key Port "Fig 425-RS51"

C. C.

- C. Length Tolerance
 - 1. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

D. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

	Coating Materials	
× 0×	Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
	Epoxy Enamel	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".
	Rust-Preventive Compound	As recommended by the manufacturer.
	Surfaces To Be Coated	
	Unfinished Surfaces	
	Interior Surfaces	Epoxy.

Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults

Coal tar epoxy.

Exterior Surfaces of All Other Valves

Polished or Machined Surfaces

Actuators and Accessories

Universal primer. Rust-preventive compound. Universal primer.

2.2 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified in the Valve and Gate Actuators section.

2.3 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, and valves boxes shall be as specified in Valve and Gate Actuators section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

B. Installation Supervision

- 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- D. Functional Testing.

The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.

- E. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

End of Section

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SECTION 40 05 62.16 - ECCENTRIC PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing all eccentric plug valves as required by the Work and as indicated in the Eccentric Plug Valve Schedule. Plug valves shall be furnished complete with actuators and accessories as specified herein, indicated in the schedule, and as specified in the Valve and Gate Actuators section.

1.2 GENERAL

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves. Plug valves to be provided by the AGS System Supplier shall be as noted on the Drawings, Eccentric Plug Valve Schedule, Aerobic Granular Sludge Equipment section, and Bid Form.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.
- D. Governing Standard
 - 1. Except as modified or supplemented herein, all eccentric plug valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C517.

E. Marking



Each valve shall be marked with the manufacturer's name, valve size, and pressure rating, and the country of origin of the body casting. All markings shall be cast on the exterior surface of the valve body. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

- F. Temporary Number Plates
 - 1. Each eccentric plug valve with an identifying number listed in the Eccentric Plug Valve Schedule, shall be tagged or marked in the factory with the identifying number.

- G. Identification
 - 1. Eccentric plug valves shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

- A. Drawings and Data General
 - 1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section.
- B. Drawings and Data Electrical and Wiring Diagrams
 - 1. Drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.
- C. Certified Test Results
 - 1. Certified copies of test reports for tests described in Section 5. of governing standard, with an affidavit of compliance as indicated in Section 6.3 of governing standard, shall be submitted to Engineer before the valves are shipped.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Eccentric plug valves furnished under this section shall be manufactured by Milliken, DeZurik, Pratt, or Val-Matic, without exception.

2.2 MATERIALS

A. Materials used in the manufacture of eccentric plug valves shall be as indicated:

Body	Cast iron,	iron, ASTM A126, Class B; or ductile ASTM A536, Grade 65-45-12.
Plug	Cast iron,	iron, ASTM A126, Class B; or ductile ASTM A536, Grade 65-45-12.
Plug Facing	Chlo duro AST	roprene, Neoprene or Buna-N, 70 Type A neter hardness in accordance with M D2240.
Body Seat	Weld	led nickel overlay.
Upper and Lower Trunnion	Bearings Sleev	ve type; stainless steel or bronze.
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Upper Thrust Bearing

TFE, Nylatron, or Delrin.

Stem Seal

V-type packing or U-cups, Buna-N or TFE.

B. The following are acceptable shop coatings.

Epoxy

For Gas Service

PPG Amercoat "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series N69 Hi-Build Epoxoline II", Sherwin-Williams "Macropoxy 646" or Carboline "Plasite 7122".

For Liquid Service other than in	PPG Amercoat "Amercoat 385 Epoyy"
For Liquid Service other than in	TTO Americaa Americaa 565 Dpoxy ,
potable water facilities	Carboline "Carboguard 890", Sherwin-Williams
	"Macropoxy 646".or Tnemec "Series N69 Hi-
	Build Epoxoline II".

2.3 VALVE CONSTRUCTION.

- A. Valve Body
 - 1. The valve port area of each valve shall be at least 80 percent of the cross section of the connecting piping for 20 inch and smaller valves and 70 percent for 24 inch and larger valves. Valves shall provide tight shutoff at the rated pressure from either direction. An adjustable closed position plug stop shall be provided.
 - 2. Each valve body shall be plainly marked to indicate the seat end. The actual length of 10 inch and smaller valves shall be within plus or minus 1/16 inch of the theoretical length. The actual length of 12 inch and larger valves shall be within plus or minus 1/8 inch of the theoretical length.
 - 3. Valve ends shall be compatible with connecting piping. All valves shall have flanged, grooved or mechanical joint ends as indicated and in the Eccentric Plug Valve Schedule. Flange diameter and drilling shall conform to ANSI B16.1, Class 125. Flanges shall be flat faced and finished to true plane surfaces within a tolerance limit of 0.005 inch. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter. Grooved end dimensions shall conform to ANSI/AWWA C606, Table 5, for rigid joints. When grooved end valves are to be installed in flanged piping, two flange adapters compatible with the connecting piping shall be provided with each valve. Mechanical joint ends shall conform to ANSI/AWWA C111/A21.11.
 - 4. Each valve shall have grease lubrication fittings on the valve body and valve bonnet.

- B. Plug
 - 1. The plug shall be of one-piece construction and shall have a cylindrical or spherical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and the body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug surfaces shall be faced with a resilient material.
- C. Seats
 - 1. Seats shall be cast in the body and shall have raised, welded-in nickel overlay not less than 0.050 inch thick on all surfaces in contact with the plug face. The overlay shall be at least 90 percent nickel and have a Brinell hardness of 200 or greater.
- D. Stem Seals
 - 1. The valve shaft shall be sealed by U-cups or by at least four self-adjusting chevron type packing rings.
- E. Working Pressure
 - 1. Valves shall be rated for a minimum working pressure as specified below, except where otherwise indicated on the Drawings in the Eccentric Plug Valve Schedule.
 - Size in inches Pressure Rating in psi
 - a. 3 to 12
 - b. 14 to 72

2.4 VALVE ACTUATORS

3.

- A. Requirements for valve actuators shall be as specified herein, indicated in the Eccentric Plug Valve Schedule, and as specified in the Valve and Gate Actuators section.
- B. Geared actuators shall be used for manually operated valves in the following applications:

175

50

- 1. For all 4 inch and larger buried valves.
- 2. For all 8 inch and larger valves.
 - For all 6 inch and larger valves in throttling or free discharge applications.
 - For all 6 inch and larger valves where the unseating pressure exceeds 25 psi.
- 5. For all chainwheel operated valves.
- C. Geared actuators for plug valves unless otherwise specified or listed in the Eccentric Plug Valve Schedule shall be rated for a differential pressure across the valve, on the seating side, of 100 psi for 6 inch to 8 inch valves, 50 psi for 10 inch and larger valves, and 25 psi for gas service valves and a maximum flow of 8 ft/s.

2.5 SHOP PAINTING

- A. All interior and exterior ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valves and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.
- B. Surfaces shall be painted as follows:

Unfinished Surfaces

Interior Surfaces

For Liquid Service

Exterior Surfaces of All Other Valves

Polished or Machined Surfaces

Epoxy.

Minimum Dry Film Thickness

Universal primer

Rust-preventive compound.

0505

C. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating

Epoxy

Universal Primer

2.6 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, and valve boxes shall be as indicated in the Eccentric Plug Valve Schedule and as specified in the Valve and Gate Actuators section.

10 míls

3 mils

2.7 TESTING

- A. Except as modified herein, eccentric plug valves shall be tested in accordance with Section 5 of the governing standard. Each valve shall be performance tested in accordance with Section 5.2 of the governing standard. The leakage test shall be applied to the seating face of the plug (tending to unseat the plug) at the rated pressure of the valve.
- B. Each valve shall be leaktight in both directions when closed by the actuator with the maximum differential pressure applied to the plug as specified herein and in the Eccentric Plug Valve Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Valves shall be installed in accordance with Valve Installation section.
- B. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- D. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- E. Performance and Other Testing

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1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

End of Section

		Eccentric Plug Valves Schedule Manual Actuators											
Tag Number	Size	Rated Working Pressure	Application	Type of Installation(2)	Ends(3)	Maximum Differential Pressure Across Valve	High Pressure Side of Plug(5)	Type of Manual Actuator(4)	Limit Switches(6)	Extensions Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands
	(in)	(psi)				(psi)				0			
PV-1600	14	6	Wastewater	IP	F	20	U	CŴ	No	No	No	No	No
PV-1601	14	6	Wastewater	IP	F	20	U	CW	No	No	No	No	No
DI / 1 / 10	(
PV-1610	6	11	Wastewater	IP	F	20	U	CW	No	No	No	No	No
PV-1610 PV-1620	6	<u>11</u> 11	Wastewater Wastewater	IP IP	F F	20 20	U U	CW CW	No No	No No	No No	No No	No No
PV-1610 PV-1620 PV-1630	6 6 6	11 11 11	Wastewater Wastewater Wastewater	IP IP IP	F F F	20 20 20	U U U	CW CW CW	No No No	No No No	No No No	No No No	No No No
PV-1610 PV-1620 PV-1630 PV-1650	6 6 6	11 11 11 11	Wastewater Wastewater Wastewater	IP IP IP IP	F F F F	20 20 20 20	U U U U	CW CW CW CW	No No No	No No No	No No No	No No No	No No No
PV-1610 PV-1620 PV-1630 PV-1650 PV-1652	6 6 6 8	11 11 11 11 11	Wastewater Wastewater Wastewater Wastewater	IP IP IP IP IP	F F F F	20 20 20 20 20 20	U U U U U	CW CW CW CW CW	No No No No	No No No No	No No No No	No No No No	No No No No

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Schedule 40 05 62.16-S02 **Eccentric Plug Valves Schedule** Electric Actuators

Tag Number	Size	Rated Working Pressure	Type of Service(1)	Application	Type of Installation(2)	Ends(3)	Maximum Differential Pressure Across Valve	High Pressure Side of Plug(5)	Type of Electric Actuator(10)	Type of Housing(7)	Operating Time	Power for Electric Actuator Motor	Actuator Provides 120 VAC For remote controls	Number of Limit Switch Assemblies	Position Transmitter	Control Devices(8)	Remote Control Station(11)	Extensions Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands
	(in)	(psi)					(psi)				(s)	(V/PH)									
PV-1110*	30	3	O-C	Wastewater	IP	F	11	U	IE	WP	60	460/3	No	2	No	А	CIS	No	No	No	No
PV-1210*	30	3	O-C	Wastewater	IP	F	11	U	IE	WP	60	460/3	No	2	No	Α	CIS	No	No	No	No
PV-1310*	30	3	O-C	Wastewater	IP	F	11	U	IE	WP	60	460/3	No	2	No	А	CIS	No	No	No	No
PV-1410*	30	3	O-C	Wastewater	IP	F	11	U	IE	WP	60	460/3	No	2	No	Α	CIS	No	No	No	No
Hot to be Used for bidd.																					
Four Rivers Sanit	ation Au	uthority							40 (05 62.16	6-S02 - 2								BV	Project N 1	lo. 411752

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Notes:

(1) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(2) Abbreviations for installation types are as follows:

- B4 Buried, depth of 4 feet [1.2 m] or less
- B20 Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
- Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet(Bxx) В
- **SV20** Submerged or vaulted, depth 20 feet [6.1 m] or less
- dine purpose Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of SV xx feet(SVXX)
- IP In plant
- (3) Abbreviations for valve ends are as indicated:
- F Flanged
- Mechanical joint MJ
- Р Push-on joint
- (4) Abbreviations for manual actuator types are as indicated:
- WN Wrench Nut LVR Lever
- CW ChainWheel
- HandWheel HW
- (5) Abbreviations for high pressure side of plug are as indicated:
- S Seating (plug shaft side)
- U Unseating (plug seat side)
- (6) Abbreviations for limit switches on manual and cylinder operated valves.
- End of travel (open close) EOT
- Pump start stop (two intermediate positions) PSS
- ELSCH See electrical schematics
- (7) Abbreviations for electronic or electric actuator housing.
- WP Weatherproof
- Submersible [xx = depth of submergence](SUBxx) SUB
- EXP Explosion proof

(8) Abbreviations for control devices are as indicated.

Table 1: Control Devices								
	Open-Close	Open-Stop-Close	Hand-Off-	Red and Green				
Abbreviations	Selector Switch	Selector Switch	Remote	Indicator Lights				
А	Required		Required	Required				
В	Required		Required					
С		Required	Required	Required				
D		Required	Required					
Е		Required		(
F	Required			Ċ				
G	Required			Required				
Н		Required		Required				
(10) 411	C 1 4	¢ (11						
(10) Abbreviations for electric actuator types are as follows:								
SE Standard	SE Standard Electric							
IE Intelliger	E Intelligent Electric							
NE Network	NE Networked Electric							
(11) Abbreviations f	for remote control	station types:						
CS Control Station without indicating lights.								
CIS Control Station with indicating lights.								
End of Schedule								

- SE Standard Electric
- IE Intelligent Electric
- Networked Electric NE

- CS Control Station without indicating lights.
- CIS Control Station with indicating lights. schedue,

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SECTION 40 05 63.53 - MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of manually operated or remote activated two position (openclose) ball valves as specified herein.
- B. Miscellaneous ball valves shall be provided where AWWA type ball valves are not required.
- C. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

- A. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.
- B. Identification
 - 1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

- A. General Drawings and Data.
 - 1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Ball valves shown on the drawing, but not specified herein, shall be selected to match piping material they are installed in.

B. Valves Type VB-1

VB-1	Rating	500 psi 3.4 MPanonshock cold WOG
		MSS SP-110
Ball valves for gauge	Code	In-line, two piece, end entry, full port
piping	Туре	ASTM B584–C84400 bronze
Drain	Body/Bonnet	
	Trim	
2 inch and smaller	Seat	Reinforced Teflon
	Ball	Brass, or chrome plated brass
	Stem	Brass or bronze
	Thrust Washer	Reinforced Teflon
	Stem Seal	Teflon or Viton
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F -29 to 204°C
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 77-100
		Series": Powell "Fig 4210T"

С. Valves Type VB-3 VB-3 800 psi6.5 MPa nonshock cold WOG Rating MSS SP-110 Process air service Code In-line, two piece, end entry, regular port Type 2 inch and smaller ASTM A351-CF8M, stainless steel Body/Bonnet Reinforced Teflon Trim Seat ASTM A276-316, stainless steel ASTM A276-316, stainless steel Ball Stem Reinforced Teflon Thrust Washer Teflon or Viton Stem Seal Threaded End End Connection -20 to 400°F -29 to 204°C Temp. Limitations Lever Valve Operator Conbraco Industries "Apollo 76-100 Manufacturers Series"; Neles-Jamesbury "Series 4000"

D. Length Tolerance

Unless otherwise specified, the actual length of valves shall be within plus or minus 1. 1/16 inch 1.6 mm of the specified or theoretical length.

E. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials Coal Tar Epoxy High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy". Ameron "Amerlock 400 High-Solids Epoxy Epoxy Enamel (for liquid service) Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus". As recommended by the manufacturer. **Rust-Preventive Compound** Surfaces To Be Coated **Unfinished Surfaces** Interior Surfaces Liquid Service Epoxy enamel. Exterior Surfaces of Valves To Be Coal tar epoxy. Buried, Submerged, or Installed in Manholes or Valve Vaults Exterior Surfaces of all other valves Universal primer. VALVE ACTUATORS

- Ball valve, except those which are equipped with power actuators or are designed for automatic operation, shall be provided with manual actuators. Unless otherwise specified or indicated on the drawings, each manual actuator shall be equipped with a lever operator. Ball valves with center lines more than 7'-6" 2.3m above the floor shall be provided with chain levers.
- B. Valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be

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provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2.3 ACCESSORIES

Α. If the drawings indicate the need for extension stems, stem guides; position indicator; floor boxes; valve boxes; or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3.1 **INSTALLATION**

retiner Materials furnished under this section shall be installed in accordance with the Valve A.

SECTION 40 05 64.11 - AWWA BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers furnishing of AWWA butterfly valves for cold water service as indicated in the AWWA Butterfly Valve Schedule. All other butterfly valves are specified in the Industrial Butterfly Valves section.
- B. AWWA butterfly valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in the Valve and Gate Actuators section.

1.2 GENERAL

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- D. Governing Standard
 - 1. Except as modified or supplemented herein, all butterfly valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C504.
- E. Marking

Supplementing the requirements of Section 6.1 of the governing standard, the country of origin of all castings and an identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

- F. Temporary Number Plates
 - 1. Each butterfly valve shall be tagged or marked in the factory with the identifying number listed in the AWWA Butterfly Valve Schedule.

- G. Identification
 - 1. AWWA butterfly valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

- A. Drawings and Data General
 - 1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.
- B. Drawings and Data Electrical and Wiring Diagrams
 - 1. Drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.
- C. Certified Test Results.
 - 1. Certified copies of test results for tests described in Section 5 of the governing standard, shall be submitted to Engineer before the valves are shipped. An affidavit of compliance with the governing standard for valves 72 inches and smaller and for valves 78 inches and larger shall be provided as indicated in Section 6.3 of ANSI/AWWA C504.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

- A. Butterfly valves shall be by the manufacturers listed below.
 - 1. Milliken
 - 2. DeZurik
 - 3. Pratt (Mueller)
 - M&H
 - 5. Val-Matic
 - 6. Rodney Hunt

2.2 MATERIALS

- A. Except as modified or supplemented herein, materials used in the manufacture of butterfly valves shall conform to the requirements of the governing standard.
- B. Acceptable shop coatings are listed in the following table.

Epoxy

For Liquid Service other	PPG Amercoat "Amercoat 385 Epoxy", Carboline
than in potable water	"Carboguard 890", Sherwin-Williams "Macropoxy 646"
facilities	or Tnemec "Series N69 Hi-Build Epoxoline II".

Rust-Preventive Compound As recommended by manufacturer.

2.3 VALVE CONSTRUCTION.

- A. Valve Bodies
 - 1. Valves shall be short-body type unless otherwise specified in the AWWA Butterfly Valve Schedule. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting disc travel by means of direct contact or interference with the valve disc (in either the open or closed position) will not be acceptable.

B. Flanges

- 1. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot (0.017 percent) of flange diameter.
- C. Mechanical Joint Ends
 - 1. Mechanical joint ends shall be either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11.
- D. Valve Shafts



Valve shafts shall be fabricated of AISI Type 304 or 316 stainless steel. The use of shafts having a hexagonal cross section will not be acceptable. The connection between shaft and disc shall be in accordance with the governing standard.

2. The connection between the shaft and the disc shall be mechanically secured by means of solid, smooth sided, stainless steel or monel taper pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of set screws, knurled or fluted dowel pins, expansion pins, roll pins, tension pins, spring pins, or other devices instead of the pins specified herein will not be acceptable.

- E. Valve Seats
 - 1. Acceptable seating surfaces mating with rubber are AISI Type 304 or 316 stainless steel, monel, or plasma-applied nickel-chrome overlay for all valves; bronze for 20 inch and smaller valves; and alloy cast iron for 20 inch and smaller manually operated valves.
 - 2. Seats shall be located on the valve body or disc. Valve seat configurations which rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.
- F. Shaft Seals
 - 1. Shaft seals shall be of the chevron type.
- G. Thrust Bearings
 - 1. Each valve shall be provided with one or more thrust bearings in accordance with the governing standard. Thrust bearings which are directly exposed to line liquid and which consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable.

2.4 VALVE ACTUATORS

- A. Requirements for valve actuators shall be as specified herein, as indicated in the AWWA Butterfly Valve Schedule, and as specified in the Valve and Gate Actuators section.
- B. All 8 inch and larger valves shall have geared actuators.
- C. If valves with an AWWA class designation higher than specified are furnished, actuator torque capabilities shall be increased accordingly and shall be acceptable to Engineer.
- D. Actuator Sizing
 - 1. The valve manufacturer shall size the actuator in accordance with the governing standard, the operating conditions and requirements indicated in the AWWA Butterfly Valve Schedule, and the valve manufacturer's requirements.
 - 2. Unless otherwise indicated or specified, actuator torque requirements shall be based on a maximum differential pressure across the valve equal to the maximum pressure associated with the valve class and a maximum velocity through the valve of 16 feet per second .
 - Valves with operating stands shall have actuator torques increased by 25 percent. Actuator torques determined by the above requirements shall be increased by any design factors required by paragraph 4.2.8 of ANSI/AWWA C504 or as specified herein.

2.5 SHOP PAINTING

A. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is
functionally equivalent to the specified coating and is compatible with the specified field painting.

B. Surfaces shall be painted as follows:

Unfinished Surfaces

Interior Surfaces

Exterior Surfaces of Valves to be Submerged

Exterior Surfaces of All Other Valves

Polished or Machined Surfaces

Flange Faces

Other Surfaces

Epoxy. Interior coatings shall comply with ANSI/AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Epoxy.

Epoxy.

Universal primer.

Rust-preventive compound

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils
Universal Primer	3 mils
	A T

2.6 ACCESSORIES

1.

Requirements for extension stems and stem guides, position indicators, floor boxes, operating Α. stands, torque tubes, valve boxes, and extension bonnets shall be as indicated in the AWWA Butterfly Valve Schedule and as specified in the Valve and Gate Actuators section.

PART 3 - EXECUTION

- **INSTALLATION** A.
 - Valves shall be installed in accordance with the Valve Installation section.

Installation Supervision

- The equipment manufacturer shall furnish installation supervision services when a. indicated in the Equipment Schedule section.
- 3. Installation Check
 - The equipment manufacturer shall provide a certificate of proper installation when a. indicated in the Equipment Schedule section.

- 4. Functional Testing.
 - The equipment manufacturer shall provide functional testing assistance when a. indicated in the Equipment Schedule section.
- 5. Performance and Other Testing
- eteresing s

Schedule 40 05 64.11-S01 **AWWA Butterfly Valves Schedule** Manual Actuators

											Ś)		
Tag Number	Size	Application	Type of Installation(2)	AWWA Class(3)	Maximum Differential Pressure	Maximum Velocity	Type of Manual Actuator(4)	Limit Switches(6)	Extensions Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Extension bonnet
	(in)				(psi)	(ft/s)				7				
BFV-1121	14	WAGS Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No
BFV-1123	14	WLC Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No
BFV-1221	14	WAGS Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No
BFV-1223	14	WLC Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No
BFV-1321	14	WAGS Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No
BFV-1323	14	WLC Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No
BFV-1421	14	WAGS Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No
BFV-1423	14	WLC Isolation	IP	F	5	4.5	CW	EOT	No	No	No	No	No	No

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40 05 64.11-S01 AWWA Butterfly Valves Schedule **Electric Actuators**

Tag Number	Size	Application	Type of Installation(2)	AWWA Class(3)	Maximum Differential Pressure	Maximum Velocity	Type of Electric Actuator(10)	Type of Housing(7)	Operating Time	Power for Electric Actuator	Actuator Provides 120 VAC For remote controls	Number of Limit Switch Assemblies	Position Transmitter	Control Devices(9)	Remote Control Station (11)	Extensions Stems	Position Indicator for Buried Valve Actuators	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes	Extension bonnet
	(in)				(psi)	(ft/s)			(s)	V/PH											
BFV-1120*	14	WAGS Isolation	IP	F	5	4.5	IE	WP	60	460/3	Yes	4	No	C	No	No	No	No	No	No	No
BFV-1122*	14	WLC Isolation	IP	F	5	4.5	IE	WP	60	460/3	Yes	4	No	C/	Ńo	No	No	No	No	No	No
BFV-1220*	14	WAGS Isolation	IP	F	5	4.5	IE	WP	60	460/3	Yes	4	No	С	No	No	No	No	No	No	No
BFV-1222*	14	WLC Isolation	IP	F	5	4.5	IE	WP	60	460/3	Yes	4	No	С	No	No	No	No	No	No	No
BFV-1320*	14	WAGS Isolation	IP	F	5	4.5	IE	WP	60	460/3	Yes	4	No	C	No	No	No	No	No	No	No
BFV-1322*	14	WLC Isolation	IP	F	5	4.5	IE	WP	60	460/3	Yes	4	No	C	No	No	No	No	No	No	No
BFV-1420*	14	WAGS Isolation		F	5	4.5	IE	WP	60 60	460/3	Yes	4	No No	C	No	No	No No	No	No	No	No
BF V-1422*	14		IP	г. Г.	5	4.5		WP	60 C	400/3	1/es		INO	C	INO	INO	INO	INO	INO	INO	INO
	* Refer to the bid form for further detail on AGS Equipment that may be provided by the Contractor.																				
Four Rivers San Rockford, IL	itation	Authority							40 05 6	64.11 - S01	- 2								BV Pro	ject No 12	ว. 411 2/20/2

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Notes:

(1) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(2) Abbreviations for installation types are as follows:

B4	Buried, depth of 4 feet [1.2 m] or less
B20	Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
Bxx	Buried, depth greater than 20 feet [6,1 m], actual depth of xx feet
SV20	Submerged or vaulted, depth 20 feet [6.1 m] or less
SVvv	Submerged or vaulted, depth 20 reet [61 m] or resp
ID	In plant
11	in plant
(2) C. f.	
(3) Sumx	Tetters define valve ends as follows:
Б	Flowerd
Г	Flanged
W	Wafer
MJ	Mechanical joint
S	Single Flange
(4) Abbre	eviations for actuator types are as follows:
WN	Wrench Nut
LVR	Lever
CW	ChainWheel COY
HW	HandWheel

- F Flanged
- W Wafer
- Mechanical joint MJ
- S Single Flange

Wrench Nut
Lever
ChainWheel
HandWheel

(5) If a value is indicated, the leakage test shall be performed using this pressure value rather than the pressure indicated by the AWWA class.

(6) Abbreviations for limit switches on manual and cylinder operated valves.

- End of travel (open close) EOT
- Pump start stop (two intermediate positions) PSS

ELSCH See electrical schematics

(7) Abbreviations for electronic or electric actuator housing.

WP Weatherproof

Submersible [xx = depth of submergence] (SUBxx) SUB EXP **Explosion** proof

(8) Cylinder actuators shall have torque safety factors applied in accordance with AWWA C504.

(9) Abbreviations for control devices are as indicated.

Table 1: Control Devices										
	Open-Close Push	Open-Stop- Close	Local-Off-	Red and Green Indicator						
Abbreviations	Button	Push Button	Remote	Lights						
А	Required		Required	Required						
В	Required		Required							
С		Required	Required	Required						
D		Required	Required	C						
E		Required								
F	Required			S						
G	Required			Required						
Н		Required		Required						
 (10) Abbreviations f SE Standard IE Intelligen NE Networke 	(10) Abbreviations for electric actuator types are as follows: SE Standard Electric IE Intelligent Electric NE Networked Electric									
(11) Abbreviation for remote control station types:CS Control Station without Indicating LightsCIS Control Station with Indicating Lights										
		End of Schedule	Y							

- Standard Electric SE
- IE Intelligent Electric
- NE Networked Electric
- (11) Abbreviation for remote control station types:

CIS Control Station with Indicating Lights retered of the second s

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I 40 05 64.11-S01 - Notes - 2

BV Project No. 411752 12/20/2022

SECTION 40 05 64.22 - INDUSTRIAL BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE

- This section covers the furnishing of manual or remote operated industrial butterfly valves as A. specified herein and as indicated in the Industrial Butterfly Valve Schedule.
- B. Industrial type butterfly valves shall be provided where AWWA type butterfly valves are not required.
- C. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Powered actuators are covered in the Valve and Gate Actuators section. dine

1.2 GENERAL

- **General Equipment Stipulations** Α.
 - The General Equipment Stipulations shall apply to all equipment furnished under this 1. section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- B. **Temporary Number Plates**
 - 1. Not used.
- C. Identification
 - Valves specified herein shall be tagged in accordance with the Equipment and Valve 1. Identification section.

SUBMITTALS 1.3

Complete drawings, details, and specifications covering the valves and their appurtenances shall A. be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

Drawings shall include separate wiring diagrams for each electrically operated or controlled B. valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

- A. Unless otherwise specified, industrial butterfly valves shall be the rubber-seat, tight-closing type. Valves specified with an electric, air, or hydraulic actuators shall be the lugged wafer style. Valve discs shall seat at 90 degrees with the pipe axis.
- B. Industrial butterfly valves with center lines more than 7'-6" above the floor shall be provided with chain-wheels and operating chains as specified herein.
- C. Flanged end valves shall be of the short-body type. Where mechanical joint ends are specified, in the valve schedule, either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11 will be acceptable. For buried or submerged service, shaft seals shall be O-ring type.

D.	Valves VBF-2	2	
	VBF-2	Rating	150 psi shutoff
		Body	ASTM A126, Class B, cast iron
	Process air	Trim	
		Seat	EPDM
	Lugged Wafer	Disc	ASTM B148, Alloy 952, aluminum
			bronze, or Nylon 11 coated ductile iron
		Stem	ASTM A276, Grade 304, 316, or 416,
			stainless steel
		Stem Seal	Synthetic O-rings
		Stem Packing	Buna-N
		Shaft Bearings	Upper and lower bearings or two upper
			bearings, bronze, reinforced teflon, or
			acetal
		Shaft Seal	Synthetic rubber O-rings
		End Connection	Wafer
		Temperature Limitations	-20 to 250°F
		Manual Valve Operator	
		6" & smaller	Lever
		▶ %" & larger	Geared Handwheel
		Manufacturer	Keystone "AR2", ABZ, Bray Series 31

2.2 Length Tolerance

Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

2.3 Shop Coatings

A. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

B.

Coating Materials	
Coal Tar Epoxy	

Rust-Preventive Compound

Universal Primer

Surfaces To Be Coated

Unfinished Surfaces

Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults

Exterior Surfaces of All Other Valves

Polished or Machined Surfaces

Actuators and Accessories

Specification Compliance

High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".

As recommended by the manufacturer.

As recommended by the manufacturer.

Material

Asphalt varnish or coal tar epoxy.

Universal primer.

Rust-preventive compound. Universal primer.

2.4 VALVE ACTUATORS

- A. Manual actuated valves 6 inches and smaller, unless chain-wheel actuators are required, shall be provided with levers as specified herein. Valves 8 inches and larger shall have enclosed, geared, hand-wheel or chain-wheel actuators with position indicators as specified herein.
- B. Requirements for automatic valve actuators shall be as specified herein, as indicated in the Industrial Butterfly Valves Schedule, and as specified in the Valve and Gate Actuator section.

C. Manual Actuators

1. Manual actuators of the types listed herein and in the Industrial Butterfly Valves Schedule shall be provided by the valve manufacturer.

2.

Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating hand-wheel.

- 3. The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.
- 4. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach

rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

- 5. Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.
- 6. Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.
- 7. Actuators shall produce the required torque with a maximum pull of 80 lbs on the lever, hand-wheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs on the hand-wheel or chain-wheel or an input of 300 foot-lbs on the operating nut.
- D. Handwheels
 - 1. Handwheel diameters shall be as recommended by the valve manufacturer.
- E. Levers
 - 1. Levers shall be capable of being locked in at least five intermediate positions between fully open and fully closed.
- F. Chain-wheels
 - 1. All valves with center lines more than 7-6" above the floor shall be provided with chainwheels and operating chains, unless otherwise specified in the Industrial Butterfly Valve Schedule. Each chain-wheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.

2.5 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, torque tubes, and valves boxes shall be as specified in Valve and Gate Actuator section, and as indicated in the Industrial Butterfly Valves Schedule.

PART 3 - EXECTUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with Valve Installation section.

- B. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- D. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- E. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

End of Section

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Schedule 40 05 64.22-S01 Industrial Butterfly Valve Schedule Manual Actuators

			1110		aatoro					_			
Tag Number	Size	Valve Type (8)	Application	Type of Installation(1)	Minimum Actuator Torque Capability (3)	Types of Manual acuator (7)	Limit Switches (4)	Extensions Stems	Position Indicator for Buried Valve Actuators	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes
	(in)				(in-lbs)								
BFVI-1100	12	VBF-2	AGS Reactor Isolation	IP	N/A	CW	EOT	No	No	No	No	No	No
BFVI-1200	12	VBF-2	AGS Reactor Isolation	IP	N/A	CW	EOT	No	No	No	No	No	No
BFVI-1300	12	VBF-2	AGS Reactor Isolation	IP	N/A	CW	EOT	Ňо	No	No	No	No	No
BFVI-1400	12	VBF-2	AGS Reactor Isolation	IP	N/A	CW	EOT	No	No	No	No	No	No
BFVI-1104*	4	VBF-2	Sludge Air Throttle	IP	N/A	CW	EOT	No	No	No	No	No	No
BFVI-1204*	4	VBF-2	Sludge Air Throttle	IP	N/A	CW	EOT	No	No	No	No	No	No
BFVI-1304*	4	VBF-2	Sludge Air Throttle	IP	N/A	CW	EOT	No	No	No	No	No	No
BFVI-1404*	4	VBF-2	Sludge Air Throttle		N/A	CW	EOT	No	No	No	No	No	No
	Lot to be used for												
Four Rivers Sani	tation A	vthority	40 0)5 64.22	-S01 -1						E	3V Proje	ct No.

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I This Page Intentionally Left Blank This Page Intentionally Left Blank Hotobertset

Schedule 40 05 64 22-S02 Industrial Butterfly Valve Schedule Electric Actuators

Tag Number	Size	Valve Type (8)	Type of Service(6)	Application	Type of Installation(1)	Minimum Actuator Torque Capability (3)	Type of Electric Actuator(2)	Type of Housing(5)	Operating Time	Power for Actuator Motor	Actuator Provides 120 VAC For remote controls	Number of Limit Switch Assemblies	Position Transmitter	Control Devices(9)	Remote Control Station (10)	Extensions Stems	Position Indicator for Buried Valve Actuators	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands	Torque Tubes
	(in)	-		7		(in lbs)			(1)			•1				2			• •		
BFVI-1515*	(in)	VBF-2	O-C	Blower Air Discharge Isolation	IP	(in-ids)	IE	WP	(s) 60	460/3	Yes	4	Yes	C	CIS	No	No	No	No	No	No
BFVI-1525*	12	VBF-2	O-C	Blower Air Discharge Isolation	IP		IE	WP	60	460/3	Yes	4	Yes	C	CIS	No	No	No	No	No	No
BFVI-1535*	12	VBF-2	O-C	Blower Air Discharge Isolation	IP		IE	WP	60	460/3	Yes	4	Yes	Ċ,	CIS	No	No	No	No	No	No
BFVI-1550*	2	VBF-2	M	Discharge Air Header Blow-off	IP		IE	WP	60	460/3	Yes	4	Yes	C	CIS	No	No	No	No	No	No
BFVI-1101* BFVI-1201*	4	VBF-2 VBF-2	0-0	AGS Air Isolation	IP IP		IE	WP WP	60 60	460/3	Yes	4	Yes		CIS	No No	No No	No	No	No	No
BFVI-1201*	4	VBF-2	0-C	AGS Air Isolation	IP		IE	WP	60	460/3	Yes	4	Yes	C	CIS	No	No	No	No	No	No
BFVI-1401*	4	VBF-2	O-C	AGS Air Isolation	IP		IE	WP	60	460/3	Yes	4	Yes	₹ C	CIS	No	No	No	No	No	No
BFVI-1102*	4	VBF-2	O-C	AGS Air Blow-off	IP		IE	WP	60	460/3	Yes	4	Yes	С	CIS	No	No	No	No	No	No
BFVI-1202*	4	VBF-2	0-C	AGS Air Blow-off	IP		IE	WP	60	460/3	Yes	4	Yes	C	CIS	No	No	No	No	No	No
BFVI-1302* BFVI-1402*	4	VBF-2 VBF-2	0-0	AGS Air Blow-off	IP IP		IE	WP WP	60 60	460/3	Ves	4	Yes	C	CIS	No No	No No	No No	No	No	No No
BFVI-1102 BFVI-1103*	8	VBF-2	M	AGS Air Control	IP		IE	WP	60	460/3	Yes	4	Yes	C	CIS	No	No	No	No	No	No
BFVI-1203*	8	VBF-2	М	AGS Air Control	IP		IE	WP	60	460/3	Yes	4	Yes	С	CIS	No	No	No	No	No	No
BFVI-1303*	8	VBF-2	M	AGS Air Control	IP		IE	WP	60	460/3	Yes	4	Yes	C	CIS	No	No	No	No	No	No
BFVI-1403*	8 mm for fi	VBF-2	M nil on A(AGS Air Control	IP by the C	ontractor	IE	WP	60	460/3	Yes	4	Yes	С	CIS	No	No	No	No	No	No
				Lotto	50	5		>`													
Four Rivers Sanita Rockford, IL Aerobic Granular S	tion Aut	hority Phase I						40	05 64.2	22-S02 -1									E	3V Project I	No. 4117 12/20/20

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Notes:

- (1) Abbreviations for installation types are as follows:
- B4 Buried, depth of 4 feet [1.2 m] or less
- B20 Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
- B Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet(Bxx)
- SV20 Submerged or vaulted, depth 20 feet [6.1 m] or less
- SV Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of xx feet (SVxx)
- IP In plant
- (2) Abbreviations for electric actuator types are as follows:
- SE Standard Electric
- IE Intelligent Electric
- NE Networked Electric
- (3) This item applies only to powered actuators. The manufacturer's rated torque capacity for each butterfly valve actuator shall be at least equal to the actuator torque capacity specified herein. The minimum actuator torque capability indicated in the schedule may [1.3 L]. be reduced by 25 percent for pneumatic cylinder actuators larger than 80 cubic inches.
- (4) Abbreviations for limit switches on manual and cylinder operated valves.
- EOT End of travel (open close)
- PSS Pump start stop (two intermediate positions)
- ELSCH See electrical schematics
- (5) Abbreviations for electronic actuator or electric actuator housing.
- WP Weatherproof
- SUB Submersible [xx = depth of submergence] (Subxx)
- EXP Explosionproof
- (6) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.
- (7) Abbreviations for manual actuator types are as follows:

HW Handwheel CR Crank CW Chainwheel LVR Lever CLVR Chain Lever WN Wrench Nut

(8) Valve Type – See Data Sheet.

(9) Abbreviations for control devices are as indicated.
Four Rivers Sanitation Authority
Rockford, IL
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1005

Table 1: Control Devices										
	Open-Close	Open-Stop-	Local-Off-							
Abbreviations	Push Button	Close Push	Remote	Red and Green Indicator Lights						
А	Required		Required	Required						
В	Required		Required							
С		Required	Required	Required						
D		Required	Required							
Е		Required								
F	Required			P						
G	Required			Required						
Н		Required		Required						

End of Schedule

(10) Abbreviations for Remote Control Stations:

- Control Station without Indicating Lights CS
- CIS Control Station with Indicating Lights

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SECTION 40 05 68 - CHECK VALVES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of check valves as specified herein and as indicated in the Check Valve Schedule.
- B. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

- A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- D. Temporary Number Plates
 - 1. Each check valve with an identifying number listed in the Check Valve Schedule, shall be tagged or marked in the factory with the identifying number.
- E. Identification

Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

- A. Drawings and Data.
 - 1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

A. Valves VC-4

valves vC-4		
VC-4	Rating	Class 125
	Туре	Dual disc wafer, full port
Process Air	Body	Cast iron or carbon steel
	Trim	
2 inch or larger pipe	Seat	EPDM or Viton
	Disc	Aluminum
	Hinge	Elastomeric
	Hinge Pins	Aluminum
	Springs	Stainless steel
	Bushings	Manufacturer's standard
	End Connection	Plain, installed between ASME B16.1,
		Class 125, flat faced flanges
	Temp. Limitations	-20 to 300°F
	Manufacturers	"Silent Seatless Check Valves" 09
		Series as manufactured by US Valve of
		 Rutherford, New Jersey or Flexi-Hinge
	•	Valve Company "Flexi-Hinge"

B. Valves VC-10

VC-10	Rating	Class 125
	Code	AWWA C508
Wastewater pump	Туре	Horizontal swing, bolted bonnet
discharge service	Body	ASTM A126 Class B cast iron
	Trim	
6 inch and larger pipe	Seat Ring	ASTM B763 Alloy 84400 bronze
	Disc	ASTM A126 Class B cast iron
	Hinge Pins	Stainless steel
	Bearings	Bronze bushings
	Cover Gasket	Manufacturer's standard
	End Connection	Flanged, ASME B16.1, Class 125, flat
хO		faced
	Temp. Limitations	-20 to 212°F
	Valve Operator	External spring or weighted lever
	Manufacturers	American Flow Control "52 SC", M&H
		"Style 259-02", Mueller "A2600-6-01
		or 6-02"

- C. Shop Coatings
 - 1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Coal Tar Epoxy

High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".

Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard°891", or Tnemec "Series N140 Pota-Pox Plus".

As recommended by the manufacturer.

Epoxy Enamel (for liquid service)

Rust-Preventive Compound

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service

Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults

Exterior Surfaces of All Other Valves

Polished or Machined Surfaces

Actuators and Accessories

Epoxy enamel.

Asphalt varnish or coal tar epoxy.

Universal primer.

Rust-preventive compound.

Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with Valve Installation section.

B. Installation Supervision

- 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.

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- D. Functional Testing.
 - The equipment manufacturer shall provide functional testing assistance when indicated in 1. the Equipment Schedule section.
- E. Performance and Other Testing
- . testing service.

Schedule 40 05 68-S01 **Check Valves Schedule**

Tag Number	Size	Type of Valve	Service	Design Capacity	Ends(1)	6505
	(in)					
CV-1515*	16	VC-4	Blower air discharge	2,970 scfm	Р	
CV-1525*	16	VC-4	Blower air discharge	2,970 scfm	Р	
CV-1535*	16	VC-4	Blower air discharge	2,970 scfm	Р	
CV-1610	6	VC-10	WAGS/WLC discharge	300 gpm	F	
CV-1620	6	VC-10	WAGS/WLC discharge	300 gpm	F	
CV-1630	6	VC-10	WAGS/WLC discharge	300 gpm	F	

* Refer to the bid form for further detail on AGS Equipment that may be provided by ted: the Contractor.

Notes:

(1)	Abbreviations	for va	lve ends	are as	indicated:

F MJ P	Flange Mechanical Joint Plain End
	End of Schedule
	X YO
/	40

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SECTION 40 05 73.13 - PRESSURE REDUCING VALVES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of pressure reducing valves as specified herein.
- B. Piping, pipe supports, insulation, and accessories which are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

- A. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- B. Identification
 - 1. Valves specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

a

- 1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:
 - Net weight of each valve and accessory.
 - b. Name of manufacturer.
 - c. Type and model.
 - d. Construction materials and finishes.
 - e. Unit dimensions.
 - f. Performance curves indicating flow capacity versus pressure drop.
- B. Operation and Maintenance Data and Manuals
 - 1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance

manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Pressure reducing valves shall be designed to meet the service requirements as indicated herein and in the Pressure Reducing Valves Schedule on the Drawings.
- B. Each pressure reducing valve shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers and specific products are listed in the Construction paragraph.

2.3 MATERIALS

A. Valve materials shall be as indicated below and in the Construction paragraph.

Shop Coatings

Epoxy Enamel (Gas and
Air Service)Ameron "Amercoat 385 Epoxy", Carboline "Carboguard
890", or Tnemec "Series N69 Hi-Build Epoxoline II".

2.4 CONSTRUCTION.

- A. Gas Service
 - 1. Pressure reducing valves for natural gas and propane gas service shall be suitable for gases with specific gravities of 0.6 and 1.5, respectively. Natural gas and propane gas pressure reducing valves shall be direct-acting type with cast iron or cast steel bodies, threaded ends, aluminum trim, and a nitrile diaphragm and disc. Valves shall be Fisher Controls "HSR or S-202 Series".
 - 2. Pressure reducing valves for digester gas service shall be suitable for gas with specific gravity of 0.8 to 0.9. Digester gas pressure reducing valves shall be pilot-operated type with stainless steel bodies, stainless steel trim, viton diaphragm, and stainless steel pilot. Valves shall be Fisher Controls "1098-EGR Series".

2.5 SHOP PAINTING

A. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop painted for corrosion protection in accordance with the following list. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Protective Coatings section.

Epoxy.

Interior Surfaces

Exterior Surfaces

Liquid Service

Epoxy (NSF certified).

Gas and Air Service

Universal primer with epoxy finish coat.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

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SECTION 40 05 76 – BASIN VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of basin valves as specified herein, except where specific requirements are stipulated in other sections.

1.2 GENERAL

- A. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- B. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Complete drawings, details, and specifications, covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

1.

- 2.1 CONSTRUCTION
 - A. Length Tolerance.
 - Unless otherwise specified, the actual length of valves shall be within $\pm 1/16$ inch of the specified or theoretical length.

B. Shop Coatings.

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Epoxy (for liquid service)

Sherwin-Williams "Macropoxy 646NSF" or Tnemec "Series N140 Pota-Pox Plus".

1705ec

As recommended by the manufacturer.

Rust-Preventive Compound

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service

Exterior Surfaces of Valves to be Buried, Submerged, or Installed in Manholes or Valve Vaults

Exterior Surfaces of all Other Valves

Polished or Machined Surfaces

Actuators and Accessories

Epoxy enamel.

Epoxy.

Universal primer.

Universal primer.

Rust-preventive compound

- 2.2 BASIN VALVES.
 - A. Basin Wall Pressure Relief Valves.
 - 1. Pressure relief valves shall be provided in concrete basin sidewalls at the locations indicated on the Drawings. The valves shall be designed for exposure to wastewater, shall be the size indicated on the Drawings, and shall be Tideflex Technologies Series 35 Flanged Check Valve. The valves shall be designed for an external back pressure of 15 feet and designed to open at a differential water head of 4 inches.

2.3 VALVE ACTUATORS.

A. Requirements for valve actuators shall be as specified in the Valve and Gate Actuators section where applicable.

2.4 **ACCESSORIES**.

When the Drawings indicate the need for extension stems; position indicator; floor boxes; or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3.1 INSTALLATION.

- A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.
- B. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- C. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- D. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- E. Performance and Other Testing

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1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

End of Section

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SECTION 40 05 86 - AIR VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing air-release valves as required by the Work.

1.2 GENERAL

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard

- 1. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable performance requirements of ANSI/AWWA C512.
- E. Identification
 - 1. Air valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

А

Drawings and Data

1. Complete assembly drawings, together with detailed specifications and data covering materials used and accessories forming a part of the valves furnished, shall be submitted in accordance with the Submittals Procedures section.

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PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Air release valves for wastewater applications with operating pressures of 300 psi or less shall be Apco/Valve and Primer "No. 400 or 450", Multiplex "Crispin S Series", ARI "No. S-020", or Val-Matic "VM-48A or 49A".

2.2 MATERIALS

A. Except as modified or supplemented herein, materials of construction shall comply with the governing standard.

Valve Trim	Austenitic stainless steel.
Float	Austenitic stainless steel, polycarbonate, or foamed
	polypropylene.
Shop Coatings	
Epoxy (NSF-61 Certified)	PPG Amercoat "Amerlock 400 High Solids Epoxy",
	Carboline "Carboguard 891", Sherwin-Williams
	"Macropoxy 646NSF" or Tnemec "Series N140 Pota-
	Pox Plus".
	A Company of the second
Epoxy	PPG Amercoat "Amercoat 385 Epoxy", Carboline
	"Carboguard 890", Sherwin-Williams "Macropoxy
· · · · · · · · · · · · · · · · · · ·	646" or Tnemec "Series N69 Hi-Build Epoxoline II".
C	
Rust-Preventive Compound	As recommended by manufacturer.
	-

2.3 SHOP PAINTING

A. All interior and exterior ferrous metal surfaces, except stainless steel components, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating. Field painting is covered in the Protective Coatings section.

B. Surfaces shall be painted as indicated:	
Interior Surfaces of Valves in Wastewater Applications	Epoxy
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound
C. Interior coatings for all valves shall be free of holidays. The total dry film thickness of shopapplied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Ероху	10 mils
Universal Primer	3 mils

2.4 SHUTOFF VALVES

A. A shutoff valve shall be provided in the piping leading to each air valve. Shutoff valves 2 inches and smaller shall be ball valves as specified in the Miscellaneous Ball Valves section. Shutoff valves 3 inches and larger for wastewater service shall be eccentric plug valves as specified in the Eccentric Plug Valve section.

PART 3 - EXECUTION

3.1 INSTALLATION

otto

A. Air release and combination air valves shall be installed in accordance with the Valve Installation section.

End of Section

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SECTION 40 05 93 - COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers single and three-phase, small (fractional) and medium (integral) horsepower, alternating current motors rated 500 horsepower and less (NEMA MG1).
- B. Motors shall be designated and coordinated with the driven equipment and shall be located as indicated on the Drawings.

1.2 GENERAL

- A. Motors furnished under driven equipment Specification sections shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.
- B. Where applicable, individual motor data sheets have been developed which specify additional requirements for specific motors.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations section shall apply to all motors, unless otherwise specified. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.
- D. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- E. Governing Standards
 - 1. Motors furnished under this section shall be designed, constructed, and tested in accordance with the latest version of NEMA MG 1, NEMA MG 10, and IEEE 112, Test Method B.
- F. Nameplates
 - 1. All motor nameplate data shall conform to NEMA MG 1 requirements.

1.3 SUBMITTALS

A. Drawings and Data - General

- 1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:
- B. Drawings and Data – Each Motor
 - 1. Name of manufacturer.
 - 2. Type and model.
 - 3. Type of bearing and method of lubrication.
 - ddine punpose, 4. Rated size of motor, hp, and service factor.
 - 5. Temperature rise and insulation rating.
 - 6. Full load rotative speed.
 - 7. Net weight.
 - Efficiency at full, 3/4, and 1/2 load. 8.
 - 9. Full load current.
 - 10. Locked rotor current.
 - Space heater wattage, where applicable. 11.
 - Motor temperature switch data, where applicable. 12.
 - Motor Shaft Grounding Ring data, where applicable. 13.
 - RTD data, where applicable. 14.
- Seismic Design Requirement Certifications C.
 - Confirmation of compliance with the requirements of the Meteorological and Seismic 1. Design Criteria section.

OPERATION AND MAINTENANCE DATA AND MANUALS 1.4

- Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.
- B. Operation and maintenance manuals shall include the following:
 - 1. Assembly, installation, alignment, adjustment, and checking instructions.
 - 2. Lubrication and maintenance instructions.

- 3. Guide to troubleshooting.
- Parts lists and predicted life of parts subject to wear. 4.
- 5. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.
- 6. Test data and performance curves, where applicable.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

Service conditions for motors shall be as specified in the driven equipment Specification A. sections. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or service environment. Where site elevation and ambient temperature is not specified in the driven equipment Specification sections, the motors shall be designed for the following.

Site elevation

Below 3.300 ft/

Ambient temperature

Unless specified otherwise, all motors shall be designed for full voltage starting and to operate B. from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

40 °C

- When powered from a variable frequency drive (VFD), motors shall be inverter duty and C. specifically selected for service with an variable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by VFDs shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.
- The number of starts per hour for motors shall be rated for the load cycling requirements of D. NEMA MG 10.

PERFORMANCE AND DESIGN REQUIREMENTS 2.2

Unless otherwise specified in the attached motor data sheet(s), design and construction of each Α. general-purpose motor shall be as specified herein. Motor voltage, frequency, speed, service factor, and insulation class shall be as follows.

Motor voltage.	460, 3 phase for ¹ / ₂ single phase for si	for ½ horsepower and larger, 120, for smaller than ½ horsepower		
Frequency.	60 Hz			
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Speed.	Constant speed
Service factor.	1.0 , except for AFD driven motors which shall be 1.15
Insulation class and temperature rise above 40° C design ambient (by resistance method.	Class F with 80° C rise at 1.0 SF
Enclosure.	Totally enclosed fan cooled
Main conduit box sized to include.	Main motor leads and space heater leads where space heaters are specified

- B. Nameplate Horsepower
 - 1. Motor nameplate horsepower [kW] shall be equal to or greater than the maximum load imposed by the driven equipment.
- C. Enclosures
 - 1. All motors shall be self-ventilated. All self-ventilated open type motors, including those with dripproof, splashproof, and weather protected enclosures, and the fan covers of totally enclosed fan cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.
 - 2. Totally Enclosed Motors
 - a. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Frames, bearing brackets, external terminal housings, and fan covers for fan cooled motors shall be cast iron. External cooling fans for fan cooled motors shall be fabricated of brass, bronze, aluminum alloy containing not more than 0.2 percent copper, malleable iron, or plastic. All plastic fans shall be fabricated of a reinforced thermosetting plastic and shall be UL approved.
 - 3. Outdoor Motors
 - a. Outdoor motors shall have NEMA weather protected enclosures. All exposed metal surfaces shall be protected, where practical, with a corrosion resistant polyester coating. Exposed uncoated surfaces shall be of a corrosion resistant metal. Enclosure exterior and interior surfaces, air gap surfaces, and windings shall be protected with a corrosion resistant polyester, polyurethane or epoxy coating.

D. Main Conduit Boxes

- 1. The main conduit box shall be in accordance with NEMA MG 1. The main conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90-degree increments. A gasket shall be furnished between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line Drawings.
- 2. The main conduit box shall be oversized at least one size larger than NEMA standard. The main conduit box shall be sized for all indicated accessory leads.

- 3. Motors furnished in NEMA 320 frame series and larger shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.
- E. Leads
 - 1. Motor power leads shall be wired into the main conduit box. Unless otherwise specified, space heater leads shall be wired into the main conduit box. All motor leads and their terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Each lead marking shall be visible after taping of the terminals.
 - 2. All motors rated 100 horsepower and larger, and all vertical motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.
- F. Terminals
 - 1. Cable type leads shall be provided with Burndy Type YA or acceptable equal compression type connectors.
- G. Grounding Connections
 - 1. All motors shall be furnished with a ground connection.
- H. Bearings
 - 1. All bearings shall be self-lubricating, shall have provisions for relubrication, and shall be designed to operate in any position or at any angle.
 - 2. Motor bearings shall be antifriction type with L_{10} life rating of 40,000 hours in accordance with ABMA Standards.
 - 3. All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy relubrication from the outside of the motor while the motor is in service, as necessary.
 - 4. Insulated Bearings

a.

Motors over 100 horsepower controlled by an adjustable frequency drive shall be furnished with one insulated bearing. The insulated bearing shall be installed on the non-drive end of the motor.

I. X Rotors

1. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced to 0.08 in./sec or less.

- J. Shafts
 - 1. Shafts shall be furnished with corrosion resistant treatment or shall be of a corrosion resistant material.
- K. Torque Characteristics
 - 1. Motors rated 200 horsepower and less shall have torques and locked-rotor current in accordance with NEMA MG 1, Part 12.
- L. Motor Space Heaters
 - 1. Unless otherwise specified in the attached motor data sheet(s), motors 1 horsepower and larger shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply.
- M. Temperature Sensing Devices
 - 1. Each motor controlled by an adjustable frequency drive shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amps at 120 volts ac. The contacts shall be wired in series with the end leads brought out to the motor terminal box.
 - 2. An auxiliary conduit box shall be provided for termination of temperature switch wiring.
- N. Motor Shaft Grounding Ring
 - 1. Each motor controlled by an adjustable frequency drive shall be furnished with a maintenance free, conductive micro fiber, shaft grounding ring with circumferential micro fibers to discharge electrical shaft currents within the motor. Motor shaft grounding ring shall be installed on the drive end on the motor shaft. Shaft grounding ring shall be installed by the motor's manufacturer in accordance with grounding ring manufacturer's recommendations.
- O. Assembly
 - 1. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.
- P. Efficiency
 - 1. Unless otherwise specified in the attached motor data sheet(s), motors shall be premium efficiency type and shall have a NEMA nominal efficiency nameplate value equal to or greater than values indicated in the following table. Efficiency shall be determined in accordance with IEEE 112, Test Method B.
 - 2. Vertical motors shall have efficiency values equal to or greater than those indicated in the following table minus 0.50.

Common Motor Requirements for Process	Equipment
---------------------------------------	-----------

	Ма	otor	Nom	inal Effi	ciency V	alues	Nomi	nal Effi	ciency V	alues
		Open Drip Enclosure			TEFC Enclosure					
	kW	hp	3600 rpm	1800 rpm	1200 rpm	900 rpm	3600 rpm	1800 rpm	1200 rpm	900 rpm
	0.7	1	84.0	85.5	82.5	75.0	77.0	85.5	82.5	75.5
	1.1	1.5	84.0	86.5	86.5	78.0	84.0	86.5	87.5	80.0
	1.5	2	85.5	86.5	87.5	86.5	85.5	86.5	88.5	85.5
	2.2	3	85.5	89.5	88.5	89.5	87.0	89.5	89.5	86.5
	3.7	5	86.5	89.5	89.5	89.5	88.5	89.5	89.5	85.5
	5.6	7.5	88.5	91.0	90.2	88.5	90.0	91.7	91.0	86.5
	7.5	10	89.5	91.7	91.7	91.0	91.0	91.7	91.0	91.0
	11.2	15	90.2	93.0	91.7	91.0	91.0	92.4	92.0	91.0
	14.9	20	91.7	93.0	92.4	92.0	92.0	93.0	92.0	91.0
	18.7	25	92.4	93.6	93.0	92.0	92.0	93.6	93.0	91.0
	22.4	30	93.0	94.1	93.6	93.0	92.4	93.6	93.0	93.0
	29.8	40	93.0	94.1	94.1	93.0	92.4	94.1	94.1	93.0
	37.3	50	93.0	94.5	94.1	93.0	93.0	94.5	94.1	93.0
	44.8	60	93.6	95.0	94.5	94.0	93.6	95.0	94.5	93.0
	56	75	94.0	95.0	95.0	94.0	93.6	95.4	95.0	94.0
	74.6	100	94.5	95.4	95.0	95.0	94.1	95.4	95.0	94.0
	93.2	125	95.0	95.4	95.0	95.0	95.0	95.4	95.0	94.0
	112	150	95.0	95.8	95.4	95.0	95.0	95.8	95.8	94.0
	149	200	95.4	95.8	95.4	95.0	95.4	96.2	95.8	94.1
	186	250	95.0	95.8	95.4	95.0	95.8	96.2	95.8	94.5
	224	300	95.4	95.8	95.4		95.8	96.2	95.8	
,	261	350	95.4	95.8	95.4		95.8	96.2	95.8	
C	298	400	95.8	95.8	95.8		95.8	96.2	95.8	
	336	450	95.8	96.2	96.2		95.8	96.2	95.8	
	373	500	95.8	96.2	96.2		95.8	96.2	95.8	

2.3 ACCESSORIES.

A. Special Tools and Accessories

 1.
 Motors requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor

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shall be provided with lifting eyebolts or lugs and appropriate fittings for adding bearing lubricant. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2.4 **ANCHORS**

Contractor shall furnish suitable anchors for each item of equipment as required for driven A. equipment.

2.5 BALANCE

All rotating parts shall be accurately machined and shall be in as nearly perfect rotational A. balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits as required by NEMA MG 1. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 **INSTALLATION**

Each motor shall be installed in accordance with the Equipment Installation section. A. Jot to be the

End of Section

SECTION 40 06 20 - SCHEDULES FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SCOPE

- A. This section consists of a schedule of 4 inch and larger pipelines indicating the type of pipe to be used. Pipe materials, installation, testing, and disinfection, when specified, are covered in other sections
- B. Piping smaller than 4 inch is covered in the various miscellaneous piping sections. Piping for plumbing, heating and air conditioning systems is covered in other sections. Piping to be furnished with equipment is covered in the applicable equipment section.

1.2 WALL FITTINGS

A. A wall pipe or sleeve will be required for all pipe passing through concrete or masonry block walls. Wall fittings and sleeves shall be as indicated on the drawings and as specified in the applicable piping section.

1.3 SCHEDULE INDEX

A. Pipe material abbreviations and their applicable specification section number are as indicated:

Abbreviation	Pipe Material	Section No.
CI	Cast iron soil pipe	22 13 17
CPVC	CPVC	40 05 05.11
CS	Miscellaneous steel pipe	40 05 24.43
CU 🔨	Copper tubing	40 05 17
CLDIP	Cement Mortar Lined Ductile iron pipe	40 05 19
PVC	PVC	40 05 05.11
SP	Steel pipe	40 05 24.26
SS	Stainless steel pipe	40 05 23

1.4 SCHEDULE

A. Pipe materials shall conform to Schedule 40 06 20-S01. All pipelines indicated on the drawings and all pipelines required for proper operation of the equipment furnished shall be provided whether listed in the schedule or not.

End of Section

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Size	Process Code	Service	Installation	Material	Spec Section
All	AGSE	AGS Effluent	В	CLDIP	40 05 19
All	AIR	Air Low Pressure (in- plant and exposed up to reactors)	I, E	CS	40 05 24.43
All	AIR	Air Low Pressure (at reactors)	Е	SS	40 05 23
All	AIR	Blower Inlet	I, E	SS	40 05 23
All	DRN	Drain	I, B	CLDIP	40 05 19
All	DRN	Drain	W	SS	40 05 23
All	PD	Sump Pump Discharge	I, B	PVC	40 05 41
All	AGSI	AGS Influent	I,B	CLDIP	40 05 19
All	NPW	Plant Water	В	CLDIP	40 05 19
All	WAGS	Waste Activated Granular Sludge	I, B	CLDIP	40 05 19
All	WAGS	Waste Activated Granular Sludge	W	SS	40 05 23
All	WLC	Water Level Correction	I, B	CLDIP	40 05 19
All	WLC	Water Level Correction	W	SS	40 05 23
All	WAGS/WLC	Combined WAGS/WLC Pump Discharge	I, B	CLDIP	40 05 19
All	WAGS/WLC	Combined WAGS/WLC Pump Discharge	W	SS	40 05 23

Pipeline Schedule 40 06 20 - S01

Legend: I = In-Plant, E = Exposed, B = Buried, W = Wetwell

End of Schedule

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SECTION 40 42 11 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing and installation of insulation, jackets, and accessories for the following mechanical systems:
 - 1. piping
 - 2. ductwork
 - 3. equipment
- B. Building insulation materials are specified in other sections. Insulation for mechanical equipment which is to be applied at the factory prior to shipment is specified in the individual equipment sections.
- C. Electrical heat tracing for piping shall be as specified in the Electrical section.

1.2 GENERAL

- A. Materials furnished and installed under this section shall be in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.
- B. Coordination
 - 1. Contractor shall be responsible for coordinating the installation of insulation with the installation of the items or systems to be insulated. Each item or system shall be tested and accepted by Engineer before installation of the insulation materials.
 - 2. Contractor shall verify that each component of the insulation systems is compatible with all other parts of the system; that all insulation materials are appropriate for the intended applications; and that all necessary devices and accessories have been provided.



All insulation of the same class shall be the product of a single manufacturer; however, all the insulation types need not be the products of one manufacturer.

C. General Equipment Stipulations

1. The General Equipment Stipulations_shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

- D. Governing Standards
 - 1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.
 - 2. All work shall comply with UL, NFPA, and ASTM safety requirements.
- E. Metal Thickness
 - 1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.
- F. Surface Burning Characteristics
 - 1. Insulation, jackets, tapes, and adhesives to be used indoors shall have a composite flame spread rating not to exceed 25 and a composite smoke developed rating of 50 when tested by UL 723, NFPA 255, or ASTM E84. All testing shall be done on materials of the same densities and installed thicknesses as the materials being installed. Insulation materials which have been treated with a flame retardant additive to meet the required flame spread and smoke developed ratings are not acceptable.
- G. Painting and Identification
 - 1. Field painting and identification shall be as specified in the Protective Coatings section.
 - 2. Piping systems with electrical heat tracing shall have warning labels attach to the outside of the pipe thermal insulation weather barrier to indicate the presence of electric heat tracing. Labels shall be located every 10 feet of pipe, alternating on either side. The labels shall be black on yellow, weatherproof, mylar, with pressure sensitive adhesive and at least 2 inches by 6 inches minimum.

1.3 SUBMITTALS

A. Drawings and Data



1.

- A complete list of materials and catalog cuts, together with detailed specifications, materials performance data, installation instructions, parts, devices, and accessories furnished, shall be submitted in accordance with the Submittal Procedures section. Information shall include certified test results to show compliance with UL, NFPA, and ASTM safety requirements.
- 2. Product data for adhesives shall include VOC content.

1.4 QUALITY ASSURANCE

A. Manufacturer Experience

1. A manufacturer shall have furnished material of the type specified which has been in successful operation for not less than the past 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.2 MATERIALS

- A. Insulation, vapor retarders, and field applied jackets shall be installed to cover piping, ductwork, equipment, fittings, and appurtenances as indicated in the Insulation Schedule.
- B. Pipe Insulation
 - 1. Type PMF1 Insulation
 - a. Type PMF1 mineral fiber pipe insulation shall be Johns Manville "Micro-Lok", Knauf "Pipe Insulation" or Owens-Corning.
 - b. Type PMF1 pipe insulation shall be a one-piece molded glass fiber material with all-purpose jacket. The all-purpose jacket shall be factory-applied, fiberglass reinforced vapor barrier type, with white kraft bonded to aluminum foil and self sealing adhesive lap. The insulation shall be suitable for a temperature range of 0°F to 850°F, shall have a maximum thermal conductivity (k) of 0.24 Btu in/hr ft2 °F at 75°F, and shall conform to ASTM C547.
 - 2. Type PFC1 Insulation



- Type PFC1 flexible cellular elastomeric pipe insulation shall be Armacell "AP/Armaflex" or K-Flex USA "Insul-Tube" for unslit insulation and Armacell "AP/Armaflex SS" or K-Flex USA "Insul-Lock Seam-Seal" for factory pre-slit insulation. Flexible cellular polyolefin foam insulation shall be IMCOA "Imcolock" or Plastic Technology, Inc. "Innofoam".
- Type PFC1 pipe insulation shall be one-piece, molded elastomeric or polyolefin foam insulation suitable for a temperature range of -40°F to 180°F, and shall have a maximum thermal conductivity (k) of 0.28 Btu in/hr ft2 °F at 75°F. The insulation shall be suitable for exposure to weather and direct sunlight or, where not indicated to be jacketed, shall be given two coats of an ultraviolet-resistant finish recommended by the manufacturer. Insulation shall conform to ASTM C534 for elastomeric or ASTM C1427 for polyolefin.

Mechanical Insulation

- 3. Type PAF1 Insulation
 - Type PAF1 acoustical pipe insulation with fiberglass insulation decoupler shall be a. Insultech "LT450A-TT-2". Type PAF1 acoustical pipe insulation and lagging shall be of the loaded vinyl noise barrier type with quilted fiberglass decoupler suitable for a temperature range of -20 °F to 350 °F, and shall have a maximum thermal conductivity (k) of 0.25 Btu in/hr ft² °F at 75 °F. The insulation system shall not require additional lagging and shall be suitable for indoor installation. The insulation shall have minimum octave-band Insertion Loss performance as follows, jddine punpose when measured in accordance with ASTM E1222:

63 Hz : 12 dB 125 Hz: 19 dB 250 Hz: 16 dB 500 Hz: 30 dB 1 kHz: 43 dB

- 2 kHz: 48 dB
- 4 kHz: 50 dB
- 8 kHz: 50 dB
- C. **Duct Insulation**
 - 1. Type DMF1 Insulation
 - Type DMF1 semi-rigid type duct insulation shall be Johns Manville "800 Series a. Spin-Glas", Knauf "Insulation Board", or Owens-Corning "Fiberglas 705".
 - Type DMF1 exterior insulation for rectangular ductwork shall be a semirigid, b. 6 pounds per cubic foot density fiberglass material with a factory-applied all service jacket. Insulation suitable for temperatures of up to 150°F, and shall have a maximum thermal conductivity (k) of 0.23 Btu in/hr ft2 °F at 75°F. The insulation shall conform to ASTM C612.
 - Type DMF2 Insulation 2.



Type DMF2 flexible type duct insulation shall be Johns Manville "Microlite", Knauf "Friendly Feel Duct Wrap", or Owens-Corning "SOFTR All-Service Duct Wrap".

Type DMF2 exterior insulation for round ductwork shall be 1 lb per cubic foot density flexible fiberglass duct wrap with factory-applied foil-scrim-kraft facing. Insulation suitable for temperatures of up to 250°F, and shall have a maximum thermal conductivity (k) of 0.27 Btu in/hr ft2 °F at 75°F. The insulation shall conform to ASTM C553.

- D. Equipment Insulation
 - 1. Type EMF1 Insulation
 - a. TypeEMF1 equipment insulation shall be Johns Manville "800 Series Spin-Glas", Knauf "Insulation Board", or Owens-Corning "Fiberglas 705".
 - b. Type EMF1 equipment insulation shall be rigid mineral fiber insulation board with a density of 6 pounds per cubic foot and a factory-applied foil-scrim-kraft facing. Insulation suitable for temperatures of up to 150°F, and shall have a maximum thermal conductivity (k) of 0.23 Btu in/hr ft2 °F at 75°F. The insulation shall conform to ASTM C612.
 - 2. Type EMW1 Insulation
 - a. Type EMW1 equipment insulation shall be Rock Wool Manufacturing Company "Delta-12 Mineral Wool Board".
 - b. Type EMW1 equipment insulation shall be high temperature mineral wool board with a thermosetting binder suitable for temperatures up to 1200°F and shall have a density of 12 pounds per cubic foot . The insulation shall conform to ASTM C592.

2.3 ACCESSORIES

- A. PVC Insulation Jackets
 - 1. PVC insulation jackets for piping systems shall be furnished and installed as specified herein and indicated on the Drawings.
 - 2. All fittings in piping systems insulated with mineral fiber shall be jacketed with a polyvinyl chloride (PVC) jacketing material. Piping systems where indicated to have PVC jackets shall be jacketed with the same PVC jacketing material. Jackets for fittings shall be one piece, factory molded to the contour of the fitting. The PVC jacket and fitting covers shall have a minimum thickness of 0.020 inches when installed indoors and 0.030 inches when installed outdoors. PVC jacketing shall be Johns Manville "Zeston 2000 Series".
- B. Aluminum Insulation Jackets
 - 1. Aluminum insulation jackets for insulated piping systems shall be furnished and installed as indicated in the insulation schedule herein and where indicated on the Drawings. Aluminum jackets shall be manufactured from alclad conforming with ASTM B209. The aluminum jacket shall have a nominal thickness of 0.016 in., with an embossed finish.
 - 2. Fittings in insulated piping systems and equipment where indicated in the insulation schedule shall be provided with aluminum jackets of the same aluminum jacketing material as the piping systems. The jacket shall have a factory-applied moisture retarder of at least 3 mils permanently bonded to the interior surface and extending the full width of the jacket. The retarder shall consist of Polysurlyn or polyethylene film and kraft paper.

PART 3 - EXECUTION

3.1 INSTALLATION.

- A. General
 - 1. Contractor shall install all insulation materials as specified herein for the piping systems, ductwork, and equipment that are not factory insulated. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried. All work shall be performed within the temperature ranges recommended by the insulation product manufacturer. Insulation shall be kept clean and dry and shall remain in the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label with the name of the manufacturer and description of materials.
 - 2. Seams of exposed insulation and jackets shall be in the least visible location.
 - 3. All adhesives used on the interior of the building defined as inside the weatherproofing system shall have a VOC content not greater than 80 g/L.
- B. Piping Insulation
 - 1. Type PMF1 Insulation
 - a. Pipe insulation, vapor retarders, and field applied jackets shall be installed to cover system piping, fittings, and appurtenances. Insulation shall be full factory unit lengths using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. End joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.
 - b. Insulated piping conveying fluids at lower than ambient temperatures shall be jacketed with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and shall be sealed with vapor barrier coating. The vapor barrier coating shall be applied at intervals not exceeding 15 feet for straight runs and not more that 6 inches from fittings. Fibrous insulation laps and butt strips that are not self-sealing shall be secured with adhesive and stapled. Staples and seams shall be coated with vapor barrier material.

On piping 2 inches and larger where the insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be of the same thickness and contour as the adjacent insulation and installed to maintain a continuous vapor barrier through the support. The insert shall be constructed of wood or heavy density insulating material suitable for the system operating temperatures.

- 2. Type PMW1 Insulation
 - a. The insulation shall be installed in layers to obtain the specified thickness. Joints and seams between insulation sections or segments shall be tight and shall be staggered between layers. The insulation shall be fastened with stainless steel wire

loops on 6 inches centers embedded into the outer layer. All cracks, voids, and depressions shall be filled with insulating cement suitable for the system operating temperatures. The surfaces to receive outer coverings shall be smooth and uniform. Flanges and expansion joints in exhaust piping shall not be insulated.

- 3. Type PFC1 Insulation
 - a. Pipe insulation shall be installed to cover all pipe, fittings, and appurtenances with all seams and joints sealed by a factory or field applied adhesive. Insulation at fittings and appurtenances shall be carefully formed and fitted. Insulation at elbows shall be mitered using segments of pipe insulation.
- 4. Type PAF1 Insulation
 - a. Pipe insulation shall be installed in accordance with the manufacturer's requirements. Pipe insulation shall be installed to cover all pipe, fittings and appurtenances. Insulation covering valves shall be removable, sections shall be either laced on or Velcro shall be used.

C. Duct Insulation

- 1. Insulation for ducts indicated on the Drawings as wrapped shall be installed as specified herein and indicated on the Drawings. Duct insulation shall be continuous through hangers and penetrations, except firewall penetrations but shall be interrupted at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their functioning and/or replacement. Insulation jackets shall be continuous across seams, reinforcement, and projections.
- 2. Insulation on ducts conveying air at temperatures below 60°F shall be installed with a continuous vapor barrier seal. Staples and joints shall be sealed with a vapor barrier coating.
- 3. Type DMF1 Insulation
 - a. Type DMF1 semirigid insulation shall be secured to all four sides of the duct with mechanical fasteners, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. At least two rows of fasteners shall be provided for each side of 12 inches and larger ducts, and one row for each side of ducts smaller than 12 inches. All joints in the insulation shall be sealed with 3 inches wide joint sealing tape or 4 inch wide strips of jacket material secured with adhesive and staples.

Type DMF2 Insulation

a. Type DMF2 flexible insulation shall be installed with waterproof, fire-retardant adhesive. Insulation jackets shall overlap at least 2 inches and shall be secured under the overlap with adhesive and stapled on 4 inch centers.

- D. PVC Jacketing
 - 1. PVC jacketing for piping systems shall be installed as specified herein and indicated on the Drawings. End joints and longitudinal seams on piping systems conveying fluids at lower than ambient temperatures shall be vapor-sealed, and covered with vapor-barrier tape to ensure a continuous vapor seal. Fittings shall be insulated with glass fiber material.
- E. Aluminum Jacketing
 - 1. Aluminum jacketing for piping systems shall be installed as specified herein and indicated on the Drawings. Jacketing shall be held in place with stainless steel securing bands uniformly spaced at not more than 18 inches to produce tight joints without "bulging". The jacket shall overlap at least 2 inches at longitudinal and circumferential joints. Joints shall be overlapped and sealed with caulk to prevent moisture penetration, and longitudinal joints shall be placed to shed water. Exposed ends of pipe insulation shall be provided with covers constructed of the same material as the jacketing.
 - 2. Elbows shall be jacketed with spirally wrapped aluminum strips or individual mitered segments or gores cut to fit the insulation.

INSULATION SCHEDULE					
Machanical Insulation					
	Size		Thickness	-	
Service	Inches	Туре	Inches	Notes	
PIPING - INDOOR (CO	NCEALED OR EXPOSE	D)			
Non-Potable Cold	Up to 3	PFC1	3/4		
Water	4 & larger	PFC1	1		
Blower air inlet, discharge and blow-off	All	PAF1	1	(10), (11)	
PIPING - OUTDOOR (EXPOSED)					
AGS Reactor Air	All	PMF1	1	(1)	
Blower air inlet, discharge and blow-off	All	PMF1	1	(10), (11)	
Piping with Heat Tracing	All	PMF1	1.5	(1)	
DUCTWORK					
Rectangular	Within conditioned	DMF1	1	(6)	
	space	DMF1	2	(5), (6)	
	All other indoor locations				

3.2 INSULATION SCHEDULE.

4

INSULATION SCHEDULE					
		Mechanical Insulation			
	Size		Thickness		
Service	Inches	Туре	Inches	Notes	
Round	Within conditioned	DMF2	2	(6)	
	space	DMF2	3	(5), (6)	
	All other indoor				
	locations			Ć	
Mechanical Insulation Types: FC - Flexible Cellular					
MF - Mineral Fiber					
MW - Mineral Wool					
AF – Acoustic Fiber					
Notes:					

- (1) Aluminum jacket.
- (2) PVC jackets shall be provided on exposed portions of insulated piping located less than 8 feet above finished floor. On all other portions of the insulated piping system PVC jackets shall be provided only for fittings.
- (3) Insulation shall be provided for portions of the piping system which pass through space above finished ceilings or is exposed above equipment, electrical panels, or cabinets.
- (4) Insulation shall be provided for exposed portions of the piping system located less than 8 feet above the finished floor or grade.
- (5) Insulation shall be provided for outside air plenums and ducts that are located upstream of the heating coil or pass through unheated spaces after the heating coil, unless indicated to be internally lined.
- (6) Insulation shall be provided for outside air plenums and ducts, air conditioning supply and return ducts, and dehumidifier reactivation air discharge ducts, unless indicated to be internally lined.
- (7) Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F.
- (8) The underside of all roof drains shall be insulated to a 1 foot radius from the center of the drain. All roof drain piping within 4 feet of the drain shall be insulated.
- (9) Includes 8 feet of the cold water inlet piping to the water heater storage tank.
- (10) Insulation thickness shall be sufficient to provide octave band attenuation as specified herein.
- (11) Provide pipe protectors consisting of 360-degree high density, 100 psi, waterproofed calcium silicate inserts encased in 360-degree sheet metal at every pipe support containing U-bolts. Inserts shall extend a minimum of 3 inches to each side of the U-bolt and shall be the same thickness as the adjacent insulation. Inserts shall be rated for the same temperature as the adjacent pipe.
- A. Unless otherwise indicated in the insulation schedule, all mechanical piping, ductwork, equipment, and accessories with an operating temperature in excess of 140°F or below 60°F shall be insulated.

End of Section

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SECTION 40 61 11 - INSTRUMENTATION AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 SCOPE

- This section covers the furnishing and installation of additions and modifications to an existing A. instrumentation and control system designated as the Plant Control System. The existing Plant Control System uses Emerson Automation Programmable Logic Controllers (PLCs) to monitor and control the plant equipment. To allow the operators the ability to interface with the Plant Control System, an iFix Human Machine Interface (HMI) application runs on redundant server computers and operator workstations. For this project, a new PLC shall be provided by the Aerobic Granular Sludge (AGS) System Supplier to monitor and control the AGS reactors, interface with the blower local control panel PLCs, and monitor and control the Waste Activated Granular Sludge / Water Level Correction (WAGS/WLC) wetwell and pumps. Modbus TCP/IP Ethernet communication shall be used to communicate between the new AGS PLC and the Plant Control System. AGS System Supplier shall provide and configure the necessary communication modules or protocol converters for this communication. In addition, Ethernet communication shall be used to exchange data between the new AGS PLC and the WAGS/WLC Variable Frequency Drives (VFDs) and the blower PLCs in the blower local control panels. All programming of new PLCs and Operator Interface Terminals (OITs) shall be provided by the AGS System Supplier.
- B. The additions and modifications to the existing HMI application will be programmed by the Owner. In addition, the Owner will program the control modifications associated with the control of the existing gate in the Primary Filter Effluent Diversion Structure.
- C. The system shall be furnished as specified, complete with all software, human machine interface (HMI) hardware, input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation.
- D. Associated Sections
 - 1. This section also includes the equipment and services specified in the following sections.

	Section 40 64 00	PROGRAMMABLE LOGIC CO	ONTROLLERS
Zor	Section 40 66 11	NETWORK SYSTEMS	
	Section 40 66 33	METALLIC AND FIBER OPT AND CONNECTORS	IC COMMUNICATION CABLE
	Section 40 67 11	PANELS, CONSOLES, AND A	APPURTENANCES
	Section 40 68 83	SOFTWARE CONTROL BLOO	CK DESCRIPTIONS
	Section 40 71 00	FLOW INSTRUMENTS	
	Section 40 72 00	PRESSURE AND LEVEL INST	TRUMENTS
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Section 40 74 00TEMPERATURE INSTRUMENTSSection 40 75 00PROCESS ANALYTICAL INSTRUMENTSSection 40 78 00PANEL MOUNTED INSTRUMENTS

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Some portions of this section and the sections listed above shall apply for the AGS System Supplier and will be identified to delineate the System Supplier's and AGS System Supplier's responsibilities. Any specified requirement that is not specifically identified as a System Supplier or AGS System Supplier responsibility shall apply to both suppliers.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Drawings

- 1. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment. The input/output (I/O) lists are attached as an appendix to the Programmable Logic Controllers section.
- 2. Principal components of the instrumentation systems shall be as indicated on the P&ID drawings and instrument device schedule attached to this section.
- D. Codes, Permits and Agency Approvals
 - 1. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where mandated by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.
- E. Supplier's Qualifications
 - 1. Equipment and software furnished under this section and under other related sections listed in the Scope paragraph above shall be designed, coordinated, and supplied by a single manufacturer or supplier, hereinafter referred to as the System Supplier. The System Supplier shall be regularly engaged in the business of supplying instrumentation. The Contractor shall utilize the services of the System Supplier to check-out and calibrate

instruments and to perform all testing, training, and startup activities specified to be provided.

- 2. The System Supplier shall have the following minimum qualifications:
 - a. The supplier shall maintain a design office staffed with qualified technical design personnel.
 - b. The supplier shall maintain competent and experienced service personnel to service the instrumentation furnished for this project.
 - c. The supplier shall have as a minimum 5 years of experience in the design, coordination, and supply of instrumentation.
- F. Coordination
 - 1. Instrumentation supplied under this section shall be designed and coordinated by System Supplier for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment. All equipment shall be designed and installed in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.
 - 2. The instrumentation supplied by the System Supplier shall be monitored by the AGS control system. System Supplier shall coordinate the installation and wiring with the AGS System Supplier.
- G. Related Equipment and Materials
 - 1. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.
- H. Device Tag Numbering System
 - 1. All devices shall be provided with permanent identification tags. The tag numbers shall agree with System Supplier's and AGS System Supplier's equipment drawings and shall be as close as practical to the tag numbers used on the Drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1.3 \rightarrow GENERAL REQUIREMENTS

A. The Drawings and Specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by System Supplier, details of such departures and the reasons shall be submitted to Engineer for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

- B. The specifications describe the minimum requirements for hardware and software. Where System Supplier's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.
- C. Governing Standards
 - 1. Equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 Class A, and NEMA ICS-1-109.60.
- D. Dimensional Restrictions
 - 1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The System Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Engineer. At least three feet of clear access space shall be provided in front of all instrumentation and control system components.
- E. Workmanship and Materials
 - 1. System Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
 - 2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except for testing.
- F. Corrosive Fluids
 - 1. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials. System Supplier shall submit certification that the instrument manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.
- G. Appurtenances

Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

- H. Programming Devices
 - 1. A programming or system-configuring device shall be provided for systems that contain any equipment that requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete, newly purchased for this

project, and shall be in like-new condition when turned over to Owner at completion of startup.

1.4 SUBMITTALS

- A. General
 - 1. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.
- B. First Stage Submittal
 - 1. The first stage submittal shall include the following items.
 - a. A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by System Supplier or AGS System Supplier and this specification.
 - b. Product catalog cut sheets on all hardware and software items, clearly marked to show the model number, optional features, and intended service of each device. (System Supplier and AGS System Supplier)
 - c. A brief, concise description of the proposed system, including major hardware and software components and personnel training. (AGS System Supplier)
 - d. A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships. (System Supplier & AGS System Supplier)
 - e. Drawings showing floor and wall space or desktop area requirements for all equipment items, including allowances for door swings and maintenance access. (System Supplier & AGS System Supplier)

- Environmental and power requirements, including heat release information for each equipment item. (AGS System Supplier)
- g. Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system. (System Supplier & AGS System Supplier)
- h. A copy of the proposed software licenses for all software associated with the system. (System Supplier & AGS System Supplier)
- i. Outline for training classes. (System Supplier & AGS System Supplier)
- j. Additional requirements identified in other Division 40 sections. (System Supplier &

AGS System Supplier)

C. Second Stage Submittal

- 1. Before any equipment is released for shipment to the site and before factory testing is scheduled, the following data shall be submitted.
- 2. At System Supplier's or AGS System Supplier's option, the first and second stage submittals may be combined.
 - a. Detailed functional descriptions of all software modules specified and furnished as part of AGS System Supplier's standard system. The descriptions shall be identified with the applicable specification paragraph.
 - b. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall be to scale and shall include overall dimensions, metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices. (AGS System Supplier)
 - c. Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If panel terminal designations, inter-device connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the site. (AGS System Supplier)
 - d. Fiber termination diagrams to show all fiber terminations at fiber patch panels and final termination at equipment. Fiber termination diagrams shall show individual fiber type (single or multimode), fiber core/cladding dimensions, fiber colors, circuit identifications, and type of terminator. (System Supplier)
 - e. Review of drawings submitted prior to the final determination of related equipment shall not relieve System Supplier or AGS System Supplier from supplying systems in full compliance with the specific requirements of the related equipment.

Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal. (AGS System Supplier)

- g. Proposed lesson plans or outlines for all training courses specified herein, including schedule, instructors' qualifications and experience, and recommended prerequisites. (System Supplier & AGS System Supplier)
- h. Standard system engineering and user manuals describing the use of the system and application programming techniques for OIT graphics, OIT database, and adding new process I/O nodes to the OIT. (AGS System Supplier)
- i. Additional Requirements identified in other Division 40 sections. (System Supplier & AGS System Supplier)

D. Third Stage Submittal

1. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted by the System Supplier and AGS System Supplier before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted. Additional requirements are identified in other Division 40 specification sections.

1.5 PREPARATION FOR SHIPMENT

- A. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.
- B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.
- C. Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.
- D. Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.
- E. Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. System Supplier shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.
- F. Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1.6 DELIVERY, STORAGE, AND SHIPPING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.7 SPARE PARTS

- A. Spare parts and consumable items are specified in other sections.
- B. Packaging
 - 1. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in antistatic material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.
- C. Replacement
 - 1. System Supplier and AGS System Supplier may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

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PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. All equipment furnished under each section referenced in SCOPE is a part of this section and shall be selected by System Supplier or AGS System Supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review.
- B. Standard Products
 - 1. The systems furnished shall be standard products. Where two or more units of the same type of equipment are supplied, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.
 - 2. To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.
- B. Where redundant hardware is provided, the system shall be capable of performing all specified functions, without reconfiguring hardware or software, with only one device of each category in service. (AGS System Supplier)

- C. Factory Assembly
 - 1. Equipment shall be shipped completely factory assembled, except where its physical size, arrangement, configuration, or shipping and handling limitations make the shipment of completely assembled units impracticable.
- 2.3

2.3 POWER SUPPLY AND INSTRUMENT SIGNAL

- A. Power supply to all control system equipment will be 120 volts ac. AGS System Supplier shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system from the power supply receptacles and junction boxes indicated on the Drawings. Power distribution hardware shall include cables and branch circuit overcurrent protection installed in accordance with the electrical section.
- B. Unless otherwise indicated, power supply to the instrumentation will be unregulated 120 volts ac. Unless otherwise indicated, all transmitted electronic analog instrument signals shall be 4-20 mA dc and shall be linear with the measured variable.
- C. Facility Distribution System
 - 1. Equipment not indicated to be powered from an uninterruptible power source shall be suitable for being supplied from the facility distribution system and shall be capable of withstanding voltage variations of ± 10 percent and harmonics up to the limits of IEEE 519 without affecting operation. AGS System Supplier shall provide voltage conditioning or filtering equipment if necessary, to meet the requirements specified.
- D. Power Supplies
 - 1. Power supplies for voltages other than those listed above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected. (AGS System Supplier)
- E. Surge Withstand
 - 1. All equipment shall meet all surge withstand capability tests as defined in ANSI C37.90 without damage to the equipment.
- F. Uninterruptible Power Supply
 - An uninterruptible power supply (UPS) shall be furnished hereunder to power the equipment indicated on the Drawings or will be furnished under another section. AGS System Supplier shall be responsible for coordinating the size of the UPS unit with the equipment furnished hereunder and shall advise Engineer if a unit of higher capacity is necessary.

2.4 SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS

- A. The equipment provided for the instrumentation and control system shall be suitable for the service conditions specified in the attached equipment sections.
- B. All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.
- C. Ambient Temperature and Elevation
 - 1. All system equipment located in air-conditioned rooms shall be suitable for operation in ambient temperatures from 10° C to 35° C and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non-air-conditioned indoor areas shall be suitable for an ambient temperature range of 0° C to 50° C and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range -20° C to 60° C and a relative humidity of 5 to 100 percent. Heaters and air conditioning/cooling equipment shall be provided where essential to maintain equipment within its manufacturer-recommended operating ranges.
 - 2. All equipment and instruments shall be designed to operate at the site elevation of 700 ft.
- D. Lightning Protection
 - 1. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.
 - 2. Grounding
 - a. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the Drawings shall be modified as recommended by AGS System Supplier.
 - 3. Surge Suppressors



Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) type, silicon junction type, Gas Discharge Tube (GDT) type, or some combination of these types, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:

- All 120 volts ac power connections to RTUs, PLCs, DCUs, instruments and control room equipment. Surge arresters shall be Transtector "SPD 12R Series", Phoenix Contact "PLT-SEC Series", MCG Surge Protection "400 Series" or equal. (AGS System Supplier)
- 2) All analog signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede or interfere with the use of smart transmitter calibration/communication.
 - a) Protection devices located at the field transmitter shall be:

- Loop Powered Transmitters Eaton MTL "TP48", Phoenix Contact "Surge Trab Series", Transtector "PDS Outdoor Series" or equal. (System Supplier & AGS System Supplier)
- Four-Wire Transmitters Phoenix Contact "BoxTrab Series", Schneider Electric ASCO Model 265, Emerson "SolarHD STC-SLAC Series", or equal. (System Supplier & AGS System Supplier)
- b) Protection devices in control panels shall be Transtector "12R IEP Series", Eaton MTL "SD Modular Series", Phoenix Contact "TTC-6P Series", or equal. (AGS System Supplier)

2.5 SOFTWARE DOCUMENTATION

- A. System Supplier and AGS System Supplier shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the optical media backup. Software documentation shall consist of the following principal items.
 - 1. One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.
 - 2. Two complete back-up copies of system and application software in executable format on optical media compatible with the system furnished.
 - 3. Three sets of user reference manuals for all standard system and application software.
 - 4. One set of user reference manuals for all operating system software.
 - 5. Three sets of printed as-built reference documentation for any special software provided specifically for this contract.
 - 6. For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. One set of this documentation shall be supplied for each and every piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2.6 **SOFTWARE LICENSE**

A. All software programs supplied as a standard part of System Supplier's or AGS System Supplier's products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict Owner from using the software on the system provided hereunder or its replacement. Owner shall have the right to make copies of the software for use on the system provided. Specific requirements of System Supplier's and AGS System Supplier's software license are subject to review and approval by Owner and Engineer.

2.7 INSTALLATION TEST EQUIPMENT

A. Each supplier shall provide all necessary testing equipment for calibration and checking of system components that they provide. System Supplier and/or AGS System Supplier shall also furnish calibration and maintenance records for all testing and calibration equipment used on the site if requested by Engineer.

2.8 PROGRAMMING DEVICES

A. An instrument programming device shall be provided for the instruments specified in other sections. Quantity of programming devices shall be as specified in other sections. (System Supplier & AGS System Supplier)

2.9 PROGRAMMING SOFTWARE

A. Instrument programming software shall be provided for the instruments specified in other sections. One software license shall be provided. (System Supplier & AGS System Supplier)

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. The installation of equipment furnished hereunder shall be by the Contractor or their assigned subcontractors.

B. Field Wiring

- 1. Field wiring materials and installation shall be in accordance with the electrical section.
- C. Instrument Installation
 - 1. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the Drawings.



All outdoor instrumentation shall be protected from direct sun exposure. Instruments shall be placed in locations to limit south and west sun exposure. Sunshades shall be provided on instruments that are subject to the direct sun exposure. Sunshades shall be located so the opening faces north or east where possible. Sunshades shall be provided as shown on the Drawings.

- D. Salvage of Existing Equipment
 - 1. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner, or shall be properly disposed of at Owner's discretion. Care shall be taken to avoid damage to equipment delivered to Owner.
2. Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer. Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3.2 FIELD QUALITY CONTROL

- A. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- D. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.
- 3.3

3.3 SYSTEM SOFTWARE CONFIGURATION

- A. AGS control system software (PLC and OIT) shall be configured by the AGS System Supplier. Modifications to the existing HMI application software and programming modifications to existing PLCs will be configured by the Owner. Configuration services provided by the AGS System Supplier shall consist of the creation of the system database, operator interface graphic and tabular display screen formats, password and security implementation, and programming of control units to provide a fully functioning system. The AGS System Supplier shall fully configure the system using data provided herein or supplied by the Engineer and/or the Owner after award of the contract. AGS System Supplier shall coordinate with the Owner to provide the necessary HMI application modifications required for remote monitoring and limited control of the AGS system.
- B. The system that is delivered to the field for installation, checkout, and startup shall have all files, or databases, that are configurable in size, sized in a manner in which there will be 50% space available for future work after the completion of this project. This sizing should include the addition of memory modules, disk drives, or any other device to insure the 50% space availability. All "tuning" of software that is dependent on space requirements shall be done prior to the completion of this project. (AGS System Supplier)

- C. Tuning of software programs shall be accomplished in such a manner that the program operates at its highest performance level. These programs include, but are not limited to Microsoft SQL Server, all PLC ladder logic, and others. (AGS System Supplier)
- D. Control System Database
 - 1. The control system database for the PLCs and OITs required for the AGS system shall be developed and configured by the AGS System Supplier. The AGS System Supplier shall enter information obtainable from the Contract Documents into the database prior to soliciting input from the Engineer and the Owner. The AGS System Supplier shall determine the need for any "pseudo" database points and shall ascertain and enter all information needed to define these points. The AGS System Supplier is responsible for entering all information associated with each point. This includes but is not limited to, descriptions, engineering units, associated displays, areas, security, etc. All fields associated with each database point must be completely filled out accurately.
- E. Graphic Screen Displays
 - 1. The AGS System Supplier shall be responsible for developing and configuring the custom graphic displays for the OITs. Each piece of major process equipment that is monitored by the control system shall be displayed on one or more graphic screen. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. These items must be done in accordance with the Configuration Standards and Conventions as described later in this section. Alarm and/or event displays shall also be provided and proven functional prior to acceptance of the system.
 - 2. All OIT graphic screens shall be animated to indicate the current state of the piece of equipment. The following graphic screens shall be provided, as a minimum.
 - a. Main Overview of AGS System
 - b. Alarm Summary
 - c. Event Summary
 - d. Overview of each major process area (with vectoring to sub-areas)
 - 3. It is suggested that the Owner create HMI screens similar to the OIT screens configured by the AGS System Supplier.
- F. Report Formats

Existing or new report formats shall be developed and programmed for the AGS system by the Owner using tag names defined in the database creation and as coordinated by the AGS System Supplier. Reports shall be provided as summarized below or as required by the Owner. The existing report format shall be followed for any new reports.

a. Daily Operating Report. A daily report, listing the major plant variables (up to 50 variables) shall be provided. The report shall include hourly values and minimum/maximum/average values where appropriate. A minimum of one general daily report shall be provided for the AGS system or as recommended by the AGS System Supplier.

- b. Monthly Operating Report. A monthly operating report, which averages the values from the above daily report, shall be provided. The report shall include monthly minimum/maximum/average values where appropriate.
- G. Configuration Standards and Conventions
 - 1. A "Software Configuration Standards and Conventions" document shall be prepared and submitted by the AGS System Supplier. The document shall be submitted for review and approval before software configuration commences. The document shall describe and define such items as proposed graphic display process line colors/representations; symbiology; color standards for "on", "off", "opened", "closed", and "alarm" conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Before submitting the initial draft document, the AGS System Supplier shall meet with the Engineer and/or Owner to review any of the Owner's existing standards and conventions. All copies of this submittal shall be provided in color to ensure the accuracy of each item. No black and white copies will be accepted. The colors used in the printed submittal shall accurately depict the colors and shapes proposed for use on the final system.
 - 2. In addition to submitting the document for review, an updated version of the document shall be submitted as part of the O&M Manuals. The document shall be revised to document any additional standards that are established throughout the configuration process.
- H. Configuration Review Meetings
 - 1. Proposed OIT graphic screens shall be reviewed with the Owner and Engineer throughout the configuration process. The required modifications and additions to the existing HMI application for the AGS system shall also be discussed in these meetings. The AGS System Supplier's programming personnel shall attend all meetings. A second review meeting shall be held at approximately 50 percent completion. Both meetings shall be held at the Owner's facilities.
- I. Software Functional Requirements
 - 1. General functional requirements for system configuration are indicated on the Drawings and described in the specifications. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system. The AGS System Supplier shall be responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Engineer or the Owner.

3.4 SYSTEMS CHECK

A. AGS System Supplier shall provide the services of a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation. System Supplier shall coordinate with this field supervisor for the installation and calibration of the instruments provided by the System Supplier.

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

- B. Field Inspection at Delivery
 - 1. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.
- C. Field Calibration of Instruments
 - 1. After each instrument has been installed, a technical representative of System Supplier and AGS System Supplier shall calibrate each instrument that they are responsible for providing and shall provide a written calibration report for each of those instruments, indicating the results and final settings. The adjustments of calibrated instrument shall be sealed or marked, insofar as possible, to discourage tampering. Instrument calibration shall be done before checkout of the system operation. A typical instrument calibration report is attached to the end of this section.
- D. Training for Installation Personnel
 - 1. The field supervisor shall train the installation personnel in reading and understanding submittal drawings, and in the correct installation and wiring procedures for the equipment. One day shall be included for this training.
- E. Field Inspection Prior to Start Up
 - 1. After installation and wiring connections are complete, the field supervisor, with additional AGS System Supplier's personnel shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended. A minimum of two working days shall be included for this task, but AGS System Supplier shall be responsible for completing the following scope of work.
 - 2. Analog Signals
 - a. Analog input signals shall be simulated at the transmitting source and verified to be received at the proper register address in the control system. Analog outputs shall be generated at the control system, and verified to be received with the correct polarity, at the respective receiving device.
 - 3. Discrete Signals

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Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device, and at the proper voltage.

Devices by Other Suppliers

a. If interrelated devices furnished by other suppliers, under other contracts, or by Owner, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

- 5. System Check Out Report
 - a. The AGS System Supplier shall submit a written report on the results of such tests to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. System Supplier shall verify, in writing, to Engineer or Owner that System Supplier has successfully completed the external connection check before beginning system startup or field acceptance testing.
- F. Start Up Assistance
 - 1. After the field supervisor has completed the system check and submitted his report, AGS System Supplier shall supply a factory-trained engineer and programmer to provide onsite start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components. Five working days shall be included for this task.

3.5 TESTING

- A. The system shall be acceptance tested at the factory and on site.
- B. AGS System Supplier shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by AGS System Supplier and witnessed by Owner and/or Engineer.
- C. AGS System Supplier shall notify Engineer and Owner in writing at least 14 days before the proposed testing date. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. AGS System Supplier shall reimburse Owner and Engineer for all expenses incurred in connection with attending repeated factory or site testing necessitated by system failure or inadequate preparation.
- D. Factory Acceptance Testing
 - 1. After system assembly and debugging at AGS System Supplier's facility, the system shall be tested before the system is shipped to the site. The factory test shall be conducted on at least the minimum system consisting of the AGS control panel that includes the AGS PLC and AGS OIT.

The entire system, including all peripherals and associated software, shall be factory tested under simulated operating conditions. Both normal operating sequences and fault conditions shall be simulated. The results shall be noted in the AGS OIT alarm/event log. The testing procedures for hardware and software are described below.

3. All basic functions shall be demonstrated, including I/O processing, communications, alarm handling, and alarm logging, , as well as the specific functions listed herein. The system shall operate continuously for at least 72 hours without faults. This operational test may run concurrently with the demonstration of hardware and software functions. The test procedure shall also include at a least four-hour period for discretionary tests to be conducted by Engineer or Owner.

- 4. For the HMI modifications associated with the addition of the AGS system, a preliminary version of such configured software may be used as part of the factory acceptance test if the Owner has made the modifications at the time of testing.
- 5. Hardware Test
 - a. Processors, processor modules, and peripheral devices associated with the system shall be assembled together as they will be installed in the field and shall be tested. The test shall demonstrate proper operation of each hardware device and communications among devices and shall include verification of selected analog and discrete inputs and outputs.
- 6. Software Test
 - a. All system software modules specified herein shall be demonstrated. Software tests shall include running all diagnostics, debugging routines, and system test routines. The operating system, advanced process control language compiler, and all associated drivers shall be fully tested and operable for the system test. Software "patches" or changes to bypass failed or flawed modules during the test will not be acceptable.
- E. Site Acceptance Testing
 - 1. After installation and checkout by AGS System Supplier's personnel, the system shall be subjected to an acceptance test.
 - 2. Site acceptance testing shall be scheduled after receipt of the System Check Out Report and AGS System Supplier shall verify that all field signal changes are reflected in the proper address locations in the system database.
 - 3. The site acceptance testing shall follow the same procedure as the factory testing and shall operate without loss of basic functions. The number of working days of continuous operation for the test shall be five. The operational demonstration shall confirm that the status, alarm, and process variable signals are valid and are being updated appropriately, and that the discrete and analog output signals from the control system are being correctly transmitted and implemented. Any errors or abnormal occurrences shall be recorded by AGS System Supplier's field representative. AGS System Supplier's field representative need not be continuously present during the site acceptance testing but shall be available to respond to the site within one hour of notification. The representative shall inspect the system for faults at least once every 24 hours and shall log or record any noted problems. The log shall include a description of the problem, its apparent cause, and any corrective action taken.

Failure of Redundant Equipment

a. Failure of redundant equipment shall not be considered downtime provided that automatic failover occurs as specified and, in the opinion of Engineer, the failure was not caused by deficiency in design or installation. In the event of repeated failure of any hardware component or software module, the acceptance test shall be terminated and re-started.

- 5. Completion of Test
 - **a.** Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the Supplementary Conditions.

3.6 TRAINING

- A. System Supplier and AGS System Supplier shall conduct training courses (as indicated below) for personnel selected by Owner. Training shall be provided in the categories listed below. Training shall be conducted by experienced instructors who are familiar with the specific system supplied.
- B. General Training Requirements
 - 1. In general, System Supplier's and AGS System Supplier's standard training courses may be used to meet the training objectives specified. Where standard courses do not meet these objectives, additional coursework shall be developed. Clock hour requirements for each level of training are shall be as listed. A "clock hour" is defined as one hour of instruction or supervised training exercise. Training hour requirements are the number of hours of training to be provided for each student. Additional training time shall be provided if considered necessary to meet the training objectives.
 - 2. Training Costs
 - a. All costs associated with the training program; excluding travel, lodging, and per diem expenses for Owner's and Engineer's personnel to attend off-site training programs; shall be the responsibility of System Supplier or AGS System Supplier and shall be included in the contract price.
 - 3. Lessons
 - a. Training lesson plans and other information for the second stage submittal as defined herein shall be submitted at least 30 days prior to the start of training.
 - 4. Video Recording

All training sessions shall be video recorded by the System Supplier or Contractor for Owner's future use in training other personnel. Video recorded sessions shall be saved to DVD/R media for delivery to Owner. Pre-recorded videos of System Supplier's standard training programs may be substituted if they cover the same topics and are developed for the same versions of hardware and software. Furnishing videos of standard training programs shall not relieve System Supplier or Contractor from any of the training requirements specified herein. Training videos specific to the operation of the AGS equipment shall be securely stored and available for viewing by only parties who have agreed to the Non-Disclosure Agreement (NDA) and End User Agreement (EUA) with the AGS System Supplier.

- 5. Instrument Training
 - a. Training on the calibration, maintenance, troubleshooting, and repair for the instrument devices provided under this project shall be provided. Training shall also be provided for any hand-held or computer-based calibration devices and their associated software. Four hours of training shall be provided at the Owner's facility. Refer to the Demonstration and Training Section for details on number of students and preferred times. (System Supplier and AGS System Supplier shall provide training sessions for the instrumentation that they provide.)
- 6. Operator Training
 - a. Owner's personnel will utilize the system for day-to-day monitoring and/or control of the facilities. The training program shall provide operators with sufficient knowledge to move from screen to screen within the system, understand the contents of group and detailed point displays, react to and acknowledge alarms, adjust control setpoints and alarm limits, control equipment connected to the system, and react to and resolve minor system errors. (AGS System Supplier).
 - b. <u>Classes</u>
 - 1) Operator training shall include sessions as specified below.
 - 2) Post-installation Session:
 - a) The post-installation training shall be conducted at Owner's facilities. The class shall consist of four hours of instruction using the lesson plan submitted and approved for use. Refer to the Demonstration and Training Section for details on number of students and preferred times.
 - c. Content of Classes:

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e)

- 1) Each session shall cover at least the following topics.
 - a) Power-up, "bootstrapping", and shutdown of all hardware devices.
 - b) Logging on and off the system and the use of passwords.
 - c) Access and interpretation of standard displays and diagnostics.
 - Moving from screen to screen within the graphic display environment.
 - Interpretation of preconfigured group and detailed point or database displays.
 - f) Response to and acknowledgment of alarms.
 - g) Adjustment of control set points and alarm limits.
 - h) Control of field equipment and devices connected to the system.
 - i) Manual entries to database points.
 - j) Appropriate responses to software and hardware errors.
 - k) Enabling and disabling individual inputs and outputs.
- 2) The operator-training program shall be developed for personnel with no prior experience with the hardware and software provided as part of the project.

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INSTRUMENT NAME & SE	INSTRUMENT NAME & SERVICE:										
BRAND & MODEL NO.:											
TAG OR LOOP NO.:											
INPUT/OUTPUT RANGE:											
INPUT	ACTUAL OUTPUT	DESIRED OUTPUT									
		5									
		8									
	· · · · ·	0									
PROPORTIONAL BAND:											
RESET:	A C										
POSITION OF SWITCHES,	JUMPERS, ETC.										
COMMENTS:	6										
DATE OF CALIBRATION:	5										
CALIBRATED BY:											
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40 61 11

Instrument Device Schedule 40 6111 - Instrument Device Schedule - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only. **Type.** This refers to the instrument type shown on the P&IDs.

Loop. This is the sequential number assigned to the instrument.

Tag. This is the ISA (or similar) alpha tag representing the function of the instrument. Service Description. This is the description of the instrument service.

Service Description. This is the description of the instrument service. Device Type & Size. This is the instrument device type and should match the description as listed in the specification. Where appropriate, the size of the device (such as diameter of flowmeters) will be listed. Output Type. This generally will be '4-20 mA' or "Dry Contact'. It could also be a serial output for smart devices (such as HART or FLD-BUS) but only if the serial output is the primary I/O interface. Output Range. This is the calibrated range for analog devices or the trip point(s) for discrete devices. Power Type. This will typically be either '2-wire' for loop powered devices or '4-wire' for 120 volt powered devices.

P&ID Drawing. This is the drawing number of the P&ID where the device is shown.

Specification. This column may include a cross reference to another specification section where applicable or to a note which provides additional information. Notes are appended to the end of the device schedule listings. Remarks. This column may include additional instrument information such as "shipped loose".

Item Ty	ype	Loop	Tag	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Remarks
1 FE	10	000	FE-1000	AGS SYSTEM INFLUENT FLOW	MAGNETIC FLOW METER	24"	mV	N/A	N/A	01-I-601	40 7100	
2 FIT	10	000	FIT-1000	AGS SYSTEM INFLUENT FLOW	MAGNETIC FLOW METER SIGNAL CONVERTER	N/A	4-20mA	0-18 MGD	4-WIRE	01-I-601	40 7100	
3 LIT	10	001	LIT-1001	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	RADAR LEVEL TRANSMITTER	N/A	4-20mA	0-20 ft (FIELD VERIFY)	2-WIRE	01-I-601	40 7200	
4 LIT	10	002	LIT-1002	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	RADAR LEVEL TRANSMITTER	N/A	4-20mA	0-20 ft (FIELD VERIFY)	2-WIRE	01-I-601	40 7200	
5 LIT	10	003	LIT-1003	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	RADAR LEVEL TRANSMITTER	N/A	4-20mA	0-20 ft (FIELD VERIFY)	2-WIRE	01-I-601	40 7200	
6 LIT	10	004	LIT-1004	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	RADAR LEVEL TRANSMITTER	N/A	4-20mA	0-20 ft (FIELD VERIFY)	2-WIRE	01-I-601	40 7200	
7 LIT	10	005	LIT-1005	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	RADAR LEVEL TRANSMITTER	N/A	4-20mA	0-20 ft (FIELD VERIEY)	2-WIRE	01-I-601	40 7200	
8 LIT	10	006	LIT-1006	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	RADAR LEVEL TRANSMITTER	N/A	4-20mA	0-20 ft (FIELD VERIEY)	2-WIRE	01-I-601	40 7200	
9 LS	L 10	001	LSL-1001	SUMP LOW LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	SET IN FIELD	N/A	01-I-601	40 7200	
10 LS	M 10	001	LSM-1001	SUMP MIDDLE LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT		N/A	01-I-601	40 7200	
11 LS	H 10	001	LSH-1001	SUMP HIGH LEVEL	WEIGHTED FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	SET IN FIELD	N/A	01-I-601	40 7200	
12 I S	HH 10	001	LSHH-1001	SUMP HIGH HIGH LEVEL		N/A	DRY CONTACT	SET IN FIELD	N/A	01-I-601	40 7200	
13 AF	10	005	AF-1005	AGS REACTORS COMMON FEELUENT PHOSPHATE CONCENTRATION	PHOSPHATE SENSOR	N/A	mV	PER AGS SYSTEM SUPPLIER	N/A	01-I-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
14 AT	10	005	AT-1005	AGS REACTORS COMMON EFFLUENT PHOSPHATE CONCENTRATION ANALYZER	PHOSPHATE ANALYZER	N/A	4-20mA	PER AGS SYSTEM SUPPLIER	4-WIRF	01-I-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
15 FF	11	100	FF-1100	AGS REACTOR NO. 1 AIR FLOW	THERMAL DISPERSION FLOW METER	IN 12" PIPE	mV	N/A	N/A	01-I-601	40 7100	PROVIDED BY AGS SYSTEM SUPPLIER
16 FIT	11	100	FIT-1100	AGS REACTOR NO. 1 AIR FLOW	THERMAL DISPERSION FLOW METER TRANSMITTER	N/A	4-20mA	PER AGS SYSTEM SUPPLIER	4-WIRF	01-I-601	40 7100	PROVIDED BY AGS SYSTEM SUPPLIER
17 PIT	11	100	PIT-1100	AGS REACTOR NO. 1 PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	PER AGS SYSTEM SUPPLIER	2-WIRE	01-I-601	40 7200	PROVIDED BY AGS SYSTEM SUPPLIER
18 I T	11	100	I T-1100	AGS REACTOR NO. 1 EVEL	SUBMERSIBLE PRESSURE SENSING LEVEL TRANSMITTER	N/A	4-20mA	PER AGS SYSTEM SUPPLIER	4-WIRE	01-I-601	40 7200	PROVIDED BY AGS SYSTEM SUPPLIER
19 1.5	н 11	100	LSH-1100	AGS REACTOR NO. 1 HIGH LEVEL	WEIGHTED FLOAT TYPE I EVEL SWITCH	N/A	DRYCONTACT	PER AGS SYSTEM SUPPLIER	N/A	01-I-601	40 7200	PROVIDED BY AGS SYSTEM SUPPLIER
20 AT	11	100	AT-1100	AGS REACTOR NO. 1 ANALYZER		N/A	PROFIBUS	PER AGS SYSTEM SUPPLIER	N/A	01-1-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
21 AF	11	101	AF-1101		TSS SENSOR		mV	PER AGS SYSTEM SUPPLIER	N/A	01-1-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
22 AF	11	102	AE-1102	AGS REACTOR NO. 1 DISSOLVED OXYGEN	DO SENSOR		mV	PER AGS SYSTEM SUPPLIER	N/A	01-1-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
23 45	11	103	AF-1103	AGS REACTOR NO. 1 DXYGEN REDUCTION POTENTIAL	ORP SENSOR	N/A	mV	PER AGS SYSTEM SLIPPLIER	N/A	01-I-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
20 1	11	104	AE-1104	AGS REACTOR NO. 1 pH	nH SENSOR	N/A	mV		N/A	01-1-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
25 4	11	106	AE-1104	AGS REACTOR NO. 1 AMMONIA / AMMONIUM CONCENTRATION	NH3 / NH4 SENSOR	N/A	mV		N/A	01-1-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER
26 55	10	200	FE-1200	AGS REACTOR NO. 2 AIR ELOW		IN 12" DIDE	mV	N/A	N/A	01-1-601	40 7100	PROVIDED BY AGS SYSTEM SUPPLIER
20 IL 27 FIT	12	200	FIT 1200	AGS REACTOR NO. 2 AIR FLOW		NIA FIFE	1 20mA			011601	40 7100	
20 DIT	12	200	DIT 1200				4-20mA			01-601	40 7 100	
20 FT	12	200	TT 1200				4-2011A			01-1-001	40 7200	
29 LI 20 LG	12	200				N/A				01-1-001	40 7200	
30 LS	<u> 12 12 12 12 12 12 12 12 </u>	200	AT 1200			IN/A		PER AGS STSTEM SUPPLIER		01-1-001	40 7200	
20 AT	12	200	AT-1200			N/A				01-1-001	40 7500	
32 AE	12	201	AE-1201			N/A	m)/		N/A	01-1-001	40 7500	
33 AE	12	202	AE-1202	AGS REACTOR NO. 2 DISSULVED UXTGEN		N/A	m)/	PER AGS SYSTEM SUPPLIER	N/A	01-1-001	40 7500	PROVIDED BY AGS STSTEM SUPPLIER.
34 AE	12	203	AE-1203			N/A	m)/	PER AGS SYSTEM SUPPLIER	N/A	01-1-001	40 7500	PROVIDED BY AGS STSTEM SUPPLIER.
30 AE	12	204	AE-1204			N/A	m)/	PER AGS SYSTEM SUPPLIER	N/A	01-1-001	40 7500	PROVIDED BY AGS STSTEM SUPPLIER.
30 AE	12	206	AE-1206					PER AGS STSTEM SUPPLIER	N/A	01-1-001	40 7 500	PROVIDED BY AGS STSTEM SUPPLIER.
37 FE	13	300	FE-1300	AGS REACTOR NO. 3 AIR FLOW		IN 12 PIPE	mv			01-1-001	40 7100	
38 FII	13	300	FIT-1300	AGS REACTOR NO. 3 AIR FLOW		N/A	4-20mA	PER AGS SYSTEM SUPPLIER	4-WIRE	01-1-001	40 7100	
39 PII	13	300	PII-1300	AGS REACTOR NO. 3 PRESSURE		N/A	4-20mA	PER AGS SYSTEM SUPPLIER	Z-WIRE	01-1-001	40 7200	
40 LI	13	300	L1-1300	AGS REACTOR NO. 3 LEVEL		N/A		PER AGS SYSTEM SUPPLIER	4-WIRE	01-1-001	40 7200	
41 LS	H 13	300	LSH-1300			N/A		PER AGS SYSTEM SUPPLIER		01-1-601	40 7200	
42 AT	13	300	AT-1300			N/A	4-20MA	PER AGS SYSTEM SUPPLIER	4-WIRE	01-1-601	40 7500	
43 AE	13	301	AE-1301	AGS REACTOR NO. 3 TOTAL SUSPENDED SOLIDS	ISS SENSUR	N/A	mv	PER AGS SYSTEM SUPPLIER	N/A	01-1-601	40 7500	
44 AE	13	302	AE-1302	AGS REACTOR NO. 3 DISSOLVED OXTGEN	DU SENSUR	N/A		PER AGS SYSTEM SUPPLIER	N/A	01-1-001	40 7500	PROVIDED BY AGS STSTEM SUPPLIER.
45 AE	13	303	AE-1303	AGS REACTOR NO. 3 OXYGEN REDUCTION POTENTIAL	URPSENSOR	N/A	mv	PER AGS SYSTEM SUPPLIER	N/A	01-1-601	40 7500	PROVIDED BY AGS SYSTEM SUPPLIER.
40 AE	13	304	AE-1304			N/A	mv	PER AGS SYSTEM SUPPLIER	N/A	01-1-001	40 7500	
4/ AE	13	3UD 400	AE-1300				111V m)/	PER AGO STOTEM SUPPLIER	IN/A	01-1-001	40 7500	
48 FE	14	400	FE-1400			IN 12" PIPE	111V			01-1-001	40 7100	
49 FII	14	400	DIT 1400			IN/A	4-20MA	PER AGO STOTEM SUPPLIER		01-1-001	40 7 100	
	14	400	F11-1400			IN/A	4-20MA	PER AGO STOTEM SUPPLIER		01-1-001	40 7200	
51 LI	14	400	L1-1400	AGS REACTOR NO. 4 LEVEL		IN/A		PER AGS SYSTEM SUPPLIER		01-1-001	40 7200	
52 LS	п 14	400	LON-1400			IN/A		PER AGO STOTEM SUPPLIER		01-1-001	40 7200	
53 AI	14	400	AI-1400			IN/A		PER AGO STOTEM SUPPLIER		01-1-001	40 7500	
54 AI	14	400	AT-1400			IN/A		PER AGO STOTEM SUPPLIER		01-1-001	40 7500	
DD AE	14	401	AE-1401			IN/A	111V	PER AGO STOTEM OUPPLIER	IN/A	01-1-001	40 7500	
56 AE	14	402	AE-1402			IN/A	mV	PER AGS SYSTEM SUPPLIER	IN/A	01-1-601	40 7500	
57 AE	14	403	AE-1403			IN/A	mV	PER AGS SYSTEM SUPPLIER	IN/A	01-1-601	40 7500	
58 AE	14	404	AE-1404			IN/A	mV	PER AGS SYSTEM SUPPLIER	IN/A	01-1-601	40 7500	
59 AE	14	4Ub 600	AE-1400			IN/A	111V 4.20m A			01-1-001	40 7 500	
60 LII	16	000				IN/A	4-20MA		Z-WIRE	01-1-602	40 7200	RATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
61 LS	н 16	000	LSH-1600			IN/A		1 KIP @ ELEV. 696.3 ft	IN/A	01-1-602	40 7200	RATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
62 LS	LL 16	000	LSLL-1600			IN/A			IN/A	01-1-602	40 7200	RATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
63 IS	H 16	010	ISH-1610			IN/A			IN/A	01-1-602	43 25 13.23	RATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
64 MS	DH 16	010	MSH-1610		LEAK DETECTION SWITCH	IN/A			IN/A	01-1-602	43 25 13.23	KATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
65 PS	H 16	b10	PSH-1610	WAGS/WLC PUMP NO. 1 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	1 KIP @ 15 psi	N/A	01-1-602	40 7200	
66 PG	16	010	PG-1610			4-1/2"			IN/A	01-1-602	40 7200	
67 IS	H 16	020	ISH-1620	WAGS/WLC PUMP NO. 2 MOTOR WINDING HIGH TEMPERATURE		IN/A	DRYCONTACT		IN/A	01-1-602	43 25 13.23	RATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
68 MS	ын 16	620	MSH-1620	IWAGS/WLC PUMP NO. 2 LEAK DETECTED	LEAK DETECTION SWITCH	N/A	DRY CONTACT	PER PUMP SUPPLIER	N/A	U1-I-602	43 25 13.23	KATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION

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Item	Туре	Loop	Tag	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Remarks
69 F	PSH 1	620	PSH-1620	WAGS/WLC PUMP NO. 2 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	TRIP @ 15 psi	N/A	01-I-602	40 7200	
70 F	PG 1	620	PG-1620	WAGS/WLC PUMP NO. 2 HIGH DISCHARGE PRESSURE	PRESSURE GAUGE	4-1/2"	N/A	0-30 psi	N/A	01-I-602	40 7200	
71 T	ISH 1	630	TSH-1630	WAGS/WLC PUMP NO. 3 MOTOR WINDING HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	PER PUMP SUPPLIER	N/A	01-I-602	43 25 13.23	RATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
72 N	/ISH 1	630	MSH-1630	WAGS/WLC PUMP NO. 3 LEAK DETECTED	LEAK DETECTION SWITCH	N/A	DRY CONTACT	PER PUMP SUPPLIER	N/A	01-I-602	43 25 13.23	RATED FOR CLASS 1. DIV 1 AREA CLASSIFICATION
73 F	PSH 1	630	PSH-1630	WAGS/WLC PUMP NO. 3 HIGH DISCHARGE PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	TRIP @ 15 psi	N/A	01-I-602	40 7200	
74 F	PG 1	630	PG-1630	WAGS/WLC PUMP NO. 3 HIGH DISCHARGE PRESSURE	PRESSURE GAUGE	4-1/2"	N/A	0-30 psi	N/A	01-I-602	40 7200	
75 F	Έ 1	650	FE-1650	WAGS/WLC PUMP COMMON DISCHARGE HEADER FLOW	MAGNETIC FLOW METER	8"	mV	N/A	N/A	01-I-602	40 7100	
76 F	FIT 1	650	FIT-1650	WAGS/WLC PUMP COMMON DISCHARGE HEADER FLOW	MAGNETIC FLOW METER SIGNAL CONVERTER	N/A	4-20mA	0-670 gpm	4-WIRE	01-I-602	40 7100	
77 F	PDG 1	510	PDG-1510	AGS BLOWER NO. 1 INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	4-1/2"	N/A	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
78 F	PDSH 1	510	PDSH-1510	AGS BLOWER NO. 1 HIGH INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	DRY CONTACT	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
79 T	ſE 1	510	TE-1510	AGS BLOWER NO. 1 INLET TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
80 T	TIT 1	510	TIT-1510	AGS BLOWER NO. 1 INLET TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
81 F	PIT 1	510	PIT-1510	AGS BLOWER NO. 1 INLET PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
82 V	/T 1	510	VT-1510	AGS BLOWER NO. 1 VIBRATION	VIBRATION TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
83 T	ISH 1	510	TSH-1510	AGS BLOWER NO. 1 ENCLOSURE HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
84 T	ſE 1	511	TE-1511	AGS BLOWER NO. 1 DISCHARGE TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
85 T	TIT 1	511	TIT-1511	AGS BLOWER NO. 1 DISCHARGE TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
86 F	PIT 1	511	PIT-1511	AGS BLOWER NO. 1 DISCHARGE PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
87 T	ſE 1	512	TE-1512	AGS BLOWER NO. 1 BEARING TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
88 T	ΓE 1	513	TE-1513	AGS BLOWER NO. 1 MOTOR TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
89 F	PDG 1	520	PDG-1520	AGS BLOWER NO. 2 INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	4-1/2"	N/A	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
90 F	PDSH 1	520	PDSH-1520	AGS BLOWER NO. 2 HIGH INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	DRY CONTACT	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
91 T	ΓE 1	520	TE-1520	AGS BLOWER NO. 2 INLET TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
92 T	TIT 1	520	TIT-1520	AGS BLOWER NO. 2 INLET TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
93 F	PIT 1	520	PIT-1520	AGS BLOWER NO. 2 INLET PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
94 V	/T 1	520	VT-1520	AGS BLOWER NO. 2 VIBRATION	VIBRATION TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
95 T	ISH 1	520	TSH-1520	AGS BLOWER NO. 2 ENCLOSURE HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
96 T	ΓE 1	521	TE-1521	AGS BLOWER NO. 2 DISCHARGE TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
97 T	TIT 1	521	TIT-1521	AGS BLOWER NO. 2 DISCHARGE TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
98 F	PIT 1	521	PIT-1521	AGS BLOWER NO. 2 DISCHARGE PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
99 T	ΓE 1	522	TE-1522	AGS BLOWER NO. 2 BEARING TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	NĪA	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
100 T	ΓE 1	523	TE-1523	AGS BLOWER NO. 2 MOTOR TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
101 F	PDG 1	530	PDG-1530	AGS BLOWER NO. 3 INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE GAUGE	4-1/2"	N/A	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
102 F	PDSH 1	530	PDSH-1530	AGS BLOWER NO. 3 HIGH INLET FILTER DIFFERENTIAL PRESSURE	DIFFERENTIAL PRESSURE SWITCH	N/A	DRY CONTACT	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
103 T	ſE 1	530	TE-1530	AGS BLOWER NO. 3 INLET TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
104 T	TIT 1	530	TIT-1530	AGS BLOWER NO. 3 INLET TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
105 F	PIT 1	530	PIT-1530	AGS BLOWER NO. 3 INLET PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
106 V	/T 1	530	VT-1530	AGS BLOWER NO. 3 VIBRATION	VIBRATION TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
107 T	ISH 1	530	TSH-1530	AGS BLOWER NO. 3 ENCLOSURE HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	PER BLOWER SUPPLIER	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
108 T	TE 1	531	TE-1531	AGS BLOWER NO. 3 DISCHARGE TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
109 T	TIT 1	531	TIT-1531	AGS BLOWER NO. 3 DISCHARGE TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
110 F	PIT 1	531	PIT-1531	AGS BLOWER NO. 3 DISCHARGE PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	PER BLOWER SUPPLIER	2-WIRE	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
111 T	TE 1	532	TE-1532	AGS BLOWER NO. 3 BEARING TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
112 T	TE 1	533	TE-1533	AGS BLOWER NO. 3 MOTOR TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	N/A	N/A	N/A	N/A	02-I-601	43 1115	PROVIDED BY AGS SYSTEM SUPPLIER.
113 T	TE 1	550	TE-1550	AGS BLOWER COMMON DISCHARGE HEADER TEMPERATURE	RESISTANCE TEMPERATURE DETECTOR	SEE	N/A	N/A	N/A	02-I-601	40 7400	
114 T	TIT 1	550	TIT-1550	AGS BLOWER COMMON DISCHARGE HEADER TEMPERATURE	RESISTANCE TEMPERATURE TRANSMITTER	N/A	4-20mA	0-350°F	2-WIRE	02-I-601	40 7400	
115 F	PIT 1	550	PIT-1550	AGS BLOWER COMMON DISCHARGE HEADER PRESSURE	PRESSURE INDICATING TRANSMITTER	N/A	4-20mA	0-15 psig	2-WIRE	02-I-601	40 7200	

 Press

 RESISTANCE TEMPERATURE DETECTOR

 RESISTANCE TEMPERATURE TRANSMITTER

 PRESSURE INDICATING TRANSMITTER

SECTION 40 64 00 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers programmable logic controllers (PLCs), including associated input/output hardware to control process equipment and serve as the interface to field devices.
- B. Control System
 - 1. The Instrumentation and Control System section shall apply to all equipment furnished under this section. Additional PLC software requirements are indicated in Software Control Block Descriptions section.

1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- C. Drawings
 - 1. Supplementing this section, the Drawings indicate the number and types of PLCs, locations of PLCs, and provide diagrams and schematics regarding connection and interaction with other equipment. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the Drawings.
- D. HO Dist
 - An input/output (I/O) field device signal listing is included as an appendix attached to this section.

1.3 SUBMITTALS

- A. See Section 40 61 11 Instrumentation and Control System
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 DELIVERY, STORAGE, AND SHIPPING

A. Delivery, storage and shipping shall be as specified in the Instrumentation and Control System Section.

1.5 SPARE PARTS

A. Not used.

PART 2 - PRODUCTS

- 2.1 GENERAL
 - A. All equipment furnished under this section shall be expressly selected by AGS System Supplier for its superior quality for the intended purpose and shall comply with the following requirements.
 - B. Interchangeability
 - 1. All programmable logic controller systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules such as coprocessors and ASCII modules shall be interchangeable among all I/O panels and systems. PLC modules and hardware by other manufacturers will be acceptable only if the PLC manufacturer does not offer suitable modules and hardware for the same functions.
 - C. Initial, Spare, and Future Memory (RAM)
 - 1. AGS System Supplier shall provide adequate memory for the amount of I/O, control algorithms, and communications in the initial system.
 - 2. Each programmable logic controller shall include provisions for future expansion and shall have 100 percent spare memory capacity and 100 percent spare data capacity installed. The spare memory capacity shall be documented by submitting to Engineer, during factory testing, a statement indicating the amounts of memory of all types being utilized and the total amount available in each system. The statement shall include an estimate of the total program and data memory necessary, including spare memory, based on the I/O hardware for the system, and previous programming experience.

D. Spare I/O

1. Each PLC input/output enclosure shall be provided with at least 20 percent spare inputs and outputs of each type. Spare I/O shall be installed, wired, and interfaced properly to the terminal strip. The spare I/O shall be in addition to any I/O installed and reserved for future process signals as may be indicated on the I/O list. In addition, each PLC input/output enclosure shall be capable of accommodating 20 percent of additional input/output capacity of each type as originally assembled, without the need for additional expansion racks, communication adapters, cables, or PLC power supplies.

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- E. Expandability
 - 1. Each PLC processor and associated I/O shall have a future expandability of at least 50 percent of the provided system.
- F. Acceptable Manufacturers
 - 1. To match the standard AGS Control System, the PLCs shall be Allen-Bradley CompactLogix. (AGS System Supplier) To establish communication with the Plant Control System, AGS System Supplier shall provide all necessary communication hardware to communicate with the Plant Control System via ModBus TCP/IP Ethernet communication.
- G. Signal Power Supplies
 - 1. Regulated dc power supplies shall be provided in each PLC enclosure for I/O. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or protected against short-circuiting. Output voltage regulation shall be as required by the instrumentation equipment supplied under another section.
 - 2. The loop power supply shall be separate from the power supply circuit for the processor and racks.
 - 3. The power source for all digital inputs from field devices shall be separately fused for each digital input module. Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.
- H. Appurtenances
 - 1. The PLC processor and I/O hardware shall be provided as complete systems, as shown on the control system block diagram drawings. The PLCs shall include all necessary hardware and software for a complete working system. All special rack or panel mounted power supplies, special interconnecting and programming cables, special grounding hardware, or isolation devices shall be furnished for proper operation of the equipment. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, intrinsically safe relays and current repeaters, surge suppression devices, and isolation devices shall be furnished and installed for proper operation of the equipment.
- I. PLC Arrangement

²The PLCs shall be distributed and arranged as indicated on the Drawings.

Service Conditions

1. PLCs will be installed in air conditioned rooms.

2.2 MINI PLC PROCESSOR

A. The programmable logic controller processor shall be an industrial type that utilizes nonvolatile type memory. Battery-backed memory is not acceptable.

- B. Diagnostics
 - 1. The processor shall utilize self-monitoring diagnostic techniques. Easily visible LEDs shall indicate "run" and "halt" status as well as memory and input/output error conditions. Diagnostic codes shall also be available through the programming device to facilitate troubleshooting.
- C. Programming Port
 - 1. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional. Removal or disruption of network communications, remote I/O communications, or HMIs to permit programming and monitoring will not be acceptable.
- D. Communications
 - 1. The processor shall be programmed to operate autonomously, regardless of communications status with other units.
- E. Environment
 - 1. The processor shall be suitable for operation in the environments specified in another section.
- F. Programming
 - 1. The processor shall be programmable using conventional relay ladder logic, or as required, and shall include the following functions and features.
 - a. Contacts, coils, branching.
 - b. Data comparisons.
 - c. On-delay and off-delay timers.
 - d. Counters with comparators.
 - e. Floating Point Math and Logical instructions.
 - f. Master control relay.
 - g. Transitional or one-shot outputs.
 - h. Standard and user-defined data tables for digital and analog value storage.
- G. Capabilities

The processor shall include the following capabilities for programming, debug of programs, and troubleshooting.

- a. Off-line programming.
- b. On-line status of coils and registers.
- c. Input/output forcing.
- H. Configuration
 - 1. Processors shall be configured for standard rack mounting and shall be of plug-in printed circuit board construction. Each programmable logic controller shall include integral

communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces as required.

- 2. Programmable logic controller systems shall support the following types of input/output.
 - a. 24-volt dc digital input and output.b. 4-20 mA dc analog input and output.
 - b. 4-20 mA dc analog input and c

I. Input/Output Hardware

- 1. Input/output hardware shall be supplied in standard modules of 4, 8, or 16 points each for assembly in local and remote input/output enclosures.
- 2. All input/output hardware shall be entirely contained within the PLC enclosure.
- 3. Programmable logic controllers having fixed, non-removable input/output hardware are acceptable.
- 4. All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices as required and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet all the requirements in the following subparagraphs.
- 5. Wiring Terminals
 - a. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

6. I/O Circuit Power Supply

a. Outputs for motor driven equipment will typically be powered from the driven equipment. Digital outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the Drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate relay-type digital output modules or interposing relays in the PLC cabinet.

Digital Input Modules

- a. Digital input modules shall sense voltages between 100 and 130 volts acand shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Return voltage may be common to the entire input module.
- 8. Relay Digital Output Modules
 - a. Where indicated on the PLC input/output listing, digital output modules shall control voltages from 24 to 110 volts dc and 24 to 230 volts ac and shall be rated at least 2 amperes. Outputs shall be individually fused and shall have LED indicators to

display output status. Digital outputs for motor driven equipment shall be powered by the driven equipment. Outputs shall withstand a surge of at least 80 amperes for 15 milliseconds.

- 9. Analog Input Modules
 - a. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Input circuitry shall be floating differential type designed to prevent loop grounding. Analog to digital conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Where analog input signals are grounded outside of the PLC enclosure, isolation shall be provided for the associated analog input point either on the analog input module or through an I/I signal isolator provided in the PLC enclosure.
- 10. Analog Output Modules
 - a. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600 ohm load. Digital to analog conversion accuracy shall be at least 12-bit (0-4095 count) resolution.
- 11. Panel Terminations
 - a. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2.3 COMMUNICATIONS

- A. Each programmable controller system shall be furnished complete with communication hardware modules for local input/output hardware.
- B. Communication hardware shall be compatible with the cable, data highway, fiber optic, or radio communication media. Ethernet components and cable are specified in other specification sections.
- C. Addressability

1. Each programmable logic controller shall be individually addressable so that only the selected controller responds when queried. IP addressing shall be used. Designation of a controller's network address may be either a software or hardware function.

- D. Communications Hardware
 - 1. AGS System Supplier shall provide all necessary communications hardware. Hardware shall be included for, but not be limited to, remote I/O, data highway, host computer, fiber optics, Ethernet.
 - 2. PLC to PLC Communications Hardware

- a. Each PLC shall communicate to other PLCs over a network as shown on the control system block diagram. AGS System Supplier shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.
- E. Communications Media
 - 1. AGS System Supplier shall provide all necessary cabling for the PLC communications network. Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules. PLC communications media shall be as specified under the Network Systems section.

2.4 PROGRAMMING SOFTWARE

- A. AGS System Supplier shall furnish one licensed copy of PLC programming software. The software shall be suitable for running on a laptop computer running Windows 10 operating system software. A full legal set of programming software documentation shall accompany each copy of the software. Each copy of the programming software shall include all necessary device drivers and add-on software packages.
- B. Standard Product
 - 1. The programming software shall be personal computer based and a standard product of the PLC manufacturer.
- C. Programming Software Features
 - 1. The programming software shall allow off-line development of all PLC-related programming, including user annotation of the program, and creation and printing of application programs and I/O cross-reference lists. Special programming tasks originally provided by AGS System Supplier shall also be included.
 - 2. On-line features shall include IEC-61131 standards program modification, ladder-logic modification, program language modification, monitoring of real-time ladder-logic execution, monitoring of program execution, monitoring and manipulation of timer and counter preset and present values, monitoring and forcing of physical I/O, and monitoring and manipulation of analog (register) and bit (binary) data table values. PLC and I/O hardware diagnostic and status information shall be accessible using the software in on-line mode.

SYSTEM ENCLOSURES

A. Programmable logic controllers and input/output hardware shall be housed in shop-assembled panels as indicated on the Drawings and as described in the Panels, Consoles, and Appurtenances section.

2.6 OPERATOR INTERFACE TERMINALS

- A. Operator interface terminals (OIT) shall be microprocessor-based flat panel type. The unit shall have data entry capabilities and shall include a password security function. The unit shall be connected to the PLC and shall display status, alarm, and diagnostic information. The unit shall provide a nominal diagonal display area dimension of 12", with a minimum resolution of 800x600, 18 bit color, and a luminance of 300 cd/m². The OIT shall be furnished with a minimum of 8 MB of flash memory and 8 MB of system memory. The operator interface unit shall be provided with an Ethernet port for communications, and one serial RS-232 or RS-485 port for programming. The OIT shall be rated NEMA 4X, suitable for panel face.
- B. Terminals shall be powered from 120 V ac, 60 Hz, single phase. Terminals shall be suitable for ambient temperatures of +32 to +130°F and a relative humidity of 5 to 95 percent.
- C. One licensed copy of the OIT software used to create the screens shall be turned over to the Owner upon successful startup and commissioning of the system.
- D. The operator interface unit shall be an Allen-Bradley PanelView Plus 7 Performance 12", or equal. (AGS System Supplier)
- E. OIT shall provide graphic screens that shall be used by the operators to access all functions and setpoints necessary for comprehensive control. The Manufacturer shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored and controlled by the control system shall be displayed on the graphic screens. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. The manufacturer shall use the configuration standards and conventions to be established by direct coordination with the Owner that shall describe and define such items as proposed graphic display process line colors/representations; color standards for "on", "off", "opened", "closed", and "alarm" conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Proposed displays shall be submitted to the Engineer and Owner for approval.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

- PLCs installation requirements are specified in Instrumentation and Control System section except as described herein.
- B. Field check, testing, and training shall be as specified in the Instrumentation and Control System section.

3.2 CONFIGURATION

A. PLC Programming and Configuration

Programmable Logic Controllers

- 1. Configuration services are specified in the Instrumentation and Control System section.
- **Communications Configuration** Β.
- ver 1. The communications shall be fully configured and installed by AGS System Supplier. Communications shall be configured as shown on the Drawings.

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

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40 6400A - Input/Output List - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only. Type: This is the type of I/O signal, as follows: AI = Analog Input AO = Analog Output DI = Discrete Input DO = Discrete Output

DO = Discrete Output Loop No. This is a sequential number for a given type within a specific controller.													
Description. This is the description or the function (i.e. Filter 1 Loss-of-Head). Field Device. This is the tag number of equipment identifier associated with the I/O point.													
Controller ID. This is the panel identification for the I/O cabinet, or controller where the I/O signal terminates. Analog Data (Signal Type). This will typically be 4-20mA, but could also be 1-5Vdc, serial, Network (Modbus TCP, MODBUS TCP/IP/IP), HART, BUS, or similar to indicate the signal type of the associated input or output.													
Analog Uata (Calibrated Range). This will be the scaled value of the input in engineering units. Analog Data (Power). This will typically be '2-wire' for devices which are loop powered from the PLC enclosure, or '4-wire' for devices which are powered form external power supplies, unless noted otherwise.													
Discrete Data (Signal Type). This will be 120VAC, 120VAC, or similar to indicate the signal type of the associated input or output. Discrete Data (CLOSED State). This will indicate the state of the input or output when it is considered to be closed or energized (normal, alarm, running, failed, etc.).													
Discrete Data (Power Source). This will indicate the location of the power source for the wetting voltage on the contacts, as follows: Field = External field power source. (May require interposing relays or isolated I/O module type.)													
PLC = Power originates from within the PLC or I/O enclosure.													
P&ID Drawing. Remarks. This	. This is the l	P&ID drawing t	he I/O point can be found on. s reference to another specification section where applicable, or to a note which provides additional information. Notes are appended to the e	nd of the I/O listing.						$\overline{\mathbf{a}}$			
	,						Analog Data			Discret	a Data		
Item Type	IO Code	Loop No.	Description	Field Device	Controller ID	Signal Type	Calibrated Range	Power Type	Signal Type	CLOSED State	Power Source	Interp Relay	P&ID Drawing Remarks
1 AI 2 AI	FI	1000	AGS SYSTEM INFLUENT FLOW AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	FIT-1000	AGS SUPPLIER PLC	4-20mA 4-20mA	0-18 MGD 0-20 ft (FIFLD VERIEY)	4-WIRE	N/A	N/A N/A	N/A N/A	N/A N/A	01-I-601 01-I-601
3 AI	LI	1002	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	LIT-1002	AGS SUPPLIER PLC	4-20mA	0-20 ft (FIELD VERIFY)	2-WIRE	N/A	N/A	N/A	N/A	01-I-601
4 Al		1003	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	LIT-1003	AGS SUPPLIER PLC	4-20mA 4-20mA	0-20 ft (FIELD VERIFY)	2-WIRE	N/A N/A	N/A N/A	N/A N/A	N/A N/A	01-I-601
6 AI	LI	1005	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	LIT-1005	AGS SUPPLIER PLC	4-20mA	0-20 ft (FIELD VERIFY)	2-WIRE	N/A	N/A	N/A	N/A	01-I-601
7 AI	LI	1006	AGS SYSTEM UNDERDRAIN SYSTEM GROUNDWATER LEVEL	LIT-1006	AGS SUPPLIER PLC	4-20mA	0-20 ft (FIELD VERIFY) PER AGS SYSTEM	2-WIRE	N/A	N/A	N/A	N/A	01-I-601
8 AI	FI	1100	AGS REACTOR NO. 1 AIR FLOW	FIT-1100	AGS SUPPLIER PLC	4-20mA	SUPPLIER	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
9 AI	PI	1100	AGS REACTOR NO. 1 AIR PRESSURE	PIT-1100	AGS SUPPLIER PLC	4-20mA	SUPPLIER	2-WIRE	N/A	N/A	N/A	N/A	01-1-601
10 AI	LI	1100	AGS REACTOR NO. 1 LEVEL	LT-1100	AGS SUPPLIER PLC	4-20mA	SUPPLIER	4-WIRE	N/A	N/A	N/A	N/A	01-L601
11 Al 12 Al	ZI	1102 1103	AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE POSITION AGS REACTOR NO. 1 AIR CONTROL VALVE POSITION	BFVI-1102 ZI-1103	AGS SUPPLIER PLC AGS SUPPLIER PLC	4-20mA 4-20mA	0-100%	4-WIRE 4-WIRE	N/A N/A	N/A N/A	N/A N/A	N/A N/A	01-I-601 01-I-601
13 AI	FI	1200	AGS REACTOR NO. 2 AIR FLOW	FIT-1200	AGS SUPPLIER PLC	4-20mA	PER AGS SYSTEM SUPPLIER	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
14 AI	PI	1200	AGS REACTOR NO. 2 AIR PRESSURE	PIT-1200	AGS SUPPLIER PLC	4-20mA 🔹	PER AGS SYSTEM SUPPLIER	2-WIRE	N/A	N/A	N/A	N/A	01-I-601
15 AI	LI	1200	AGS REACTOR NO. 2 LEVEL	LT-1200	AGS SUPPLIER PLC	4-20mA	PER AGS SYSTEM SUPPLIER	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
16 AI 17 AI	ZI	1202 1203	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE POSITION AGS REACTOR NO. 2 AIR CONTROL VALVE POSITION	BFVI-1202 ZI-1203	AGS SUPPLIER PLC	4-20mA 4-20mA	0-100%	4-WIRE 4-WIRE	N/A N/A	N/A N/A	N/A N/A	N/A N/A	01-I-601 01-I-601
18 AI	FI	1300	AGS REACTOR NO. 3 AIR FLOW	FIT-1300	AGS SUPPLIER PLC	4-20mA	PER AGS SYSTEM	4-WIRE	N/A	N/A	N/A	N/A	01-1-601
19 AI	PI	1300	AGS REACTOR NO. 3 AIR PRESSURE	PIT-1300	AGS SUPPLIER PLC	4-20mA	PER AGS SYSTEM SUPPLIER	2-WIRE	N/A	N/A	N/A	N/A	01-I-601
20 AI	LI	1300	AGS REACTOR NO. 3 LEVEL	LT-1300	AGS SUPPLIER PLC	4-20mA	PER AGS SYSTEM SUPPLIER	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
21 AI	ZI	1302	AGS REACTOR NO. 3 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE POSITION	BFVI-1302	AGS SUPPLIER PLC	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
22 AI	ZI FI	1400		ZI-1303 EIT-1400		4-20mA	PER AGS SYSTEM	4-WIRE	N/A	N/A	N/A	N/A	01-1-601
24 41	PI	1400		PIT-1400	AGS SUPPLIER PLC	4-20mA	SUPPLIER PER AGS SYSTEM	2-WIRE	N/A	N/A	N/A	N/A	01-L601
25 AI	 LI	1400	AGS REACTOR NO. 4 LEVEL	LT-1400	AGS SUPPLIER PLC	4-20mA	SUPPLIER PER AGS SYSTEM	4-WIRE	N/A	N/A	N/A	N/A	01-1-601
26 AI	ZI	1402	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE POSITION	BFVI-1402	AGS SUPPLIER PLC	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
27 AI	ZI	1403	AGS REACTOR NO. 4 AIR CONTROL VALVE POSITION	ZI-1403	AGS SUPPLIER PLC	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
28 AI	LI	1600	WAGS/WLC WETWELL LEVEL	LT-1600	AGS SUPPLIER PLC	4-20mA	0-22 ft (CONFIRM IN FIELD)	2-WIRE	N/A	N/A	N/A	N/A	01-I-602
29 AI	FI	1650	WAGS/WLC PUMP COMMON DISCHARGE HEADER FLOW	FIT-1650	AGS SUPPLIER PLC	4-20mA	0-670 gpm	4-WIRE	N/A	N/A	N/A	N/A	01-I-602
30 AI 31 AI	PI	1550	AGS BLOWER COMMON DISCHARGE HEADER TEMPERATURE	PIT-1550	AGS SUPPLIER PLC	4-20mA 4-20mA	0-15 psig	2-WIRE	N/A	N/A N/A	N/A	N/A N/A	02-1-601
32 AI	ZI	1550	AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE POSITION	BFVI-1550	AGS SUPPLIER PLC	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	N/A	02-I-601
33 AO 34 AO	ZC	1102	AGS REACTOR NO. 1 WAGS & WEC MANIFOLD AIR BLOWOFF VALVE POSITION COMMAND	BFVI-1102 BFVI-1103	AGS SUPPLIER PLC	4-20mA 4-20mA	0-100%	4-WIRE	N/A N/A	N/A N/A	N/A N/A	N/A N/A	01-1-601
35 AO	ZC	1202	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE POSITION COMMAND	BFVI-1202	AGS SUPPLIER PLC	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
36 AO 37 AO	ZC	1203	AGS REACTOR NO. 2 AIR CONTROL VALVE POSITION COMMAND	BFVI-1203 BFVI-1302	AGS SUPPLIER PLC	4-20mA 4-20mA	0-100%	4-WIRE 4-WIRE	N/A N/A	N/A N/A	N/A N/A	N/A N/A	01-I-601
38 AO	ZC	1303	AGS REACTOR NO. 3 AIR CONTROL VALVE POSITION COMMAND	BFVI-1303	AGS SUPPLIER PLC	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
39 AO	ZC	1402	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE POSITION COMMAND	BFVI-1402	AGS SUPPLIER PLC	4-20mA	0-100%	4-WIRE	N/A	N/A	N/A	N/A	01-I-601
40 AO 41 AO	ZC	1403 1550	AGS REACTOR NO. 4 AIR CONTROL VALVE POSITION COMMAND	BEVI-1403 BEVI-1550	AGS SUPPLIER PLC	4-20mA 4-20mA	0-100%	4-WIRE 4-WIRE	N/A N/A	N/A N/A	N/A N/A	N/A N/A	02-L601
42 DI	LAHH	1001	SUMP HIGH HIGH LEVEL	LCP-1101	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	NORMAL	PLC	NO	01-I-601
43 DI	YA	1001		LCP-1101	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	NORMAL	PLC	NO	01-I-601
44 DI 45 DI	YI	1101	AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR VALVE IN REMOTE	BFVI-1101	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-l-601
46 DI	ZIC	1101	AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR VALVE CLOSED	BFVI-1101	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601
47 DI	ZIO	1101	AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR VALVE OPEN	BFVI-1101	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601
48 DI 49 DI	ZIC	1102	AGS REACTOR NO. 1 WAGS & WED MAINFOLD AIR BLOWOFF VALVE IN REMOTE	BFVI-1102 BFVI-1102	AGS SUPPLIER PLC	N/A	N/A N/A	N/A	120VAC		PLC	NO	01-I-601
50 DI	ZIO	1102	AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE OPEN	BFVI-1102	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601
51 DI	YI	1103	AGS REACTOR NO. 1 AIR CONTROL VALVE IN REMOTE	BFVI-1103	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601
52 DI 53 DI	ZIO	1103	AGS REACTOR NO. 1 AIR CONTROL VALVE OLOGED	BFVI-1103 BFVI-1103	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601
54 DI	YI	1110	AGS REACTOR NO. 1 INFLUENT VALVE IN REMOTE	PV-1110	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601
55 DI	ZIC	1110	AGS REACTOR NO. 1 INFLUENT VALVE CLOSED	PV-1110	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601
	210		AGS REACTOR INC. LINFLUENT VALVE OPEN	PV-1110	AGO SUPPLIEK PLU	IN/A	IN/A	IN/A	IZUVAC	UPEN	FLG	UN	

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I 40 64 00A - 1

By By Control							Analog Data			Discrete	e Data	1		
D D	Item Type IO C	Code Loop No.	Description	Field Device	Controller ID	Signal Type	Calibrated Range	Power Type	Signal Type	CLOSED State	Power Source	Interp Relay	P&ID Drawing	Remarks
B B	57 DI YI	1120	AGS REACTOR NO. 1 WAGS DISCHARGE VALVE IN REMOTE	PV-1120	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
Del Del <thdel< th=""> <thdel< th=""> <thdel< th=""></thdel<></thdel<></thdel<>	58 DI ZIC	1120	AGS REACTOR NO. 1 WAGS DISCHARGE VALVE CLOSED	PV-1120	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
C C	59 DI ZIO	1120	AGS REACTOR NO. 1 WAGS DISCHARGE VALVE OPEN	PV-1120	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC		PLC	NO	01-I-601	
1 1	60 DI 11	1122	AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE IN REMOTE	PV-1122		N/A I	N/A	N/A	120VAC		PLC	NO	01-1-001	
10 0	62 DI ZIO	1122	AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN	PV-1122	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
b b	63 DI LAH	1 1200	AGS REACTOR NO. 2 HIGH LEVEL	LSH-1200	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	NORMAL	PLC	NO	01-I-601	
10 10 10 10 100 100 100 100	64 DI YI	1201	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE IN REMOTE	BFVI-1201	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
D D	65 DI ZIC	1201	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSED	BFVI-1201	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
B B	66 DI ZIO	1201	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE OPEN	BFVI-1201	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
D D	67 DI YI	1202	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE IN REMOTE	BFVI-1202	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
B D <thd< th=""> D <thd< th=""> <thd< th=""></thd<></thd<></thd<>	68 DI ZIC	1202	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE CLOSED	BFVI-1202	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
N U	69 DI ZIO	1202	AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE OPEN	BFVI-1202	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
9 9	70 DI 11	1203	AGS REACTOR NO. 2 AIR CONTROL VALVE IN REMOTE	BEVI-1203	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC		PLC	NO	01-1-601	
D D	71 DI ZIC	1203	AGS REACTOR NO. 2 AIR CONTROL VALVE CLOSED	BEVI-1203	AGS SUPPLIER PLC	N/A	N/A N/Δ	N/A	120VAC			NO	01-1-601	
D D	73 DI YI	1205	AGS REACTOR NO. 2 INFLUENT VALVE IN REMOTE	PV-1210	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
B B	74 DI ZIC	1210	AGS REACTOR NO. 2 INFLUENT VALVE CLOSED	PV-1210	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
	75 DI ZIO	1210	AGS REACTOR NO. 2 INFLUENT VALVE OPEN	PV-1210	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
G G	76 DI YI	1220	AGS REACTOR NO. 2 WAGS DISCHARGE VALVE IN REMOTE	PV-1220	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
B D DD DD <thdd< th=""> DD DD DD</thdd<>	77 DI ZIC	1220	AGS REACTOR NO. 2 WAGS DISCHARGE VALVE CLOSED	PV-1220	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
D D	78 DI ZIO	1220	AGS REACTOR NO. 2 WAGS DISCHARGE VALVE OPEN	PV-1220	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
10 10<	79 DI YI	1222	AGS REACTOR NO. 2 WATER LEVEL CORRECTION DISCHARGE VALVE IN REMOTE	PV-1222	AGS SUPPLIER PLC	N/A r	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
D D	80 DI ZIC	1222	AGS REACTOR NO. 2 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSED	PV-1222	AGS SUPPLIER PLC	N/A r	N/A	N/A	120VAC		PLC	NO	01-I-601	
B C		J 1200	AGS REACTOR NO. 2 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN	PV-1222		N/A I	N/A	N/A	120VAC			NO	01-1-001	
S D	83 DI VI	1300	AGS REACTOR NO. 3 WAGS & WILC MANIFOLD AIR VALVE IN REMOTE	BEVI-1300	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC		PLC	NO	01-I-601	
B B	84 DI ZIC	1301	AGS REACTOR NO. 3 WAGS & WLC MANIFOLD AIR VALVE CLOSED	BFVI-1301	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
G H	85 DI ZIO	1301	AGS REACTOR NO. 3 WAGS & WLC MANIFOLD AIR VALVE OPEN	BFVI-1301	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
0 0	86 DI YI	1302	AGS REACTOR NO. 3 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE IN REMOTE	BFVI-1302	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
B D	87 DI ZIC	1302	AGS REACTOR NO. 3 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE CLOSED	BFVI-1302	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
B D	88 DI ZIO	1302	AGS REACTOR NO. 3 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE OPEN	BFVI-1302	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
A A B	89 DI YI	1303	AGS REACTOR NO. 3 AIR CONTROL VALVE IN REMOTE	BFVI-1303	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
0 0	90 DI ZIC	1303	AGS REACTOR NO. 3 AIR CONTROL VALVE CLOSED	BFVI-1303	AGS SUPPLIER PLC	N/A N	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
No. No. <td>91 DI ZIO</td> <td>1303</td> <td>AGS REACTOR NO. 3 AIR CONTROL VALVE OPEN</td> <td>BFVI-1303</td> <td>AGS SUPPLIER PLC</td> <td>N/A I</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td></td> <td>PLC</td> <td>NO</td> <td>01-I-601</td> <td></td>	91 DI ZIO	1303	AGS REACTOR NO. 3 AIR CONTROL VALVE OPEN	BFVI-1303	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC		PLC	NO	01-I-601	
P D	92 DI 11	1310	AGS REACTOR NO. 3 INFLUENT VALVE IN REMOTE	PV-1310			N/A	N/A	120VAC		PLC	NO	01-1-601	
N N	94 DI ZIO	1310	AGS REACTOR NO. 3 INFLUENT VALVE COED	PV-1310	AGS SUPPLIER PLC		N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
N N	95 DI YI	1320	AGS REACTOR NO. 3 WAGEN DISCHARGE VALVE IN REMOTE	PV-1320	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
B B	96 DI ZIC	1320	AGS REACTOR NO. 3 WAGS DISCHARGE VALVE CLOSED	PV-1320	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
B D V D	97 DI ZIO	1320	AGS REACTOR NO. 3 WAGS DISCHARGE VALVE OPEN	PV-1320	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
B C	98 DI YI	1322	AGS REACTOR NO. 3 WATER LEVEL CORRECTION DISCHARGE VALVE IN REMOTE	PV-1322	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
B) D	99 DI ZIC	1322	AGS REACTOR NO. 3 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSED	PV-1322	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
Bit Math	100 DI ZIO	1322	AGS REACTOR NO. 3 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN	PV-1322	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
00 0 0.0	101 DI LAH	H 1400	AGS REACTOR NO. 4 HIGH LEVEL	LSH-1400	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	NORMAL	PLC	NO	01-I-601	
No. No. <td>102 DI YI</td> <td>1401</td> <td>AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR VALVE IN REMOTE</td> <td>BEVI-1401</td> <td>AGS SUPPLIER PLC</td> <td></td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td></td> <td>PLC</td> <td>NO</td> <td>01-I-601</td> <td></td>	102 DI YI	1401	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR VALVE IN REMOTE	BEVI-1401	AGS SUPPLIER PLC		N/A	N/A	120VAC		PLC	NO	01-I-601	
ID ID<	103 DI ZIC	1401	AGS REACTOR NO. 4 WAGS & WILC MANIFOLD AIR VALVE CLOSED	BEVI-1401	AGS SUPPLIER PLC	N/A	N/Α N/Δ	N/A	120VAC	OPEN	PLC	NO	01-1-601	
100 100 <td>105 DI YI</td> <td>1402</td> <td>AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE IN REMOTE</td> <td>BFVI-1402</td> <td>AGS SUPPLIER PLC</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td>IN REMOTE</td> <td>PLC</td> <td>NO</td> <td>01-I-601</td> <td></td>	105 DI YI	1402	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE IN REMOTE	BFVI-1402	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
10 10<	106 DI ZIC	1402	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE CLOSED	BFVI-1402	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
Image Image <th< td=""><td>107 DI ZIO</td><td>1402</td><td>AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE OPEN</td><td>BFVI-1402</td><td>AGS SUPPLIER PLC</td><td>N/A 1</td><td>N/A</td><td>N/A</td><td>120VAC</td><td>OPEN</td><td>PLC</td><td>NO</td><td>01-I-601</td><td></td></th<>	107 DI ZIO	1402	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR BLOWOFF VALVE OPEN	BFVI-1402	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
100 100 <td>108 DI YI</td> <td>1403</td> <td>AGS REACTOR NO. 4 AIR CONTROL VALVE IN REMOTE</td> <td>BFVI-1403</td> <td>AGS SUPPLIER PLC</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td>IN REMOTE</td> <td>PLC</td> <td>NO</td> <td>01-I-601</td> <td></td>	108 DI YI	1403	AGS REACTOR NO. 4 AIR CONTROL VALVE IN REMOTE	BFVI-1403	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
10 10 100	109 DI ZIC	1403	AGS REACTOR NO. 4 AIR CONTROL VALVE CLOSED	BFVI-1403	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
10 10<	110 DI ZIO	1403	AGS REACTOR NO. 4 AIR CONTROL VALVE OPEN	BFVI-1403	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
110 100 <td>111 DI YI</td> <td>1410</td> <td>AGS REACTOR NO. 4 INFLUENT VALVE IN REMOTE</td> <td>PV-1410</td> <td>AGS SUPPLIER PLC</td> <td>N/A I</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td>IN REMOTE</td> <td>PLC</td> <td>NO</td> <td>01-I-601</td> <td></td>	111 DI YI	1410	AGS REACTOR NO. 4 INFLUENT VALVE IN REMOTE	PV-1410	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
114 114 115 <td>112 DI ZIC</td> <td>1410</td> <td>AGS REACTOR NO. 4 INFLUENT VALVE OLUSED</td> <td>PV-1410</td> <td>AGS SUPPLIER PLC</td> <td>N/A I</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td></td> <td></td> <td>NO</td> <td>01-1-601</td> <td></td>	112 DI ZIC	1410	AGS REACTOR NO. 4 INFLUENT VALVE OLUSED	PV-1410	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC			NO	01-1-601	
111 Dit D	113 DI ZIO	1410	AGS REACTOR NO. 4 INFLUENT VALVE OPEN	PV-1410	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC		PLC	NO	01-1-601	
111 Dis Zoo 1420 ASS REACTOR NG 4 WAGS DISCHARGE VALVE OPEN ADB PMEMILIE R.C. NA NA <	115 DI ZIC	1420	AGS REACTOR NO. 4 WAGS DISCHARGE VALVE CLOSED	PV-1420	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
117 D1 Y Y42 ASS REACTOR NO 4 WATEL LEVEL CORRECTION DISCHARGE VALVE ONE MONTE PLC NA NA <td>116 DI ZIO</td> <td>1420</td> <td>AGS REACTOR NO. 4 WAGS DISCHARGE VALVE OPEN</td> <td>PV-1420</td> <td>AGS SUPPLIER PLC</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td>OPEN</td> <td>PLC</td> <td>NO</td> <td>01-I-601</td> <td></td>	116 DI ZIO	1420	AGS REACTOR NO. 4 WAGS DISCHARGE VALVE OPEN	PV-1420	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
118 Di ZC 142 ASS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE CORSE PM-422 ASS SUPPLEE PLC NA NA NA 120 C CLOSED PLC NO 01-601 Excention AC 170 DI ALM 1600 MASSMIC METTER LEVEL CORRECTION DISCHARGE VALVE CORSE PM-422 ASS SUPPLEE PLC NA NA NA NA 120 C NO 01-601 Excention AC NO 01-601 CLOSED PLC NO 01-601 Excention AC NO 01-601 Excention AC NO 01-601 NO 01-602 Excention AC NO 01-602 <td< td=""><td>117 DI YI</td><td>1422</td><td>AGS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE IN REMOTE</td><td>PV-1422</td><td>AGS SUPPLIER PLC</td><td>N/A</td><td>N/A</td><td>N/A</td><td>120VAC</td><td>IN REMOTE</td><td>PLC</td><td>NO</td><td>01-I-601</td><td></td></td<>	117 DI YI	1422	AGS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE IN REMOTE	PV-1422	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-601	
191 100 104 1	118 DI ZIC	1422	AGS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSED	PV-1422	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-601	
120 120 120 124 160 WAGSMUC WETWELL HURL LEVEL LSH-1000 AGS SUPPLIE PLC NA NA <td>119 DI ZIO</td> <td>1422</td> <td>AGS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN</td> <td>PV-1422</td> <td>AGS SUPPLIER PLC</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td>OPEN</td> <td>PLC</td> <td>NO</td> <td>01-I-601</td> <td></td>	119 DI ZIO	1422	AGS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN	PV-1422	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-601	
Int Unit WALSWALL WE INSELL OW LOW LEVEL UNIT UNIT <	120 DI LAH	H 1600	WAGS/WLC WETWELL HIGH LEVEL	LSH-1600	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	NORMAL	PLC	NO	01-I-602	
Inf Unit	121 DI LALI	L 1600	WAGS/WLC WE I WELL LOW LOW LEVEL	LSLL-1600	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC		PLC	NO	U1-I-602	
101 101 <td>122 UI YI 123 DI 70</td> <td>1651</td> <td></td> <td>GSD-1651</td> <td>AGS SUPPLIER PLC</td> <td>N/A</td> <td>N/A</td> <td>IN/A N/A</td> <td>120VAC</td> <td></td> <td></td> <td>NO</td> <td>01-1-602</td> <td></td>	122 UI YI 123 DI 70	1651		GSD-1651	AGS SUPPLIER PLC	N/A	N/A	IN/A N/A	120VAC			NO	01-1-602	
125 01 Y 1652 0STREUTION CHAMEER CATE NO.2 NEMOTE PLC NO 014402 FUTURE IO 125 01 ZC 1652 DSTREUTION CHAMEER CATE NO.2 CLOSED EUTURE IO 127 10 ZO 1652 DSTREUTION CHAMEER CATE NO.2 CLOSED EUTURE IO 127 10 ZO 1652 DSTREUTION CHAMEER CATE NO.2 CLOSED EUTURE IO 128 10 Y 1653 DSTREUTION CHAMEER CATE NO.3 OPEN GSD-1652 AGS SUPPLIER PLC NA NA NA 120VAC IN REMOTE PLC NO 014-602 FUTURE IO 128 10 Y 1653 DSTREUTION CHAMEER CATE NO.3 CLOSED GSD-1653 AGS SUPPLIER PLC NA NA NA 120VAC IN REMOTE PLC NO 014-602 FUTURE IO 130 11 Y 1550 AGS SUPPLIER PLC NA NA NA NA NA NA NA NA NA <td< td=""><td>124 DI 710</td><td>1651</td><td>DISTRIBUTION CHAMBER GATE OPEN</td><td>GSD-1651</td><td>AGS SUPPLIER PLC</td><td>N/A</td><td>N/A</td><td>N/A</td><td>120VAC</td><td>OPEN</td><td>PLC</td><td>NO</td><td>01-1-602</td><td></td></td<>	124 DI 710	1651	DISTRIBUTION CHAMBER GATE OPEN	GSD-1651	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN	PLC	NO	01-1-602	
128 01 2/2 1852 DISTRUITION CHAMBER ATE NO.2 CLOSED NO. NA <	125 DI VI	1652	DISTRIBUTION CHAMBER GATE NO. 2 IN REMOTE	GSD-1652	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-602	FUTURE I/O
120 1622 DISTRBUTION CHAMBER GATE NO.2 OPEN GSD-1652 AGS SUPPLIER PLC NA NA NA NA 120/AC OPEN PLC NO 01-4002 PLTURE IO 128 DI TH 1653 DISTRBUTION CHAMBER GATE NO.3 INCERTO GSD-1653 AGS SUPPLIER PLC NA NA NA NA 120/AC CORED PLC NO 01-4002 PLTURE IO 130 DI ZIC 1653 DISTRBUTION CHAMBER GATE NO.3 INFER GSD-1653 AGS SUPPLIER PLC NA NA NA NA NA 120/AC CORED PLC NO 01+4002 PLTURE IO 130 DI ZIC 1653 AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE IN REMOTE BSV-1550 AGS SUPPLIER PLC NA	126 DI ZIC	1652	DISTRIBUTION CHAMBER GATE NO. 2 CLOSED	GSD-1652	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-602	FUTURE I/O
12801Y11653DISTRIBUTION CHAMBER GATE NO 3 IN REMOTEVICN1N2VICN4NA120VACIN REMOTEPLCNO01-le02FUTURE IO13901ZO1653DISTRIBUTION CHAMBER GATE NO 3 OPENSOPENSOPENPLCNO01-le02FUTURE IO13001Y1150DISTRIBUTION CHAMBER GATE NO 3 OPENSOPENSOPENPLCNO01-le02FUTURE IO13101Y1150ASS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE IN REMOTEBPV1-150ASS SUPPLIER PLCNANANA120VACNPENTNO02-le0113201ZC1550ASS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE COSEDBPV1-150ASS SUPPLIER PLCNANANA120VACCLOSEDPLCNO02-le0113301ZC1101ASS REACTOR NO.1 WASS & WLC MANIFOLD AIR VALVE COSEBPV1-150ASS SUPPLIER PLCNANANA120VACCLOSEDPLCNO02-le01134D0ZC1101ASS REACTOR NO.1 WASS & WLC MANIFOLD AIR VALVE CLOSE COMMANDBPV1-101ASS SUPPLIER PLCNANANA120VACCLOSE CMDFILDYES01-le01FLDFLDYES01-le01FLDFLDYES01-le01FLDYES01-le01FLDYES01-le01FLDYES01-le01FLDYES01-le01FLDYES01-le01FLDYES01-le01FLD <td< td=""><td>127 DI ZIO</td><td>1652</td><td>DISTRIBUTION CHAMBER GATE NO. 2 OPEN</td><td>GSD-1652</td><td>AGS SUPPLIER PLC</td><td>N/A I</td><td>N/A</td><td>N/A</td><td>120VAC</td><td>OPEN</td><td>PLC</td><td>NO</td><td>01-I-602</td><td>FUTURE I/O</td></td<>	127 DI ZIO	1652	DISTRIBUTION CHAMBER GATE NO. 2 OPEN	GSD-1652	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-602	FUTURE I/O
129DIZC1653DISTRIBUTION CHAMBER GATE NO. 3 CLOSEDFUCNANANANA120VACCLOSEDPLCNO01-462FUTURE IO131DIYI1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE IN REMOTEBFV-1550AGS SUPPLIER PLCNANANANA120VACIN REMOTEPLCNO01-462FUTURE IO132DIZIC1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE CLOSEDBFV-1550AGS SUPPLIER PLCNANANANA120VACCLOSEDPLCNO02+601133DIZIC1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE CLOSE COMMANDBFV-1550AGS SUPPLIER PLCNANANANA120VACCLOSE CLOSEPLCNO02+601134DOZCC1161AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR VALVE COPENBFV-1500AGS SUPPLIER PLCNANANA120VACCLOSE CMDPLCNO02+601135DOZCC1101AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR VALVE COPEN COMMANDBFV-1101AGS SUPPLIER PLCNANANANA120VACCLOSE CMDFIELDYES01+601136DOZCC1101AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMANDBFV-1101AGS SUPPLIER PLCNANANANA120VACCLOSE CMDFIELDYES01+601137DOZCC1110AGS REACTOR NO. 1 WAGS & WLC MANIFO	128 DI YI	1653	DISTRIBUTION CHAMBER GATE NO. 3 IN REMOTE	GSD-1653	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	IN REMOTE	PLC	NO	01-I-602	FUTURE I/O
130DIZIO1653DISTRIBUTION CHAMBER GATE NO. 3 OPENCASS UPPLICE PLCNANANANA120VACOPENPLCNO01-4602PUTURE I/O131DIXIC1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE IN REMOTEBFV1550AGS SUPPLIER PLCNANANA120VACCLOSE DPLCNO02-4601133DIZIC1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE COSEBFV1550AGS SUPPLIER PLCNANANA120VACCLOSE DPLCNO02-4601133DIZIC1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE COSE COMMANDBFV1-1500AGS SUPPLIER PLCNANANA120VACCLOSE CMPLCNO02-4601134DOZCC1101AGS REACTOR NO.1 WAGS & WLC MANIFOLD AR VALVE COPENBFV1-1501AGS SUPPLIER PLCNANANA120VACCLOSE CMFIELDYES01-4601135DOZCC1101AGS REACTOR NO.1 WAGS & WLC MANIFOLD AR VALVE CORE COMMANDPV-1101AGS SUPPLIER PLCNANANA120VACOFEN CMDFIELDYES01-4601137DOZCC1110AGS REACTOR NO.1 WAGS SECHARGE VALVE CORSE COMMANDPV-1110AGS SUPPLIER PLCNANANA120VACOFEN CMDFIELDYES01-4601138DOZCC1110AGS REACTOR NO.1 WAGS SECHARGE VALVE CORSE COMMANDPV-1120AGS SUPPLIER PLCNANA<	129 DI ZIC	1653	DISTRIBUTION CHAMBER GATE NO. 3 CLOSED	GSD-1653	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSED	PLC	NO	01-I-602	FUTURE I/O
131UIYI1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALUE IN REMOTEBFV-1550AGS SUPPLIER PLCNANANA120 VACCLOSEPLCNO024-601133DIZIC1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALUE (OSEDBFV-1550AGS SUPPLIER PLCNANANA120VACCLOSEPLCNO024-601133DIZIC1550AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE (OSEDBFV-1550AGS SUPPLIER PLCNANANA120VACCLOSE OMDFIELDYES014-601134DOZCC1101AGS REACTOR NO. 1WAGS & WLC MANIFOLD AR VALVE OPEN COMMANDBFV-1101AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES014-601135DOZCC1101AGS REACTOR NO. 1INFLUENT VALVE OPEN COMMANDPV-1101AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES014-601136DOZCC1101AGS REACTOR NO. 1INFLUENT VALVE OPEN COMMANDPV-1101AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES014-601137DOZCC1102AGS REACTOR NO. 1 WAGS SUCCHARGE VALVE OPEN COMMANDPV-1120AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES014-601138DOZCC1120AGS REACTOR NO. 1 WAGS SUCCHARGE VALVE OPEN COMMANDPV-1120AGS SUPPLIER PLCNANA <t< td=""><td>130 DI ZIO</td><td>1653</td><td>DISTRIBUTION CHAMBER GATE NO. 3 OPEN</td><td>GSD-1653</td><td>AGS SUPPLIER PLC</td><td>N/A I</td><td>N/A</td><td>N/A</td><td>120VAC</td><td>OPEN</td><td>PLC</td><td>NO</td><td>01-I-602</td><td>FUTURE I/O</td></t<>	130 DI ZIO	1653	DISTRIBUTION CHAMBER GATE NO. 3 OPEN	GSD-1653	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC	OPEN	PLC	NO	01-I-602	FUTURE I/O
132142150NAS120150NAS120VACCLOSEPLCNO024-601133DL150AGSBLOWRE COMMON DISCHARGE TO VENT CONTROL VALVE OPENBFV-1500AGS SUPPLIER PLCNANANA120VACCLOSEPLCNO024-601134DUZCC1101AGS REACTOR NO. 1 WAGS & WLC MANIFOLD AIR VALVE OPENBFV-1101AGS SUPPLIER PLCNANANA120VACCLOSEDPLCYES01-601136DOZCC1110AGS REACTOR NO. 1 INFLUENT VALVE CLOSE COMMANDBFV-1101AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES01-601136DOZCC1110AGS REACTOR NO. 1 INFLUENT VALVE CLOSE COMMANDPV-1110AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES01-601137DOZCC1110AGS REACTOR NO. 1 INFLUENT VALVE CLOSE COMMANDPV-1100AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES01-601138DOZCC1110AGS REACTOR NO. 1 WAGS DISCHARGE VALVE CLOSE COMMANDPV-1120AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES01-601139DOZCC1120AGS REACTOR NO. 1 WAGS DISCHARGE VALVE CLOSE COMMANDPV-1120AGS SUPPLIER PLCNANANA120VACCLOSE CMDFIELDYES01-601140DOZCC1	131 DI YI	1550	AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE IN REMOTE	BFVI-1550	AGS SUPPLIER PLC	N/A I	N/A	N/A	120VAC		PLC	NO	02-I-601	
Instruction	132 DI ZIC	1550	AGS BLOWER COMMON DISCHARGE TO VENT CONTROL VALVE ODEN	DEVI-1550	AGS SUPPLIER PLC	IN/A	N/A	IN/A	120VAC				02-1-001	
Instruction Doc Loos internet Doc Next Not. Write out on writ	133 DI ZIO	0 1550		DF VI-1550 BEVI-1101	AGS SUPPLIER PLC	N/A		IN/A	120VAC			VES	01-1-601	
Instrument Instrument <td>135 DO ZCC</td> <td>0 1101</td> <td>AGS REACTOR NO. 1 WAGS & WLC INIAINI OLD AIR VALVE GLOGE GUININIAND</td> <td>BFVI-1101</td> <td>AGS SUPPLIER PLC</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td></td> <td>FIELD</td> <td>YES</td> <td>01-I-601</td> <td></td>	135 DO ZCC	0 1101	AGS REACTOR NO. 1 WAGS & WLC INIAINI OLD AIR VALVE GLOGE GUININIAND	BFVI-1101	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC		FIELD	YES	01-I-601	
137 DO ZCO 1110 AGS REACTOR NO.1 INFLUENT VALVE OPEN COMMAND PV-1110 AGS SUPPLIER PLC N/A N/A N/A 120 VAC OPEN CMD FIELD YES 01-601 138 DO ZCO 1120 AGS REACTOR NO.1 IWAGS DISCHARGE VALVE CLOSE COMMAND PV-1120 AGS SUPPLIER PLC N/A N/A N/A N/A 120VAC CLOSE CMD FIELD YES 01-601 139 DO ZCO 1120 AGS REACTOR NO.1 WAGS DISCHARGE VALVE OPEN COMMAND PV-1120 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FIELD YES 01-601 140 DO ZCC 1122 AGS REACTOR NO.1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND PV-1122 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FIELD YES 01-601 141 DO ZCC 1121 AGS REACTOR NO.1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND PV-1122 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FIELD YES 01-601 142 DO ZCC 1	136 DO ZCC	C 1110	AGS REACTOR NO. 1 INFLUENT VALVE CLOSE COMMAND	PV-1110	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	01-I-601	+
138DOZCC1120AGS REACTOR NO. 1 WAGS DISCHARGE VALVE CLOSE COMMANDPV-1120AGS SUPPLIER PLCN/AN/AN/A120VACCLOSE CMDFIELDYES01-4601139DOZCC1120AGS REACTOR NO. 1 WAGS DISCHARGE VALVE OPEN COMMANDPV-1120AGS SUPPLIER PLCN/AN/AN/AN/A120VACOPEN CMDFIELDYES01-4601140DOZCC1122AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSE COMMANDPV-1122AGS SUPPLIER PLCN/AN/AN/A120VACOPEN CMDFIELDYES01-4601141DOZCC1121AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMANDPV-1122AGS SUPPLIER PLCN/AN/AN/A120VACOPEN CMDFIELDYES01-4601142DOZCC1201AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMANDBFV-1201AGS SUPPLIER PLCN/AN/AN/A120VACCLOSE CMDFIELDYES01-4601142DOZCC1201AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMANDBFVI-1201AGS SUPPLIER PLCN/AN/AN/A120VACCLOSE CMDFIELDYES01-4601143DOZCO1201AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE OPEN COMMANDBFVI-1201AGS SUPPLIER PLCN/AN/AN/A120VACOPEN CMDFIELDYES01-4601144DOZCC1201AGS REACTOR NO. 2 I	137 DO ZCO	0 1110	AGS REACTOR NO. 1 INFLUENT VALVE OPEN COMMAND	PV-1110	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	01-I-601	1
139 D0 ZC0 1120 AGS REACTOR NO. 1 WAGS DISCHARGE VALVE OPEN COMMAND PV-1120 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FielD YES 01-601 140 D0 ZC0 1122 AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSE COMMAND PV-1122 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-601 141 D0 ZC0 1122 AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND PV-1122 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-601 141 D0 ZC0 1121 AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND PV-1120 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FielD YES 01-601 142 D0 ZC0 1201 AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND BFVI-1201 AGS SUPPLIER PLC N/A N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-401 01-401 01-401	138 DO ZCC	C <u>1120</u>	AGS REACTOR NO. 1 WAGS DISCHARGE VALVE CLOSE COMMAND	PV-1120	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	01-I-601	
140 D0 ZCC 1122 AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSE COMMAND PV-1122 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-601 141 D0 ZCC 1122 AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND PV-1122 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FielD YES 01-601 142 D0 ZCC 1201 AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND BV-1201 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-601 143 D0 ZCC 1201 AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND BV-1201 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-601 143 D0 ZCC 1201 AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE OPEN COMMAND PV-120 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FielD YES 01-601 10-1601 10-1601 10-1601 <td>139 DO ZCO</td> <td>0 1120</td> <td>AGS REACTOR NO. 1 WAGS DISCHARGE VALVE OPEN COMMAND</td> <td>PV-1120</td> <td>AGS SUPPLIER PLC</td> <td>N/A</td> <td>N/A</td> <td>N/A</td> <td>120VAC</td> <td>OPEN CMD</td> <td>FIELD</td> <td>YES</td> <td>01-I-601</td> <td></td>	139 DO ZCO	0 1120	AGS REACTOR NO. 1 WAGS DISCHARGE VALVE OPEN COMMAND	PV-1120	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	01-I-601	
141 DO ZCO 1122 AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND PV-1122 AGS SUPPLIER PLC N/A N/A 120VAC OPEN CMD FielD YES 01-601 142 DO ZCC 1201 AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND BFV-1201 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-601 143 DO ZCO 1201 AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND BFV-1201 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FielD YES 01-601 144 DO ZCC 1210 AGS REACTOR NO. 2 INFLUENT VALVE CLOSE COMMAND PV-1210 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FielD YES 01-601 144 DO ZCC 1210 AGS REACTOR NO. 2 INFLUENT VALVE CLOSE COMMAND PV-1210 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FielD YES 01-1-601 144 DO ZCO 1210 AGS REACTOR NO	140 DO ZCC	C 1122	AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSE COMMAND	PV-1122	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	01-I-601	
142 D0 ZCC 1201 JAGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND BFVI-1201 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FIELD YES 011-601 143 D0 ZCO 1201 AGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND BFVI-1201 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD FIELD YES 011-601 144 D0 ZCC 1210 AGS REACTOR NO. 2 INFLUENT VALVE CLOSE COMMAND PV-1210 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FIELD YES 011-601 144 D0 ZCC 1210 AGS REACTOR NO. 2 INFLUENT VALVE CLOSE COMMAND PV-1210 AGS SUPPLIER PLC N/A N/A N/A 120VAC CLOSE CMD FIELD YES 011-601 145 D0 ZCO 1210 AGS REACTOR NO. 2 INFLUENT VALVE OPEN COMMAND PV-1210 AGS SUPPLIER PLC N/A N/A N/A N/A 120VAC CLOSE CMD FIELD YES 011-601	141 DO ZCO	0 1122	AGS REACTOR NO. 1 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND	PV-1122	AGS SUPPLIER PLC	N/A 1	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	01-I-601	
143 DO ZCO 1201 AGS REACTOR NO. 2 VIALUS & WLC MAINFULD AIR VALVE OPEN COMMAND PV-1201 AGS SUPPLIER PLC N/A N/A 120VAC OPEN CMD Field YES 01-601 144 DO ZCO 1210 AGS REACTOR NO. 2 INFLUENT VALVE OPEN COMMAND PV-1201 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD Field YES 01-601 145 DO ZCO 1210 AGS REACTOR NO. 2 INFLUENT VALVE OPEN COMMAND PV-1210 AGS SUPPLIER PLC N/A N/A N/A 120VAC OPEN CMD Field YES 01-601	142 DO ZCC	0 1201	JAGS REACTOR NO. 2 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND	BEVI-1201	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	ODEN OND		YES	01-I-601	
145 DO ZCO 1210 AGS REACTOR NO. 2 INFLUENT VALVE OPEN COMMAND PY-1210 AGS SUPPLIER FLC INA INA INA IZVAC OPEN CMD FIELD YES 011-601	143 DU 200	0 1201	AGS REACTOR NO. 2 WAGS & WILL MANIFULD AIK VALVE UPEN CUMMAND	DEVI-1201 DV-1210	AGS SUPPLIER PLC	N/A		IN/A	120VAC			VES	01-1-001	
	145 DO ZCC	0 1210	AGS REACTOR NO. 2 INFLUENT VALVE OPEN COMMAND	PV-1210	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	01-I-601	+

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

						Analog Data				Discrete	e Data		<u> </u>	
Item Type	IO Code	ELOOP NO.	Description	Field Device	Controller ID	Signal Type	Calibrated Range	Power Type	Signal Type	CLOSED State	Power Source In	nterp Relay	P&ID Drawing	Remarks
146 DO	ZCC	1220	AGS REACTOR NO. 2 WAGS DISCHARGE VALVE CLOSE COMMAND	PV-1220	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-I-601	
147 DO	ZCO	1220	AGS REACTOR NO. 2 WAGS DISCHARGE VALVE OPEN COMMAND	PV-1220	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-I-601	
148 DO	ZCC	1222	AGS REACTOR NO. 2 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSE COMMAND	PV-1222	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-I-601	
149 DO	200	1222	AGS REACTOR NO. 2 WATER LEVEL CONRECTION DISCHARGE VALVE OPEN COMMAIND	PV-1222		N/A	N/A	N/A	120VAC		FIELD Y	/ES	01-1-001	
151 DO	700	1301	AGS REACTOR NO. 3 WAGS & WI C MANIFOLD AIR VALVE OPEN COMMAND	BEVI-1301	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC		FIELD Y	/ES	01-I-601	
152 DO	ZCC	1310	AGS REACTOR NO. 3 INFLUENT VALVE CLOSE COMMAND	PV-1310	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-I-601	
153 DO	ZCO	1310	AGS REACTOR NO. 3 INFLUENT VALVE OPEN COMMAND	PV-1310	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-I-601	
154 DO	ZCC	1320	AGS REACTOR NO. 3 WAGS DISCHARGE VALVE CLOSE COMMAND	PV-1320	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-l-601	
155 DO	ZCO	1320	AGS REACTOR NO. 3 WAGS DISCHARGE VALVE OPEN COMMAND	PV-1320	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-I-601	
156 DO	ZCC	1322	AGS REACTOR NO. 3 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSE COMMAND	PV-1322	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-I-601	
157 DO	ZCO	1322	AGS REACTOR NO. 3 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND	PV-1322	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-I-601	
158 DO	200	1401	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR VALVE CLOSE COMMAND	BFVI-1401	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-I-601	
159 DO	200	1401	AGS REACTOR NO. 4 WAGS & WLC MANIFOLD AIR VALVE OPEN COMMAND	BFVI-1401	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC		FIELD Y	(ES (ES	01-1-601	
161 DO	700	1410	AGS REACTOR NO. 4 INFLUENT VALVE COESE COMMININD	PV-1410	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC		FIELD	/ES	01-1-601	
162 DO	ZCC	1420	AGS REACTOR NO. 4 WAGS DISCHARGE VALVE CLOSE COMMAND	PV-1420	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	/ES	01-I-601	
163 DO	ZCO	1420	AGS REACTOR NO. 4 WAGS DISCHARGE VALVE OPEN COMMAND	PV-1420	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-I-601	
164 DO	ZCC	1422	AGS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE CLOSE COMMAND	PV-1422	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-I-601	
165 DO	ZCO	1422	AGS REACTOR NO. 4 WATER LEVEL CORRECTION DISCHARGE VALVE OPEN COMMAND	PV-1422	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-l-601	
166 DO	ZCC	1651	DISTRIBUTION CHAMBER GATE CLOSE COMMAND	GSD-1651	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD Y	/ES	01-I-602	
167 DO	ZCO	1651	DISTRIBUTION CHAMBER GATE OPEN COMMAND	GSD-1651	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-I-602	
168 DO	700	1652	DISTRIBUTION CHAMBER GATE NO. 2 CODE COMMAND	GSD-1652		N/A	N/A		120VAC		FIELD Y	/ES	01-1-602	
170 DO	700	1653	DISTRIBUTION CHAMBER GATE NO. 2 OPEN COMMAND	GSD-1653	AGS SUPPLIER PLC	N/A N/Δ	N/A N/Δ	N/A	120VAC			/ES	01-1-002	
171 DO	ZCO	1653	DISTRIBUTION CHAMBER GATE NO. 3 OPEN COMMAND	GSD-1653	AGS SUPPLIER PLC	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD Y	/ES	01-I-602	FUTURE I/O
170 41		1005					PER AGS SYSTEM							
172 AI	AI	1005	AGS REACTORS COMMON EFFLUENT PHOSPHATE CONCENTRATION	AT-1005	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A	N/A	01-1-601	
173 ΔΙ	Δι	1101		AT-1100			PER AGS SYSTEM	N/A	N/A	Ν/Δ	Ν/Δ	Δ/Δ	01-1-601	
173 AI	~	1101	AGS REACTOR NO. I TOTAL SUGFLINDED SOLIDS	AI-1100	AGS SUFFLIENTED	WODB03 KTO	SUPPLIER		IN/A	IN/A		N/A	01-1-001	
174 AI	AI	1102	AGS REACTOR NO. 1 DISSOLVED OXYGEN	AT-1100	AGS SUPPLIER PLC	MODBUS RTU	PER AGS SYSTEM	N/A	N/A	N/A	N/A N	N/A	01-I-601	
							SUPPLIER							
175 AI	AI	1103	AGS REACTOR NO. 1 OXYGEN REDUCTION POTENTIAL	AT-1100	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	01-I-601	
							PER AGS SYSTEM							
176 AI	AI	1104	AGS REACTOR NO. 1 PH	AT-1100	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	01-l-601	
177 ΔΙ	A1	1106		AT 1100			PER AGS SYSTEM	N/A	N/A	NI/A	N/A N	1/A	01 601	
	Ai	1100		AT-1100	AGS SOFFEIEN FEC		SUPPLIER	N/A	IN/A	IN/A	IN/A	N/A	01-1-001	
178 AI	AI	1201	AGS REACTOR NO. 2 TOTAL SUSPENDED SOLIDS	AT-1200	AGS SUPPLIER PLC	MODBUSIRTU	PER AGS SYSTEM	N/A	N/A	N/A	N/A	N/A	01-I-601	
		-					SUPPLIER			-				
179 AI	AI	1202	AGS REACTOR NO. 2 DISSOLVED OXYGEN	AT-1200	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	01-l-601	
							PER AGS SYSTEM							
180 AI	AI	1203	AGS REACTOR NO. 2 OXYGEN REDUCTION POTENTIAL	AT-1200	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	01-l-601	
181 AI	ΔI	1204	AGS REACTOR NO 2 nH	AT-1200	AGS SUPPLIER PLC	MODBUS RTU	PER AGS SYSTEM	N/A	N/A	N/A	Ν/Δ	Δ/Δ	01-1-601	
		1204		AT-1200	AGG GOLT EIERT EG	MODBOOTTO	SUPPLIER	11/7	10/5	11/17			01-1-001	
182 AI	AI	1206	AGS REACTOR NO. 2 AMMONIA / AMMONIUM CONCENTRATION	AT-1200	AGS SUPPLIER PLC	MODBUS RTU	PER AGS SYSTEM	N/A	N/A	N/A	N/A N	N/A	01-I-601	
		-					DER AGS SVSTEM							
183 AI	AI	1301	AGS REACTOR NO. 3 TOTAL SUSPENDED SOLIDS	AT-1300	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	01-l-601	
							PER AGS SYSTEM							
184 AI	AI	1302	AGS REACTOR NO. 3 DISSOLVED OXYGEN	AT-1300	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A P	N/A	01-1-601	
185 AI	ΔI	1303	AGS REACTOR NO. 3 OXYGEN REDUCTION POTENTIAL	AT-1300	AGS SUPPLIER PLC	MODBUS RTU	PER AGS SYSTEM	N/A	N/A	N/A	Ν/Δ	Δ/Δ	01-1-601	
105 A		1303		AT-1300	AGG BETT ELETT EG		SUPPLIER	IN/A	10/5				01-1-001	
186 AI	AI	1304	AGS REACTOR NO. 3 pH	AT-1300	AGS SUPPLIER PLC	MODBUS RTU	PER AGS SYSTEM	N/A	N/A	N/A	N/A N	N/A	01-I-601	
							DER AGS SVSTEM							
187 AI	AI	1306	AGS REACTOR NO. 3 AMMONIA / AMMONIUM CONCENTRATION	AT-1300	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	01-I-601	
400 41		4404		AT 4400			PER AGS SYSTEM					1/4	04 1 004	
188 AI	AI	1401	AGS REACTOR NO. 4 TOTAL SUSPENDED SOLIDS	AI-1400	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A	N/A	01-1-601	
189 AI	AI	1402	AGS REACTOR NO. 4 DISSOLVED OXYGEN	AT-1400	AGS SUPPLIER PLC	MODBUS RTU	PER AGS SYSTEM	N/A	N/A	N/A	N/A	J/A	01-1-601	
							SUPPLIER							
190 AI	AI	1403	AGS REACTOR NO. 4 OXYGEN REDUCTION POTENTIAL	AT-1400	AGS SUPPLIER PLC	MODBUS RTU	PER AGS SYSTEM	N/A	N/A	N/A	N/A N	N/A	01-I-601	
		1					PER AGS SYSTEM							
191 AI	AI	1404	AGS REACTOR NO. 4 pH	AT-1400	AGS SUPPLIER PLC	MODBUS RTU	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	01-I-601	
102 11	Δι	1406		AT-1400			PER AGS SYSTEM	N/A	N/A	Ν/Δ	N/A	J/A	01-1-601	
192 AI	Ai	1400		AT-1400	AGS SUFFLIER FLC	WODBUS KTU	SUPPLIER	N/A	IN/A	IN/A	IN/A	N/A	01-1-001	
193 AI	SI	1610	WAGS/WLC PUMP NO. 1 SPEED	VFD-1610	AGS SUPPLIER PLC	MODBUS TCP/IP	0-100%	N/A	N/A	N/A	N/A N	N/A	01-I-602	
194 AI	SI	1620	WAGSWLC PUMP NO. 2 SPEED	VFD-1620	AGS SUPPLIER PLC	MODBUS TCP/IP	0-100%	N/A	N/A	N/A	N/A N	N/A	01-I-602	
195 AI	51	1630	WAGS/WLC PUMP NO. 3 SPEED	VFD-1630	AGS SUPPLIER PLC	MODBUS ICP/IP	DEB BLOWER	N/A	N/A	N/A	N/A P	N/A	01-1-602	
196 AI	II	1510	AGS BLOWER NO. 1 MOTOR CURRENT	LCP-1510	AGS SUPPLIER PLC	MODBUS TCP/IP		N/A	N/A	N/A	N/A N	N/A	02-I-601	
							PER BLOWER							
197 AI	JI	1510	AGS BLOWER NO. 1 MOTOR POWER	LCP-1510	AGS SUPPLIER PLC	MODBUS TCP/IP	SUPPLIER	N/A	N/A	N/A	N/A	N/A	02-I-601	
108 41	91	1510		LCP-1510			PER BLOWER	Ν/Δ	N/A	Ν/Δ	Ν/Δ	Δ/Δ	02-1-601	
130 74	01	1010		201-1010	AGG GOLT EIEICT EG		SUPPLIER	11/7	19/7	11/74			02-1-001	
199 AI	TI	1510	AGS BLOWER NO. 1 SUCTION TEMPERATURE	LCP-1510	AGS SUPPLIER PLC	MODBUS TCP/IP	PER BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
\vdash	_	-		-										
200 AI	PI	1510	AGS BLOWER NO. 1 SUCTION PRESSURE	LCP-1510	AGS SUPPLIER PLC	MODBUS TCP/IP		N/A	N/A	N/A	N/A N	N/A	02-I-601	
	T.	45.11		00.1515			PER BLOWER			N1/A	N1/A	1/4	00.1.001	
201 AI	11	1511	AGO BLOWER NU. 1 DISCHARGE TEMPERATURE	LCP-1510	AGS SUPPLIER PLC	WODBUS TCP/IP	SUPPLIER	IN/A	IN/A	IN/A	IN/A	N/A	u∠-I-6U1	
202 41	Ы	1511	AGS BLOWER NO. 1 DISCHARGE PRESSURE	I CP-1510			PER BLOWER	N/A	N/A	N/A	N/A	J/A	02-1-601	
202 AI	1.1	1911		201-1010	AUD OUFFLILIN FLU		SUPPLIER			17/1	rva r	1//7	02-1-001	
203 AI	11	1520	AGS BLOWER NO. 2 MOTOR CURRENT	LCP-1520	AGS SUPPLIER PLC	MODBUS TCP/IP	PER BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
\vdash	_						PER BLOWER							
204 AI	JI	1520	AGS BLOWER NO. 2 MOTOR POWER	LCP-1520	AGS SUPPLIER PLC	MODBUS TCP/IP	SUPPLIER	N/A	N/A	N/A	N/A N	N/A	02-I-601	
205	C'	4500		100 4500			PER BLOWER	N1/A	N1/A	N1/A	NI/A	1/4	00.1.001	
205 AI	31	1520	AGO DLUWER NU. 2 MUTUR SPEED	LUP-1520	AGS SUPPLIER PLC	WODBUS ICP/IP	SUPPLIER	IN/A	IN/A	IN/A	IN/A	N/A	UZ-I-0U1	

						Analog Data			Discrete	e Data			
Item Type IO Code	Loop No.	Description	Field Device	Controller ID	Signal Type Calibr	ated Range	Power Type	Signal Type	CLOSED State	Power Source	Interp Relay	P&ID Drawing	Remarks
206 AI TI	1520	AGS BLOWER NO. 2 SUCTION TEMPERATURE	LCP-1520	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
207 AI PI	1520	AGS BLOWER NO. 2 SUCTION PRESSURE	LCP-1520	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
208 AI TI	1521	AGS BLOWER NO. 2 DISCHARGE TEMPERATURE	LCP-1520	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
209 AI PI	1521	AGS BLOWER NO. 2 DISCHARGE PRESSURE	LCP-1520	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
210 AI II	1530	AGS BLOWER NO. 3 MOTOR CURRENT	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
211 AI JI	1530	AGS BLOWER NO. 3 MOTOR POWER	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
212 AI SI	1530	AGS BLOWER NO. 3 MOTOR SPEED	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-l-601	
213 AI TI	1530	AGS BLOWER NO. 3 SUCTION TEMPERATURE	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
214 AI PI	1530	AGS BLOWER NO. 3 SUCTION PRESSURE	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
215 AI TI	1531	AGS BLOWER NO. 3 DISCHARGE TEMPERATURE	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
216 AI PI	1531	AGS BLOWER NO. 3 DISCHARGE PRESSURE	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
217 AO FC	1000	AGS REACTORS INFLUENT FLOW COMMAND	FIT-1000	AGS SUPPLIER PLC	MODBUS TCP/IP 0-15 N	MGD	N/A	N/A	N/A	N/A	N/A	01-I-601	SETPOINT SENT TO PLC-PFS
218 AO SC	1610	WAGS/WLC PUMP NO. 1 SPEED COMMAND	VFD-1610	AGS SUPPLIER PLC	MODBUS TCP/IP 0-100	%	N/A	N/A	N/A	N/A	N/A	01-I-602	
219 AO SC	1620	WAGS/WLC PUMP NO. 2 SPEED COMMAND	VFD-1620	AGS SUPPLIER PLC	MODBUS TCP/IP 0-100	%	N/A	N/A	N/A	N/A	N/A	01-I-602	
220 AO SC	1630	WAGS/WLC PUMP NO. 3 SPEED COMMAND	VFD-1630	AGS SUPPLIER PLC	MODBUS TCP/IP 0-100	%	N/A	N/A	N/A	N/A	N/A	01-I-602	
221 AO SC	1510	AGS BLOWER NO. 1 MOTOR SPEED COMMAND	LCP-1510	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
222 AO SC	1520	AGS BLOWER NO. 2 MOTOR SPEED COMMAND	LCP-1520	AGS SUPPLIER PLC	MODBUS TCP/IP	BLOWER	N/A	N/A	N/A	N/A	N/A	02-I-601	
223 AO SC	1530	AGS BLOWER NO. 3 MOTOR SPEED COMMAND	LCP-1530	AGS SUPPLIER PLC	MODBUS TCP/IP		N/A	N/A	N/A	N/A	N/A	02-I-601	
224 DI YI	1100	AGS REACTOR NO. 1 SAMPLING SYSTEM IN AUTO	AT-1100	AGS SUPPLIER PLC	N/A N/A	C	N/A	MODBUS TCP/IP	IN AUTO	N/A	NO	01-I-601	
225 DI YI	1200	AGS REACTOR NO. 2 SAMPLING SYSTEM IN AUTO	AT-1200	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN AUTO	N/A	NO	01-I-601	
226 DI YI	1300	AGS REACTOR NO. 3 SAMPLING SYSTEM IN AUTO	AT-1300	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN AUTO	N/A	NO	01-I-601	
227 DI YI	1400	AGS REACTOR NO. 4 SAMPLING SYSTEM IN AUTO	AT-1400	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN AUTO	N/A	NO	01-I-601	
228 DI YI	1610	WAGS/WLC PUMP NO. 1 IN AUTO	VFD-1610	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN AUTO	N/A	NO	01-I-602	
229 DI YIR	1610	WAGS/WLC PUMP NO. 1 RUNNING	VFD-1610	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUNNING	N/A	NO	01-I-602	
230 DI YA	16104	WAGS/WICPUMP NO.1 FAILUT	VED-1610	AGS SUPPLIER PLC			N/A	MODBUS TCP/IP	NORMAI	N/A	NO	01-1-602	
230 DI TA	1610R		VED 1610				N/A			N/A	NO	01-1-002	
	1610		VED 1610				N/A				NO	01-1-002	
	1610	WAGSWELC FOMP NO. THIGH MOTOR TEMPERATORE	VED 1610				N/A			N/A	NO	01-1-002	
233 DI PAN	1010	WAGSWUC PUWP NO. 1 NG DISCHARGE PRESSURE	VFD-1010				N/A			N/A	NO	01-1-002	
234 DI 11	1620	WAGSWALC PUMP NO. 2 IN AUTO	VFD-1620		N/A N/A		N/A	MODBUS TCP/IP		N/A	NO	01-1-002	
235 DI 11R	1620	WAGSWILL PUMPING 2 KUNNING	VFD-1620	AGS SUPPLIER PLC	N/A N/A		N/A		RUNNING	N/A	NU	01-1-002	
236 DI YA	1620A	WAGSWER POMPINO. 2 FAULI	VFD-1620	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-1-602	
237 DI YA	1620B	WAGS/WLC PUMP NO. 2 LEAK DE LECTED	VFD-1620	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-I-602	
238 DI TAH	1620	WAGS/WLC PUMP NO. 2 HIGH MOTOR TEMPERATURE	VFD-1620	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-I-602	
239 DI PAH	1620	WAGS/WLC PUMP NO. 2 HIGH DISCHARGE PRESSURE	VFD-1620	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-I-602	
240 DI YI	1630	WAGS/WLC PUMP NO. 3 IN AUTO	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN AUTO	N/A	NO	01-I-602	
241 DI YIR	1630	WAGS/WLC PUMP NO. 3 RUNNING	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUNNING	N/A	NO	01-I-602	
242 DI YA	1630A	WAGS/WLC PUMP NO. 3 FAULT	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-I-602	
243 DI YA	1630B	WAGS/WLC PUMP NO. 3 LEAK DETECTED	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-I-602	
244 DI TAH	1630	WAGS/WLC PUMP NO. 3 HIGH MOTOR TEMPERATURE	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-I-602	
245 DI PAH	1630	WAGS/WLC PUMP NO. 3 HIGH DISCHARGE PRESSURE	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	01-I-602	
246 DI YI	1510	AGS BLOWER NO. 1 IN REMOTE	LCP-1510	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN REMOTE	N/A	NO	02-I-601	
247 DI YIR	1510	AGS BLOWER NO. 1 RUNNING	LCP-1510	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUNNING	N/A	NO	02-I-601	
248 DI TAH	1510	AGS BLOWER NO. 1 HIGH MOTOR TEMPERATURE	LCP-1510	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-1-601	
249 DI YA	1510	AGS BLOWER NO. 1 FAULT	LCP-1510	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
250 DI TAH	1511	AGS BLOWER NO. 1 HIGH ENCLOSURE TEMPERATURE	LCP-1510	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
251 DI YI	1520	AGS BLOWER NO. 2 IN REMOTE	LCP-1520	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN REMOTE	N/A	NO	02-I-601	
252 DI YIR	1520	AGS BLOWER NO. 2 RUNNING	LCP-1520	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUNNING	N/A	NO	02-I-601	
253 DI TAH	1520	AGS BLOWER NO. 2 HIGH MOTOR TEMPERATURE	LCP-1520	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
254 DI YA	1520	AGS BLOWER NO. 2 FAULT	LCP-1520	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
255 DI TAH	1521	AGS BLOWER NO. 2 HIGH ENCLOSURE TEMPERATURE	LCP-1520	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
256 DI YI	1530	AGS BLOWER NO. 3 IN REMOTE	LCP-1530	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	IN REMOTE	N/A	NO	02-I-601	
257 DI YIR	1530	AGS BLOWER NO. 3 RUNNING	LCP-1530	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUNNING	N/A	NO	02-I-601	
258 DI TAH	1530	AGS BLOWER NO. 3 HIGH MOTOR TEMPERATURE	LCP-1530	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
259 DI YA	1530	AGS BLOWER NO. 3 FAULT	LCP-1530	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
260 DI TAH	1531	AGS BLOWER NO. 3 HIGH ENCLOSURE TEMPERATURE	LCP-1530	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	NORMAL	N/A	NO	02-I-601	
261 DO UCR	1610	WAGS/WLC PUMP NO. 1 RUN COMMAND	VFD-1610	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUN CMD	N/A	NO	01-I-602	
262 DO UCS	1610	WAGS/WLC PUMP NO. 1 STOP COMMAND	VFD-1610	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	STOP CMD	N/A	NO	01-I-602	
263 DO UCR	1620	WAGS/WLC PUMP NO. 2 RUN COMMAND	VFD-1620	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUN CMD	N/A	NO	01-I-602	
264 DO UCS	1620	WAGS/WLC PUMP NO. 2 STOP COMMAND	VFD-1620	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	STOP CMD	N/A	NO	01-I-602	
265 DO UCR	1630	WAGS/WLC PUMP NO. 3 RUN COMMAND	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUN CMD	N/A	NO	01-I-602	
266 DO UCS	1630	WAGS/WLC PUMP NO. 3 STOP COMMAND	VFD-1630	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	STOP CMD	N/A	NO	01-I-602	
267 DO UCR	1510	AGS BLOWER NO. 1 RUN COMMAND	LCP-1510	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUN CMD	N/A	NO	02-I-601	
268 DO UCR	1520	AGS BLOWER NO. 2 RUN COMMAND	LCP-1520	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUN CMD	N/A	NO	02-I-601	
269 DO UCR	1530	AGS BLOWER NO. 3 RUN COMMAND	LCP-1530	AGS SUPPLIER PLC	N/A N/A		N/A	MODBUS TCP/IP	RUN CMD	N/A	NO	02-I-601	

SECTION 40 66 11 - NETWORK SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

- A. The Network Systems section covers the furnishing of all hardware and software for network systems for the Instrumentation and Control System. Principal components of the network systems shall be as indicated on the block diagram Drawings and as described below.
- B. AGS System Supplier shall furnish all necessary equipment, interconnecting cables, accessories, and appurtenances for proper network operation and to meet the functional requirements indicated on the Drawings and specified herein. Configuration of all hardware shall be provided by the AGS System Supplier.
- C. Equipment and services provided under the Network section shall be subject to the general requirements specified in the Instrumentation and Control System section. Supplementing this section, network data, special requirements, and options may be indicated on the Drawings.
- D. Control System
 - 1. The Instrumentation and Control System section shall apply to all systems described herein. All applicable requirements specified in the Instrumentation and Control System section shall apply to equipment and services provided herein.
- E. Network Functional Description
 - 1. The network system shall provide communications between the operator workstations, servers, PLCs, and OITs.
- 1.2 GENERAL
 - A. AGS System Supplier shall select the equipment for its superior quality and the intended performance. The AGS System Supplier shall install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the following requirements.
 - B. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
 - C. Drawings
 - 1. Supplementing this section, the Drawings indicate locations and arrangement of hardware and enclosures, provide mounting details, and may show other information regarding the connection and interaction with other equipment.

- D. Governing Standards
 - 1. Governing Standards for network systems shall be as specified in the Instrumentation and Control System section.
- E. Power and Instrument Signals
 - 1. Unless otherwise specified, electric power supply to the network equipment will be unregulated 24 volts dc or 120 volts ac.
- F. Appurtenances
 - 1. Special power supplies, special cable, special grounding, and isolation devices shall be furnished for proper performance of the equipment.
- G. Interchangeability and Appearance
 - 1. To the extent possible, components used for similar types of functions and services shall be the same brand and model line. Similar components of different network hardware shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.
- H. Programming Devices
 - 1. A programming or system-configuring device, or software required for programming, shall be provided for systems that contain any equipment that requires such a device or software for routine maintenance and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup. Programming software shall be licensed to the Owner.

1.3 SUBMITTALS

- A. See Section 40 61 11 Instrumentation and Control System
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.
- B. Network Design submittal (to be provided with the First Stage Submittals):



A complete network topology diagram, detailing all hardware, cabling, and the interconnections between all connected equipment. Interconnections to existing installed equipment and Owner-furnished equipment shall be included in the diagram.

- 2. A complete listing of IP addresses to be assigned to all equipment furnished under this contract shall be provided. The assignment of IP addresses shall be coordinated with the Owner.
- C. O&M Manuals.
 - 1. All above documentation shall also be provided in the O&M manuals.

1.4 DELIVERY, SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

1.5 CONNECTION TO OWNER NETWORKS

- A. Network hardware and software provided shall be compatible with the Owner's existing network systems wherever a system interconnection is provided. AGS System Supplier shall verify existing systems to ensure compatibility.
- B. All connections to the Owner's existing network shall be fully coordinated between the Owner and the AGS System Supplier. Prior to connecting to the existing network, the AGS System Supplier shall provide a written request to the Owner for an Owner's representative to be available when existing systems are disconnected and at the time of any new connections.

1.6 COORDINATION WITH OWNER

A. The AGS System Supplier shall coordinate all demolitions, installations, and rework on the existing networks with the Owner and the Engineer. No work shall be performed without the written consent of the Owner. The AGS System Supplier shall submit a written request to perform work on the existing network, including date, time, scope of work, length of time, and any Owner's support that may be required.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum Ethernet network device stipulations.

2.2 NETWORK CABLING SPECIFICATIONS

- A. Individual network equipment and related devices shall be coordinated with items provided in the following sections:
 - 40 66 33 Metallic and Fiber Optic Communication Cable and Connectors

2.3 ETHERNET NETWORK HARDWARE

A. Ethernet network hardware shall be provided as specified and/or as shown on the Drawings. All specified functionality of provided Ethernet network equipment shall adhere to the IEEE 802 standards. Ethernet Hubs will not be accepted for network systems. Ethernet switches shall be provided to connect multiple network segments together, selectively forwarding traffic between the segments.

- B. Industrial (Panel-Mounted) Ethernet Switches
 - 1. Each switch mounted in process areas shall include the following functionality:
 - a. Ports: Switch shall support the quantity of 10/100BaseTX ports and 100BaseFX fiber ports to meet the functionality indicated on the Drawings, with a minimum of 20% spare auto-negotiating 10/100Base-T, RJ-45 ports, and two multimode fiber uplink ports. A minimum of four UTP ports shall be provided.
 - b. Each switch connection shall automatically sense the network speed of the devices to which it is connected.
 - c. Capable of ring-based media redundancy with 30 ms recovery time.
 - d. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.
 - e. Prioritization: IEEE 802.1p QoS Support.
 - f. Network Segregation: Port VLAN.
 - g. Management: SNMPv3 and Browser-based management shall be supported.
 - h. IGMP snooping supported.
 - i. LED indication of the link activity for each port.
 - j. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 60C. Optional -40 to 60C rating availability.
 - k. Redundant 24 VDC power supply inputs •
 - 1. Conformal coating option for use in hazardous environments.
 - m. Mounting: DIN-rail mounted suitable for panel installation.
 - n. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.
 - 2. Switches shall be Allen Bradley "1783", or approved equal. (AGS System Supplier)
- C. Ethernet Connectors
 - 1. Ethernet wiring connectors shall be RJ-45 male modular plug connectors.
 - 2. Standard RJ45 Connectors
 - a. Standard connectors shall be polycarbonate, clear connectors. Connectors shall conform to RJ-45 and ISO 8877 standards. Contacts shall be gold plated with a 0.5A current rating and a -25° to 60° C temperature rating. Connectors shall accept unshielded Cat-5e or Cat-6, AWG 24, solid conductor cable.

2.4 PROTOCOL GATEWAYS

Protocol gateways shall be supplied to convert communications to the Owner's standard communication protocol or other protocols as noted on the Drawings. Gateways shall be provided with the following functionality:

- 1. Environmental: Suitable for installation in industrial environments with an operating temperature range of 15° to 140°F.
- 2. 24 VDC Power Supply Input
- 3. Management: SNMPv3 and browser-based management shall be supported.

- 4. Convert EtherNet/IP communications to Modbus TCP/IP.
- 5. Protocol converters shall be manufactured by Prosoft, Moxa, or equal.

2.5 SPARE PARTS

A. Not used.

PART 3 - EXECUTION

3.1 NETWORK INSTALLATION REQUIREMENTS

A. Additional network installation requirements are specified in the Instrumentation and Control System section. Networks shall be installed and tested in accordance with the following requirements.

3.2 NETWORK CONFIGURATION

- A. The AGS System Supplier shall fully configure all network devices. All device selections shall be fully coordinated with the Owner to ensure compatibility with existing systems and standards.
- B. Ethernet Switches
 - 1. The AGS System Supplier shall fully configure all Ethernet switches. The following shall be configured:
 - a. Unused ports shall be disabled for security purposes.
 - b. Spanning Tree or other appropriate redundancy scheme shall be configured for all redundant links. Trunking or other bandwidth sharing redundancy schemes shall be utilized where available to minimize switching times and increase available bandwidth.
 - c. Management Password Security
 - d. Quality of Service, with any traffic to/from PLCs getting priority over all other traffic.

C. Network Configuration Report

- The AGS System Supplier shall provide a configuration report to the Owner detailing all connections, addresses, and port assignments
- D. Management Software
 - 1. Management software shall be fully configured for all network devices provided.

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3.3 NETWORK TESTING

- A. After each network has been installed, a technical representative of AGS System Supplier shall test the network and shall provide a written report for each test.
- B. Field Testing
 - 1. After each network has been installed, a technical representative of AGS System Supplier shall test the network and shall provide a written report for each test. Specific testing requirements are described in the individual network specification sections.
- C. Systems Check
 - 1. A technical representative of AGS System Supplier shall participate in the checkout of network systems. Systems check requirements shall be as specified in the Instrumentation and Control System section.
- D. Test Equipment
 - 1. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by AGS System Supplier for the duration of the testing work and this test equipment will remain the property of AGS System Supplier.
 - 2. Ethernet Network Minimum Test Requirements
 - a. The following minimum tests are to be performed by the AGS System Supplier:
 - 1) Verify Link Integrity Status LED is lit on both sides of each link
 - 2) Verify proper operation and failover of each redundant component and redundant link.
 - 3) Verify alarming of each link failure.
 - 4) Verify bandwidth Usage
 - 3. Ethernet Network Test Reports
 - a. Upon completion and testing of the installed Ethernet network, the AGS System Supplier shall submit test reports to the Engineer in printed form. Test reports are to show all test results performed by the AGS System Supplier for each port and piece of equipment. Date of calibration of the test equipment is also to be provided.

3.4 NETWORK TROUBLESHOOTING

A. It is the AGS System Supplier's responsibility to provide trouble-free and reliable networks. The AGS System Supplier shall employ any means necessary to ensure operational networks. The AGS System Supplier shall obtain any needed test equipment, including but not limited to time-domain reflectometers, protocol analyzers and network sniffers, to troubleshoot any problems. The AGS System Supplier shall utilize the services of a trained and certified Network Engineer that is regularly involved in troubleshooting network problems, in the event that operational or reliability problems exist. Acceptable certifications include Cisco CCNP, Cisco CCIE, or Network Professional Association Certified Network Professional (CNP). End of Section

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SECTION 40 66 33 - METALLIC AND FIBER OPTIC COMMUNICATION CABLE AND CONNECTORS

PART 1 - GENERAL

1.1 SCOPE

- A. The Metallic and Fiber Optic Communications Cable and Connectors section covers the furnishing and installation of cable systems to provide communications for the Instrumentation and Control System as indicated on the Drawings.
- B. Accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.
- C. Equipment and services provided under this section shall be subject to the General Computer Control System Requirements specified in the Instrumentation and Control System Section and the Network Systems section. Supplementing the Metallic and Fiber Optic Communications Cable and Connectors section, network data, special requirements, and options are indicated on the Drawings.

1.2 SUBMITTALS

- A. See Section Instrumentation and Control System section.
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.
- B. Qualifications
 - 1. The name, address and telephone number of the proposed contractor or subcontractor, including specific personnel to perform the work shall be included with the submittals. Provide the experience record of the subcontractor and personnel in performing work similar to that specified. Include the agency, contact person, and telephone number of at least three (3) previous network installation projects completed by the proposed subcontractor. The Engineer shall review and approve the network installation subcontractor and personnel prior to any of the related work being performed. This review will be conducted during the project submittal phase, as described below.

Drawings and Data

- 1. All material and equipment documentation shall be submitted for review in accordance with the Submittals section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment.
- 2. Product data shall include the following in the Submittals section:
 - a. Cut sheets and catalog literature for proposed fiber optic cable, and fiber optic cable accessories (pigtails, connectors, etc.)

- b. Manufacturer specifications and data that clearly shows that the fiber optic cable meets all requirement specified herein.
- c. Sample of the proposed cable.
- d. Physical dimension drawings of all fiber optic accessories.
- e. Proposed fiber identification sequence and labeling.
- f. Provide off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.
- g. Provide a Recommended Spare Parts List (RSPL).
- h. Provide a list of recommended special tools for fiber installation testing or maintenance.
- D. Operations and Maintenance Manuals
 - 1. Operation and Maintenance Manuals shall have the following items included in addition to those items specified in other sections:
 - a. Description of all components.
 - b. Methods of connection.
 - c. Connection diagram.
 - d. OTDR trace plots for all fibers.

1.3 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section.

1.4 QUALIFICATIONS

A. Due to the specialized nature of installing, splicing, terminating, and testing optical fiber cable, the Contractor shall utilize personnel who are experienced in such practices. The installing Contractor or Subcontractor shall have performed similar installation and testing work on at least three projects of similar size and complexity. The personnel assigned to the installation and testing shall also have experience on at least three projects of similar size and complexity.

PART 2 - PRODUCTS

2.1 GENERAL

A. All fiber optic cable, fiber optic hardware and accessories shall be designed, assembled and connected in accordance with the requirements of these Specifications and the Drawings.

2.2 ETHERNET UNSHIELDED TWISTED PAIR (UTP) CABLE

A. Ethernet cables and connectors shall be provided for a complete and working system, and/or as shown on the Drawings. Cable for Ethernet wiring shall be UTP Cat-6 cable. Jacket color coding for cables shall be as follows:

Four Rivers Sanitation Authority40 66 33 - 2Rockford, ILAerobic Granular Sludge - Phase I
- 1. Standard Cat-6 Yellow
- 2. Crossover cables Red
- B. Category 6 UTP Cable
 - 1. Cat-6 cable shall meet the following requirements:
 - a. 24 AWG
 - b. 4 pair solid strand FEP Teflon insulation
 - c. 100 Ohm impedance
 - d. 1-250 MHz frequency range
 - e. Min attenuation 19.9 Db
 - f. 100 Ohm impedance
 - g. Min NEXT 44.3dB/100MHz
 - h. Min PS-NEXT 42.3dB/100MHz
 - i. Min ELFEXT 27.8dB/100MHz
 - j. Min PS-ELFEXT 24.8dB/100MHz
 - k. Min return loss 20.1 dB/100 MHz
 - 1. Max delay skew 45 ns
 - m. Max propagation delay 540 ns
 - 2. Plenum rated cable shall have FEP insulation jacketing and FEP insulation for conductors. Non plenum rated cable shall have PVC insulation jacketing and polyethylene insulation for conductors. Cat-6 cable shall be Belden 1872 or equal. (System Supplier)

C. Ethernet Patch Cables

1. Pre-wired and terminated patch cables with RJ-45 connectors and lever protecting boot shall be furnished for all connections to computers, network equipment, and controller equipment except where physical conditions (i.e. length over 12 ft. or conduit size) require unterminated wire to be installed. Patch cables shall be Cat-6 and shall meet the requirements of Cat-6 cable specified in this section. Straight through cables shall be wired using the T568-B standard for both connectors as shown in section 3 (Ethernet Cable Installation). Crossover cables shall be wired using the T568-B standard for the opposite end.

2.3 FIBER OPTIC CABLE

The fiber optic cable must meet all of the requirements of the following paragraphs.

- 1. The fiber optic cable must meet the following requirements of the National Electrical Code (NEC) Section 770.
- 2. Riser Applications Applicable Flame Test UL 1666.
- 3. Finished cables shall conform to the applicable performance requirements of Table 8-6 and 8-7 in the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Fiber Optic Premises Distribution Cable (ICEA S-83-596).

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- 4. Every fiber in the cable must be usable and meet required specifications.
- 5. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
- 6. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.
- 7. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.
- 8. All optical fibers shall be 100 percent attenuation tested. The attenuation shall be measured at 850 nm, and 1300 nm for multimode fibers. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of 5 years. These values shall be available upon request.
- 9. The storage temperature range for the cable on the original shipping reel shall be -40°C to +70°C. The operating temperature range shall be -40°C to +70°C. Testing shall be in accordance with FOTP-3.
- 10. The attenuation specification shall be a maximum attenuation for each fiber at $23 \pm 5^{\circ}$ C.
- 11. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB at 850 nm/1300 nm (multimode) in any one kilometer length of fiber.
- 12. Required Fiber Grade: Maximum Fiber Attenuation at 850 nm shall be 3.5 dB/km.
- 13. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm.
- 14. The cable shall contain 24 fibers. Each buffer tube shall contain up to 12 fibers.
- 15. The fibers shall not adhere to the inside of the buffer tube.
- 16. Each fiber shall be distinguishable from others by means of color coding in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding."
- 17. The fibers shall be colored with ultraviolet (UV) curable inks.
 - Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding."
- 19. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.
- 20. The buffer tubes shall be resistant to kinking.
- 21. The cable jacket color shall be black.

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- 22. Fibers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fibers shall be placed so that they do not interrupt the consecutive positions of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 3.0 nm in outer diameter.
- 23. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
- 24. The outer cable jacket shall be marked with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet (e.g. "62.5/125 MICRON TYPE OFNR (UL) 00001 Feet"). The print color shall be white.
- 25. The cable shall be all-dielectric.
- 26. The cable shall be gel-free.
- 27. Flammability All cables shall comply with the requirements of the 1996 NEC Article 770. All cables shall pass UL 1666.
- B. Fiber optic cable shall be as manufactured by Corning Cable Systems, Belden, Commscope, TE Connectivity, or equal. (System Supplier)
- C. Singlemode Fiber
 - 1. Singlemode fiber optic cable shall meet the following requirements:
 - a. The dispersion unshifted single-mode fiber utilized in the cable specified herein shall conform to the specifications herein.
 - b. Cladding Diameter: $125.0 + 1.0 \,\mu\text{m}$.
 - c. Core-to-Cladding Offset: < 0.8 µm.
 - d. Cladding Non-Circuladty: < 1.0%.
 - e. Coating Diameter: $245 \pm 10 \ \mu m$.
 - f. Colored Fiber Diameter: nominal 900 μm.
 - g. Attenuation Uniformity: No point discontinuity greater than 0. 1 0 dB at either 1310 nm or 1550 nm.
 - Attenuation at the Water Peak: The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km.
 - i. Cutoff Wavelength: The cabled fiber cutoff wavelength(λccf ,) shall be < 1260 nm.
 - j. Mode-Field Diameter: 9.30 \pm 0.50 µm at 1310 nm 10.50 \pm 1.00 micrometers at 1550 nm.
 - k. Zero Dispersion Wavelength (λo): 1301.5 nm < λo < 1321.5 nm.
 - 1. Zero Dispersion Slope (So): $< 0.092 \text{ ps/(nm^2 *km)}.$
 - m. Fiber Polarization Mode Dispersion (PMD): < 0.5 ps/(sq. km)

h.

- D. Fiber optic cable connectors
 - 1. All optical fibers shall be terminated with connectors that are type ST for multimode cable and type SC for singlemode cable.
 - 2. Epoxy Connectors
 - a. Epoxy connectors shall be provided to terminate each fiber in the cable. Connector style, ST, SC, or other, shall be coordinated with the patch panels and field devices that will interface directly with the cable. Connectors shall be compatible with the supplied cable. Connector loss shall be no greater than 0.3 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each termination. Connectors shall be Corning Cable Systems Connectors, or equal. (System Supplier)
 - 3. Fiber Optic Jumper Cables
 - a. Singlemode fiber optic jumper cables shall be furnished and installed for equipment interfacing and between termination cabinets. (System Supplier)

2.4 INDUSTRIAL COMMUNICATIONS CABLING

- A. Industrial communications cable shall be provided for bus networks.
- B. Modbus RTU Cabling
 - 1. Modbus RTU shall

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The System Supplier shall be responsible for the coordination of the installation of all cable furnished hereunder. The System Supplier shall be responsible for the termination of all cable furnished hereunder.
- B. Cable Damage
 - If the cable becomes damaged during installation, the Contractor shall stop work and notify the Engineer immediately. The Owner and Engineer will decide whether to replace the entire reel of cable or to install a splice at the damaged section. If the Owner decides to replace the entire reel of cable, the Contractor shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the Owner. Installation of new cable to replace damaged cable shall not be a basis of extra payment or contract completion time. In addition to installation of the new cable, the Contractor shall reimburse the Owner for the entire cost of the replacement reel of cable. This cost will be withheld from the contract price. If the Owner decides to install a splice at the damaged point, and the cable is damaged a second

time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at the Contractor's expense.

- C. Ethernet Cable Installation
 - 1. Straight through cables shall be wired using the latest version of T568 standard for both connectors as shown in the table below (connector pin numbers are left to right with the clip down). Crossover cables shall be wired using the T568A standard for one connector and the T568B standard for the opposite end as shown in the table below.

Connector Pin	568A Wiring Conductor	568B Wiring Conductor	505
1 2	White/Green Green	White/Orange Orange	2
3 6	White/Orange Orange	White/Green Green	
4 5	Blue White/Blue	Blue White/Blue	
7 8	White/Brown Brown	White/Brown Brown	

2. Shielded Cat-6 cabling shall be grounded on only one end of the cable.

D. Fiber Optic Cable Installation

- 1. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification. Fiber optic cable installation shall meet the following requirements:
 - a. All fiber optic cable shall be installed, terminated, and tested by the System Supplier or his fiber subcontractor as specified above.
 - b. In pulling the cable, strain-release, or other tension limiting devices shall be used to limit the pull tension to less than 600 lbs.
 - Minimum bend radius restrictions shall be satisfied both during and after cable installation.
 - d. Horizontal, unsupported cable runs shall be supported at continuous distances of 5 feet or less.
 - e. All conduit and cabinet entrances shall be sealed with RTV or other re-enterable sealant material to prevent ingress of water, dust or other foreign materials.
 - f. Cable routing within occupied office areas shall conform to Federal, State, and local electrical and fire codes.
 - g. Any non-terminating (field) splices shall be documented as to the physical location and cable meter mark (prior to stripping). Field splices shall be OTDR-tested and documented prior to final cable acceptance testing.

h. Fiber optic cables shall be installed in accordance with the latest version of NECA 301, Installing And Testing Fiber Optic Cables.

3.2 CABLE TESTING

- A. After the network cabling has been installed, each network cable shall be tested.
- B. Test Equipment
 - 1. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.
- C. Ethernet UTP Cable Testing
 - 1. The System Supplier shall utilize the previously specified test equipment, and additional tools as needed to validate the Ethernet UTP cable installation. All test equipment shall bear current calibration certification from a certified calibration laboratory, as appropriate. Each cable shall be tested for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs. A check off sheet shall be utilized, shall be signed by the technician testing the cables, and shall be submitted for approval. Any identified faults shall be corrected at no additional cost.
- D. Fiber Optic Cable Testing
 - 1. Acceptance testing of the data highway (fiber and electronic equipment) shall be conducted as a part of integrated system field testing, as specified elsewhere. Prior to such tests, however, the fiber optic cable shall be tested as specified herein.
 - 2. The System Supplier, or his fiber subcontractor, shall conduct fiber optic cable testing as specified below. All testing following field installation shall be witnessed by the Engineer. The Contractor shall bear the cost for field witnessed testing in accordance with the General Equipment Stipulations section. A test plan shall be submitted prior to the proposed test dates. The test plan and procedures shall be mutually agreed to prior to conducting the tests.
 - 3. Each optical fiber of each fiber optic cable shall be OTDR (Optical Time Domain Reflectometer) tested on the reel at the factory, on the reel upon arrival at the jobsite, and after installation and termination. For each fiber, an OTDR (Optical Time Domain Reflectometer) trace soft/hardcopy is required to be provided to the Owner and Engineer. OTDR traces shall be provided for each test (at the factory, on the reel at the job-site, and after installation). A 100 foot launch cable shall be spliced to each fiber for each fiber OTDR test, to ensure accurate results. This end-to-end trace shall be performed from BOTH ends of the fiber. Also for each fiber, an end-to-end power attenuation (insertion loss) test shall be performed. The attenuation test shall use a stabilized optical source and an optical power meter calibrated to the appropriate operating wavelength (1300 nm).
 - 4. For each installed fiber, the power attenuation shall not exceed the following, tested from connector to connector at the respective patch panels:

- a. (0.0035)L + (0.25)N + 3.0 dB
 - 1) Where L = The length of the fiber optic cable in meters and
 - 2) N = the number of splices in the fiber.
- 5. Any fiber optic cables containing one or more fibers not meeting this performance will not be accepted by the Owner, and shall be repaired or replaced at no additional cost.
- 6. Each fiber optic jumper cable shall be tested and must exhibit an end-to-end attenuation of less than 2.0 dB at 1300 nm. Any jumper exceeding this level shall be replaced at no additional cost to the owner. Any damaged cable still on the reel shall be returned to the manufacturer for replacement at no additional cost to the Owner.
- 7. All fiber cable testing shall be documented on pre-approved test forms. Three (3) copies of all documentation (including OTDR traces) shall be submitted to the Engineer upon successful completion of the testing.

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SECTION 40 67 11 - PANELS, CONSOLES, AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

- A. The Panels, Consoles and Appurtenances section covers the furnishing of panels, consoles, and appurtenances as indicated on the Drawings and listed in the attached Equipment Schedules 40 67 11-S01 and 40 67 11-S02.
- B. This section also describes requirements for panels furnished under other sections whose respective specification refers to this section. Panels furnished under other sections are not listed in the attached Equipment Schedules.
- C. Control System
 - 1. The Instrumentation and Control System section shall apply to all equipment furnished under the Panels, Consoles and Appurtenances section.

1.2 GENERAL

- 1. Equipment furnished and installed under this section shall be fabricated and assembled in full conformity with the Drawings, specifications, equipment schedules, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- B. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- C. Seismic Design Requirements
 - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- D. Drawings
 - 1. General dimensions and arrangements are indicated on the Drawings and on the attached equipment schedules. AGS System Supplier and System Supplier shall be responsible for coordinating the console and enclosure sizes and arrangements to accommodate the equipment provided.

1.3 SUBMITTALS

A. See Section 40 61 11 – Instrumentation and Control System

- 1. Submittals shall be as specified in the Instrumentation and Control System section.
- B. Meterolical and Seismic Compliance
 - 1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 DELIVERY, STORAGE, AND SHIPPING

A. Delivery, storage and shipping shall be as per the Instrumentation and Control System section.

PART 2 - PRODUCTS.

2.1 PANEL DESIGN AND FABRICATION FEATURES

- A. All panels furnished shall conform to the stipulations of NEMA ICS-6-1993 (R2001, R2006). Unless indicated otherwise on the Drawings, the following paragraphs describe general fabrication specifications for the PLC cabinets, instrument panels, consoles, enclosures, and subpanels.
- B. Power Entrance
 - 1. The power entrance to each panel shall be provided with a surge protection device. Refer to the Instrumentation and Controls section for surge suppression requirements.
- C. Power Wiring
 - 1. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 14 AWG. Wiring for ac power distribution, dc power distribution, intrinsically safe, and control circuits shall have different colors and shall agree with the color-coding legend on AGS System Supplier's panel wiring diagrams. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame retardant covering rated for not less than 90°C.
- D. Instrument and Control Wiring



All internal panel wiring shall be type MTW stranded copper wiring rated not less than 600 volts. Electronic analog circuits shall be twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Intrinsically safe circuits shall be physically separated from other circuits in accordance with applicable codes. Wires within the panel shall conform to the minimum size as shown in the table below.

<u>Type</u>	Minimum Wire Size	<u>Color</u>
AC Control	16 AWG	Red

DC Control	16 AWG	Blue
Analog Circuits	18 AWG Twisted Pair	Black / Red

2. All wiring shall be grouped or cabled and firmly supported inside the panel. Each individual wire in power, control, and instrumentation circuits shall be provided with identification markers at each point of termination. The wire markers shall be positioned to be readily visible for inspection and the identification numbers shall match the identification on the supplier's panel wiring drawings. Wiring shall be bundled in groups and bound with nylon cable ties or routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and with space equal to at least 40 percent of the depth of the duct remaining available for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

E. Terminal Blocks

- 1. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
- F. Backup Power
 - 1. Power supply to the panels shall be from electrical sources shown on the Drawings, which may be backed by redundant utility feeds, engine generators, or externally mounted uninterruptible power supplies (UPSs) specified in other sections.
 - 2. Where indicated in the attached equipment schedules, on the Drawings or in the referring equipment specifications, free-standing vertical panels and wall cabinets shall each be provided with an interior-mounted UPS to provide backup power to critical loads upon loss of power supply to the panel. UPS-backed power shall be provided to the programmable logic controller CPU, instrument loops, I/O modules (operating and wetting voltages), all network communications devices, and any other load essential to preventing loss of control system function. Backup power for panel interior lights, heaters, and convenience receptacles is not required. UPSs for free-standing vertical panels and wall cabinets shall meet the requirements specified below.
 - 3. UPS for Free-Standing Vertical Panels and Wall Cabinets
 - a. Each UPS shall accept incoming 120 volts ac, 60Hz, single-phase utility power, apply surge protection, and supply power to the connected loads. The UPS shall be a double-conversion ("on-line") type to provide a breakless transfer to backup power. In the event of incoming power failure, the UPS shall provide 120 volts ac, 60 Hz, single-phase power to its connected loads by inverting power stored within integral storage batteries. The UPS shall be contained inside the enclosure and

supported by a dedicated shelf attached to the backplane or sidewall. The shelf shall be between 12 and 18 inches from the bottom of the enclosure and shall not be directly above any electronic or electromechanical devices.

- b. The UPS shall have at least two integral NEMA 5-15R receptacles for connection of battery-backed loads. Upon restoration of incoming power, the UPS shall recharge the batteries and return its connected loads to the incoming power source. The factory-installed line cord and plug shall not be altered. The UPS output shall be connected by plug and line cord to terminal blocks as necessary to distribute power to loads not having a power cord and plug; all other loads shall be connected directly to the UPS's integral receptacles or to permanently installed receptacles fed from the UPS output.
- c. The UPS shall maintain a temperature-compensated, float charge voltage on the batteries when utility power is available. Overcurrent protection when utility power is available shall be from a circuit breaker internal to the UPS. The UPS shall be intrinsically current-limiting when the unit is on battery.
- d. The UPS shall meet the following requirements.

Capacity, minimum	1000 VA / 700 watts
Filtering and surge protection (on utility power)	Meets IEEE/ANSI C62.41 Category B (IEEE 587)
Voltage, output (on battery)	120 volts \pm 3 percent
Voltage, output (on-line)	Nominal <u>+</u> 3 percent
Frequency and waveform, output (on battery)	60 ± 0.3 Hz, true sine-wave
Efficiency, minimum (on-line)	90 percent
Operating environment	0 to 40° C, 0 to 95 percent relative humidity, non-condensing
Backup time, minimum at half of rated	10 minutes
load Recharge time, maximum to 90 percent of full charge	12 hours

- The UPS shall have spare capacity of at least 30 percent based on actual connected loads. The AGS System Supplier shall advise the Engineer if the UPS capacity needs to be higher than specified above to meet this requirement.
 - The UPS shall have a visual status indicator for low (or faulty) battery and incoming ac power failure. The UPS shall emit an audible signal when the UPS is operating on battery power. A relay shall be installed within the panel and its coil connected across the UPS input power as a means of providing a contact for remote indication of a power failure condition.
- g. The UPS shall be furnished with an Ethernet network card with RJ-45 connector for communicating status and alarm conditions to the Instrumentation and Control System HMI. Communication shall be via 10/100-BaseT Ethernet and shall use HTTP, SMTP, SNMP, Modbus TCP, or other protocol as necessary to transfer the information into the HMI database for display and alarming. Special software or drivers necessary to complete the communications link shall be furnished with the UPS systems. One copy of any special software or drivers necessary to allow

monitoring over the network shall be provided for all UPSs furnished under this section.

- h. Batteries shall be sealed maintenance-free, gelled electrolyte lead-acid, or valveregulated, maintenance-free, lead-acid. Flooded-electrolyte type batteries will not be acceptable.
- i. The UPS shall be APC "Smart-UPS," Vertiv/Liebert "GXT4," Toshiba "1000 Series," or equal. (AGS System Supplier)
- G. Device Tag Numbering System
 - 1. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the Instrument Device Schedule and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered labels or tape labels will not be permitted.
 - a. Nameplates
 - 1) Nameplates shall be provided on the face of the panel or on the individual device. Panel nameplates shall have legends and approximate dimensions as indicated on the Drawings and shall be made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified under the Device Tag Numbering System paragraph.
 - b. Indicating Light Color Designations
 - 1) Indicating lights are specified in the Panel Mounted Instruments section. Indicating lights shall be colored as shown in the following table unless indicated otherwise on the Drawings, in other specification sections, or in the instrument device schedule.

	<u>Color</u>	Meaning
\sim	Red	Associated equipment or device is "running," "open," or is in an "unsafe" state or position
xO	Green	Associated equipment or device is "stopped," "closed," or is in a "safe" state or position
ð	Amber	Associated equipment or device has "failed" or a process alarm condition is present or imminent.
	White	All other conditions not defined above.
р.	.	

- c. Painting 1) In
 - Interior and exterior surfaces of all carbon-steel panels shall be thoroughly cleaned and painted with rust inhibitive (universal) primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils. Color shall be ANSI 61 Gray. One quart of touch-up paint shall be furnished with the panels.

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- d. Panel-Mounted Instruments
 - Instruments, power supplies, pilot devices, and appurtenances mounted 1) within or on the face of the panel shall meet the requirements specified in Section 40 78 00, Panel Mounted Instruments, for those items unless noted otherwise herein, on the Drawings or, if applicable, within the referring equipment specification section.
- Factory Test e.
 - Panels shall be factory tested electrically and pneumatically by the panel 1) fabricator before shipment. p05%

2.2 FREESTANDING VERTICAL PANELS

- The following paragraphs specify the freestanding vertical panels: Α.
 - 1. Construction
 - Panel construction shall be an indoor, dusttight, completely enclosed cubicle formed a. from steel structural members and steel plates. The base shall be formed of steel channels, with flanges extending upwards. The base shall be provided with 1/2 inch diameter holes at 12 inch centers so that the base can be bolted to the concrete equipment base. Welds, seams, and edges on all exposed surfaces shall be ground smooth. Suitable lifting facilities shall be provided for handling and shipment.
 - 2. Structure
 - Panel structure shall be suitably braced and of sufficient strength to support all a. equipment mounted on or within, to withstand handling and shipment, to remain in proper alignment, and to be rigid and freestanding. Top, sides, and back shall be fabricated from USS 10 gage or heavier carbon steel sheets, with stationary back suitable for back to wall installation, or designed for rear access with hinged back doors. Doors shall not be greater than 24 inches wide or spaced not greater than 36 inches center to center. Rear access doors shall be fabricated from USS 14 gage or heavier carbon steel.
 - Panel Front 3.

The front shall be a hinged door, or doors, with mounted instruments and control devices, fabricated from USS 10 gage carbon steel sheet and suitably braced and supported to maintain alignment. Panels with hinged fronts shall be of sufficient width to permit door opening without interference with rear projection of flush mounted instruments.

- 4. Doors
 - Doors shall be essentially full height, having turned back edges and additional a. bracing to ensure rigidity and prevent sagging. Doors shall be mounted with strong, continuous, piano type hinges. Positive latches, acting from a common door handle, shall hold doors securely compressed at top, side, and bottom against rubber gaskets.

- 5. Mounted Instruments
 - a. The front shall be stationary, with mounted instruments and control devices, fabricated from 3/16 inch carbon steel plate. Panel fronts shall be suitably reinforced between mounting cutouts and drilling to support instruments and devices without deformation and shall be free from waves and other imperfections, Panel fronts shall be recessed at the base. Adjoining panel sections shall be accurately shop fitted to assure satisfactory assembly in the field.
 - b. Instrument Arrangement
 - Panel instruments and control devices shall be arranged in a logical configuration for the plant operators. The centerline of recorders shall be within 3 feet and 5'-9" above the base of the panel for convenient reading and chart replacement. Control switches shall be within 6 feet and 2'-6" above the base of the panel. Indicators may be located within 2'-6" and 6'-6" above the base of the panels. Annunciators and clocks may be mounted near the top of the panels.
- 6. Size and Arrangement
 - **a.** Panel dimensions and general instrument arrangement shall be as indicated on the Drawings or in the attached equipment schedules.
- 7. Interior Lighting
 - a. Illumination of panel interiors shall be provided by ceiling mounted lamp fixtures spaced at approximately 2'-6" and near the door. Fixtures shall be nominal 40-watt fluorescent tube type, with a common "On-Off" switch near each end door. Duplex-grounded receptacles shall be provided for service and maintenance tools at spacing not greater than 5 feet throughout the length of a panel. The lighting and receptacle circuit shall be fused separately from the instrumentation systems.

2.3 WALL-MOUNTED CABINETS

- A. Cabinets, which contain the system components indicated on the Drawings, shall be suitable for wall mounting and shall meet the NEMA enclosure rating as indicated on the Drawings or, if applicable, in the attached equipment schedules or the referring equipment specification section. The enclosures shall be fabricated from USS 14 gage, or heavier, carbon steel, stainless steel, or fiberglass. Cabinets shall be equipped with full size gasketed doors with hinges and a chromium-plated or stainless steel three-point latch. The cabinet shall have a hasp for accommodating a padlock. A screened vent shall be provided in the bottom of enclosures that contain pneumatic devices.
- B. Floor stands shall be provided to support cabinets not fastened to a wall or other support. Floor stands shall be full-depth and shall have a minimum height of 12 inches. Floor stand material and finish shall match the cabinet.
- C. All wall-mounted cabinets shall meet the requirements of the panel fabrication paragraph of this section.

2.4 FIBER OPTIC PATCH PANELS

- A. Fiber optic patch panels (also referred to as fiber termination cabinets) shall be furnished to terminate fibers at the fiber optic modules, and any other data highway attached equipment. The cabinets shall meet the following requirements:
 - 1. The patch panels shall be the wall rack mounted type, having provisions for terminating multiple fiber optic cables. Splice trays, strain relief cable attachment points, fiber organizers and bend radius hardware shall be furnished with each termination cabinet.
 - 2. Panel size shall be suited to the number of fibers to be terminated within the cabinet. Bayonet/flanged couplings shall be furnished and mounted for each fiber to be terminated.
 - 3. Fiber terminations shall be spliced to pigtail cables (specified below) having ST connectors. The pigtails shall be terminated in an orderly method.
- B. Fiber optic patch panels shall be OFS Technologies "LGX," Corning Cable Systems "WCH Series," or equal. (System Supplier)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Installation requirements are specified in the Instrumentation and Control System section. In addition, equipment furnished under this section shall conform to the following manufacturing stipulations.
 - 1. Piping
 - a. All tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipment. Flexible polyethylene tubing shall be used to connect devices mounted on hinged doors.
 - 2. Wiring



All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40 percent of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

- 3. More Than One Panel
 - a. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams. The panel

fabricator shall provide such additional circuits as may be indicated on the electrical schematic Drawings.

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FREESTANDING VERTICAL PANELS

1.000	General	
1.010	Specification Section 40 67 11	
2.000	Freestanding Vertical Panels	
2.010	Tag Number/Panel ID	02-CP-001
2.020	NEMA Enclosure Rating	
	12	X
	4	07
	4X	
2.030	Materials of construction	
	Carbon steel	X
	316 Stainless steel	
	Fiberglass polyester	
2.040	Environmental provisions	
	Sunshade and drip shield	O
	Cooling fan	X
	Air conditioner	
2.050	Door Arrangements	
	Hinged rear doors	
	Hinged front door with instruments	Х
	Hinged front door without instruments	
	Fixed front	
	Recessed base	
2.060	Dimensions (min. L x W x H)	112" x 86" 14.5"
2.070	Panel interior-mounted UPS	Х
2.080	Conduit entrance	
	Bottom open	
	Removable top plates	
3.000	Exceptions, Clarifications, and Comments	Provided by AGS System Supplier
3.010	None	

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1.000	General			
1.010	Specification Section 40 67 11			
2.000	Wall Mounted Cabinets			
2.010	Tag Number/Panel ID	LSH-1100 Junction Box	LT-1100 Junction Box	LSH-1200 Junction Box
2.020	NEMA Enclosure Rating			
	12			3
	3R			
	4			
	4X	Х	X	Х
2.030	Materials of construction			
	Carbon steel			
	316 Stainless steel	X	Х	Х
	Fiberglass polyester			
2.040	Environmental provisions	.0.		
	Sun shade	0		
	Cooling fan			
	Air conditioner			
2.050	Dimensions (min. L x W x H)	12" x 12" x 6"	12" x 12" x 6"	12" x 12" x 6"
3.000	Exceptions, Clarifications, and Comments	Provided by System Supplier	Provided by System Supplier	Provided by System Supplier
3.010	Install bellow for submersible pressure sensing level transmitter.		Х	
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WALL-MOUNTED CABINETS

1.000	General			
1.010	Specification Section 40 67 11			
2.000	Wall Mounted Cabinets			
2.010	Tag Number/Panel ID	LT-1200 Junction Box	LSH-1300 Junction Box	LT-1300 Junction Box
2.020	NEMA Enclosure Rating			
	12			S
	3R			
	4			Y
	4X	Х	X	Х
2.030	Materials of construction			
	Carbon steel			
	316 Stainless steel	X	X	Х
	Fiberglass polyester			
2.040	Environmental provisions	.0		
	Sun shade	07		
	Cooling fan			
	Air conditioner			
2.050	Dimensions (min. L x W x H)	12" x 12" x 6"	12" x 12" x 6"	12" x 12" x 6"
3.000	Exceptions, Clarifications, and Comments	Provided by System Supplier	Provided by System Supplier	Provided by System Supplier
3.010	Install bellow for submersible pressure sensing level transmitter.	X		Х
Zotto				

WALL-MOUNTED CABINETS

1.000	General			
1.010	Specification Section 40 67 11			
2.000	Wall Mounted Cabinets			
2.010	Tag Number/Panel ID	LSH-1400 Junction Box	LT-1400 Junction Box	LCP-1600
2.020	NEMA Enclosure Rating			X
	12			3
	3R			
	4			
	4X	Х	X	
2.030	Materials of construction			
	Carbon steel			Х
	316 Stainless steel	X	Х	
	Fiberglass polyester			
2.040	Environmental provisions	.0.		
	Sun shade	0		
	Cooling fan			
	Air conditioner			
2.050	Dimensions (min. L x W x H)	12" x 12" x 6"	12" x 12" x 6"	12" x 12" x 6"
3.000	Exceptions, Clarifications, and Comments	Provided by System Supplier	Provided by System Supplier	Provided by System Supplier
3.010	Install bellow for submersible pressure sensing level transmitter.		Х	
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WALL-MOUNTED CABINETS

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SECTION 40 68 83 - SOFTWARE CONTROL BLOCK DESCRIPTIONS

PART 1 - GENERAL

1.1 SCOPE

- A. This section provides functional descriptions of the PLC and computer software requirements for the Instrumentation and Control System as indicated on the Drawings. These descriptions are intended to provide an overview of the operating concept of the plant process equipment rather than describing in detail every operating feature or interlock. As described in the Scope of the Instrumentation and Control System section, the AGS System Supplier shall provide the configuration of the AGS control system (PLC and OIT) to monitor and control the AGS reactors and WAGS/WLC pumps. This system shall also communicate directly with each blower local control. For the existing HMI application, the Owner will configure the new screens associated with the AGS reactors, blowers, and WAS/WLC pumps as coordinated with the AGS System Supplier. The Owner will also make the necessary programming modifications to the existing Main Pump II PLC that controls the existing Primary Filter Effluent Diversion Structure gate, PFEG-2, to control the flow to the AGS reactors.
- B. Control System
 - 1. The Instrumentation and Control System section shall apply to all systems described in this section.

1.2 SUBMITTALS

- A. See Section 40 61 11 Instrumentation and Control System
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The descriptions are applicable to the software provided by the AGS System Supplier and blower supplier.

PART 3 - EXECUTION

3.1 PLC PROGRAMMING FUNCTIONAL REQUIREMENTS

A. The following paragraphs describe general configuration tasks that are required for the system PLC(s). These tasks shall be programmed in any applicable PLC. Each PLC may have multiple instances of each of these tasks or may have no instances of some or all of these tasks. The

input/output lists (located in these documents as specified in the Instrumentation and Control System section) and detailed equipment control descriptions (included herein) shall be referenced to determine the requirements for each PLC.

- B. The following paragraphs cover functional requirements of the software, which are generic and may or may not be related to any specific control loop.
- C. Available Process Values
 - 1. All PLC-generated process alarm, equipment status, and process variable values shall be available at any operator workstation.
- D. Flow Values
 - 1. Flow values shall be integrated, totalized, and stored in the PLC registers so the values displayed on the HMI computers and on the field processor will be identical.
- E. System Failure
 - 1. Failure of a PLC shall result in safe shutdown of associated process equipment. Interposing relays shall be provided where required to assure that equipment will revert to its fail-safe condition. Failure of any PLC or its communication shall be alarmed on the HMI computer.
- F. HMI Computers
 - 1. The HMI computers shall function as a monitoring system, not as a controller, for the process equipment. The computer shall download set points and other information to the PLCs, and the PLCs shall perform all control algorithms, so a temporary failure of the any HMI computer will not disrupt plant control.
- G. Rack/Module Configuration
 - 1. The rack and module definitions for each PLC, as well as the PLC communications configuration shall be completely configured to allow proper addressing of all field connected I/O points. This shall include configuration of any remote input/output (RIO) racks.
- H. PLC Database Definition
 - 1. The PLC database will include both field I/O points and internally generated points required for programming. All field I/O points and internal programming points shall be fully defined according to database naming conventions approved by Owner. As a minimum, each database point shall be provided with a tag name, engineering unit, alarm parameters, and description.
- I. Analog Scaling
 - 1. Each analog input and output will be appropriately scaled for use in internal PLC programming, monitoring by the HMI computers, or transmission to other PLCs. Requirements for raw count values shall be coordinated with the operator interface software to ensure compatibility.

- J. Equipment Runtimes
 - 1. For each equipment item whose "run" status is monitored by a PLC, an internal equipment runtime shall be accumulated by the respective PLC. The runtime procedure will monitor the status of the equipment "run" contact and, when the equipment is running, increment a software timer that maintains equipment runtime to within a one-minute resolution. The timer shall stop incrementing, but not reset, when the "run" contact indicates that the equipment is not running. The timer value shall increment an hour counter that maintains an integer value representing the equipment run time in hours. The counter value shall be available for display on the HMI computer. A manual reset of the runtime value shall be available at the HMI computers for personnel at the supervisor level and above.
- K. Change-of-State Alarms
 - 1. While equipment is controllable from the PLC ("in remote"), discrete output commands shall be compared to their respective process feedback status signal (where available) to verify proper execution. If the feedback status does not match the most recent output command (after an adjustable 2 to 300 second time delay), an alarm message shall be displayed on the HMI computer and the condition shall be logged as an alarm, requiring operator acknowledgment. The alarm shall remain energized until the proper discrete condition is sensed or until the operator resets the alarm through the HMI computer.
- L. Equipment Availability
 - 1. In general, equipment with PLC control has been provided with a local selector switch that transfers control to the PLC. The PLC shall monitor the position of this switch to determine if the equipment is available for PLC control. If the equipment is not available, the PLC program shall not attempt to implement remote manual or automatic status changes for the equipment. The PLC program may, however, need to implement special routines if equipment unavailability affects a sequence (as described in the detailed equipment descriptions).
- M. Maintained/Momentary Outputs
 - 1. The need for maintained or momentary control outputs shall be determined from the input/output listing and the electrical schematics. In general, equipment with only one control output indicated in the I/O list shall be programmed for a maintained control output. Equipment with two (or more) control outputs shall be programmed for momentary outputs. Provisions shall be made, in either case, to remove the active state (start, open, forward, initiate, etc.) control output when an equipment failure is sensed or when the equipment transitions from available to unavailable (local switch change).

Equipment Mode Changes

1. Unless otherwise indicated in the equipment control descriptions, equipment in automatic mode shall be transitioned to manual mode (and stopped) if the equipment fails or becomes unavailable or if the PLC processor resets.

- O. Manual/Auto Bumpless Transfer
 - 1. Unless otherwise indicated in the equipment control descriptions, equipment changes from automatic to manual control shall be bumpless. Equipment running or stopped in automatic mode shall remain running or stopped when manual mode is selected.

3.2 HMI FUNCTIONAL REQUIREMENTS

- A. The Owner will make all modifications to the existing HMI application as required for this project. In each detailed equipment control description provided later in this section, suggested new HMI screens and control features and HMI screen modifications are provided for the Owner.
- B. Trend Displays
 - 1. Trend displays shall be developed to present real-time and historical process data in an X-Y graph format as suggested by the AGS System Supplier for the AGS reactor variables and blower variables. In addition, a trend screen is suggested for the WAGS/WLC wetwell and pumps.
- C. Alarms
 - 1. Alarm signals as indicated by the AGS System Supplier and as described in the detailed equipment control descriptions should be added to the existing HMI application by the Owner. Existing alarm summary screens and/or alarm banners should be modified to include these new alarms.
- D. Reporting
 - 1. Existing daily and monthly reports should be expanded by the Owner to include the AGS system variables as recommended by the AGS System Supplier.
- E. Historical Data Collection
 - 1. System data should be collected for historical archiving and for use in trending and reporting functions. Requirements for data collection should be as needed to support the trends and reports developed.
- F. Manual Entry of Data

The human machine interface (HMI) computers should allow manual entry of laboratory data and other variables, which should then be available for display and use in reports. Operator entered commands from any of the HMI computers should be logged at all HMI computers.

3.3 EQUIPMENT CONTROL AND CONTROL MODE OVERVIEW

A. The following paragraphs explain the general format and control modes that are used in the detailed equipment descriptions. These paragraphs apply to the attached, project specific, equipment control descriptions included herein.

- B. General
 - 1. Appended to this section are the equipment control programming requirements, with requirements for both PLC programming and the minimum operator interface functions. The HMI requirements represent the anticipated display generation requirements and shall be adjusted if the PLC programming warrants adjustment.
- C. Control Modes
 - 1. There are two general control modes available for the process equipment: 1) remote manual, and 2) remote auto. Remote manual control provides a means for operators to adjust equipment status or setpoint, through the HMI, using manually initiated commands. Remote automatic control provides a means for automatically changing equipment status or setpoint based on measured process parameters, calculated values, or operator setpoints. Some equipment may have more than one remote auto mode.
 - 2. Descriptions for local control are included in the detailed equipment control descriptions. They are provided primarily for documentation purposes and for information. These controls are hardwired and require no programming effort.

3.4 DETAILED EQUIPMENT CONTROL DESCRIPTIONS.

A. The following paragraphs describe specific function requirements for various software control blocks in the control system. These descriptions are intended to provide an overview of the operational concept for the facilities, rather than describing in detail every operating feature or interlock.

B. <u>Primary Filter Effluent Diversion Structure Gate</u>

Loop Components: Existing Primary Filter Effluent Diversion Structure Gate (PFEG-2), Existing Primary Filter Effluent Diversion Structure Level Transmitter (LIT-111), AGS System Influent Flow Meter (FIT-1000)

Function: Control the position of the primary filter effluent diversion structure gate to provide the desired influent flow to the AGS system.

Suggested HMI Requirements: Modify the existing HMI screen used to display the primary filter effluent diversion structure gate (PFEG-2) to allow the operator to display the desired AGS system influent flow and actual flow (FIT-1000). If these features are not currently available on the existing HMI screen, the operator should be able to select remote-manual or remote-automatic control modes for the gate, enter the desired gate position if remote-manual control mode is selected, the desired AGS influent flow setpoint if remote-automatic control mode is selected, and a diversion structure high level setpoint. The AGS system influent flow value should be configured to be historically recorded and available for trending. A Primary Filter Effluent Diversion Structure High Level Alarm signal should be added to the HMI Alarm screen and banner.

Operational Descriptions: The existing control logic programmed within the PLC-PFS for controlling the position of the gate should be modified to provide the control modes specified below. In any control mode, a software interlock should be programmed to prevent the

diversion structure level from exceeding an operator entered high level setpoint. When the level is equal or greater than the high level setpoint for a programmed time delay, the interlock controls should place the gate into remote-manual control mode and position the gate to a programmed position to send more flow to the distribution chamber.

Local-Manual Control Mode – Operator will use the existing hand switches on the gate actuator.

Local-Automatic Control Mode – None

Remote-Manual Control Mode – With remote control selected at the gate actuator (using the Local-Remote hand switch on the actuator) and Remote-Manual control mode selected on the HMI screen, the operator will control the position of the gate by manually entering the desired gate position using a HMI data entry field.

Interface Requirements: None

P&ID Reference: 01-I-601

C. <u>AGS Reactor Influent Valves</u>

Loop Components: AGS Reactor No. 1 Influent Valve (PV-1110), AGS Reactor No. 2 Influent Valve (PV-1210), AGS Reactor No. 3 Influent Valve (PV-1310), AGS Reactor No. 4 Influent Valve (PV-1410)

Function: Open and close the AGS reactor influent valve to send primary filtered water to the AGS reactor.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor and their associated equipment. For the reactor influent valves, the HMI should be configured to indicate the valve open or closed positions. No control features for these valves will be available from the HMI screens.

Operational Descriptions: The AGS reactor influent valves shall be controlled from the AGS control system. In general, the AGS control system shall open or close a reactor's influent valve based on the AGS process control automation. Typically, the AGS control system shall open the reactor influent valve at the beginning of the Fill/Draw phase and close the valve at the end of this phase. For the other phases, this valve shall be closed. During normal operation of the reactors, one of the reactor influent valves shall be open at all times.

Setpoints and Ranges: None

Interface Requirements: The AGS control system shall send the position feedback (open or closed) signals for each of the AGS reactor influent valves to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

D. AGS Reactor WAGS Valves

Loop Components: AGS Reactor No. 1 WAGS Valve (BFV-1120), AGS Reactor No. 2 WAGS Valve (BFV-1220), AGS Reactor No. 3 WAGS Valve (BFV-1320), AGS Reactor No. 4 WAGS Valve (BFV-1420)

Function: Open and close the AGS reactor WAGS valve to send waste activated granular sludge from the reactor to the WAGS/WLC wetwell.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor and their associated equipment. For the reactor WAGS valves, the valve HMI symbol should be configured to indicate the open or closed positions. No control features for these valves will be available from the HMI screens.

Operational Descriptions: The AGS reactor WAGS valves shall be controlled from the AGS control system. In general, the AGS control system shall open or close a reactor's WAGS valve based on the AGS process control automation. Typically, the AGS control system shall automatically open the reactor's WAGS valve during the Settle phase for a set time duration to waste from the reactor.

Setpoints and Ranges: None

Interface Requirements: The AGS control system shall send the position feedback (open or closed) signals for each of the AGS reactor WAGS valves to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

E. <u>AGS Reactor WLC Valves</u>

Loop Components: AGS Reactor No. 1 WLC Valve (BFV-1122), AGS Reactor No. 2 WLC Valve (BFV-1222), AGS Reactor No. 3 WLC Valve (BFV-1322), AGS Reactor No. 4 WLC Valve (BFV-1422), AGS Reactor No. 1 Level Transmitter (LT-1100), AGS Reactor No. 2 Level Transmitter (LT-1200), AGS Reactor No. 3 Level Transmitter (LT-1300), AGS Reactor No. 4 Level Transmitter (LT-1400)

Function: Open and close the AGS reactor WLC valve to send water to the WAGS/WLC wetwell during the water level correction step.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor and their associated equipment. For the reactor WLC valves, the valve HMI symbol should be configured to indicate the open or closed positions. No control features for these valves will be available from the HMI screens. The AGS reactor level values should be configured to be historically recorded and available for trending.

Operational Descriptions: The AGS reactor WLC valves shall be controlled from the AGS control system. In general, the AGS control system shall open or close a reactor's WLC valve based on the AGS process control automation. Typically, the AGS control system shall automatically open the reactor's WLC valve during the React phase to lower the reactor level

and close the valve once the level is equal to the setpoint level (setpoint set by AGS control system).

Setpoints and Ranges: None

Interface Requirements: The AGS control system shall send the position feedback (open or closed) signals for each of the AGS reactor WLC valves to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

F. AGS Reactor Air Control Valves

Loop Components: AGS Reactor No. 1 Air Control Valve (BFVI-1103), AGS Reactor No. 2 Air Control Valve (BFVI-1203), AGS Reactor No. 3 Air Control Valve (BFVI-1303), AGS Reactor No. 4 Air Control Valve (BFVI-1403), AGS Reactor No. 1 Air Flow Meter (FIT-1100), AGS Reactor No. 2 Air Flow Meter (FIT-1200), AGS Reactor No. 3 Air Flow Meter (FIT-1300), AGS Reactor No. 4 Air Flow Meter (FIT-1400)

Function: Control the position of the AGS reactor air control valve to deliver the required amount of air to the AGS reactor diffusers.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor and their associated equipment. For the reactor air control valves, the valve HMI symbol should be configured to indicate the percent open and when the valve is in the full open or full closed positions. No control features for these valves will be available from the HMI screens. The AGS reactor air flow values and air control valve positions should be configured to be historically recorded and available for trending.

Operational Descriptions: The AGS reactor air control valves shall be controlled from the AGS control system. In general, the AGS control system shall use a flow control loop to control the position of the reactor's air control valve to maintain a desired air flow rate when the reactor is in the React phase. The air flow rate setpoint shall be determined by the AGS control system based on the parameters measured by the reactor analyzers as compared to the setpoints required by AGS process control automation.

Setpoints and Ranges: Setpoints entered through the AGS control system.

Interface Requirements: The AGS control system shall send the valve position feedback (percent open), valve fully open and closed (discrete signals), and air flow rate for each of the AGS reactor air control valves to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

G. AGS Reactor WAGS & WLC Manifold Air Valves

Loop Components: AGS Reactor No. 1 WAGS & WLC Manifold Air Valve (BFVI-1101), AGS Reactor No. 2 WAGS & WLC Manifold Air Valve (BFVI-1201), AGS Reactor No. 3

WAGS & WLC Manifold Air Valve (BFVI-1301), AGS Reactor No. 4 WAGS & WLC Manifold Air Valve (BFVI-1401)

Function: Open and close the AGS reactor WAGS & WLC manifold air valve to send air to the manifold.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor and their associated equipment. For the reactor WAGS & WLC manifold air valves, the valve HMI symbol should be configured to indicate the open or closed positions. No control features for these valves will be available from the HMI screens.

Operational Descriptions: The AGS reactor WAGS & WLC manifold air valves shall be controlled from the AGS control system. In general, the AGS control system shall open or close a reactor's WAGS & WLC manifold air valve based on the AGS process control automation. Typically, the AGS control system shall automatically open the reactor's WAGS & WLC manifold air valve for a timed duration to clean the manifold.

Setpoints and Ranges: None

Interface Requirements: The AGS control system shall send the position feedback (open or closed) signals for each of the AGS reactor WAGS & WLC manifold air valves to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

H. AGS Reactor WAGS & WLC Manifold Air Blowoff Valves

Loop Components: AGS Reactor No. 1 Air Blowoff Valve (BFVI-1102), AGS Reactor No. 2 Air Blowoff Valve (BFVI-1202), AGS Reactor No. 3 Air Blowoff Valve (BFVI-1302), AGS Reactor No. 4 Air Blowoff Valve (BFVI-1402), AGS Reactor No. 1 Air Pressure Transmitter (PIT-1100), AGS Reactor No. 2 Air Pressure Transmitter (PIT-1200), AGS Reactor No. 3 Air Pressure Transmitter (PV-1300), AGS Reactor No. 4 Air Pressure Transmitter (PV-1400),

Function: Control the position of the AGS reactor air blowoff valve to reduce air pressure.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor and their associated equipment. For the reactor air blowoff valves, the valve HMI symbol should be configured to indicate the percent open and when the valve is in the full open or full closed positions. No control features for these valves will be available from the HMI screens. The AGS reactor air pressure values and air blowoff control valve positions should be configured to be historically recorded and available for trending.

Operational Descriptions: The AGS reactor air blowoff valves shall be controlled from the AGS control system. In general, the AGS control system shall use a pressure control loop to control the position of the reactor's air blowoff valve to maintain an air pressure setpoint when the WAGS & WLC manifold air valve is open.

Setpoints and Ranges: Setpoints entered through the AGS control system.

Interface Requirements: The AGS control system shall send the valve position feedback (percent open) and valve fully open and closed (discrete signals) for each of the AGS reactor

air blowoff valves and each reactor's air pressure to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

I. AGS Reactor Water Quality Analyzers

Loop Components: AGS Reactor No. 1 Water Quality Analyzer Point Module (AT-1100), AGS Reactor No. 1 Total Suspended Solids Sensor (AE-1101), AGS Reactor No. 1 Dissolved Oxygen Sensor (AE-1102), AGS Reactor No. 1 ORP Sensor (AW-1103), AGS Reactor No. 1 pH Sensor (AE-1104), AGS Reactor No. 1 Ammonium Sensor (AE-1106), AGS Reactor No. 2 Water Quality Analyzer Point Module (AT-1200), AGS Reactor No. 2 Total Suspended Solids Sensor (AE-1201), AGS Reactor No. 2 Dissolved Oxygen Sensor (AE-1202), AGS Reactor No. 2 ORP Sensor (AW-1203), AGS Reactor No. 2 pH Sensor (AE-1204), AGS Reactor No. 2 Ammonium Sensor (AE-1206), AGS Reactor No. 3 Water Quality Analyzer Point Module (AT-1300), AGS Reactor No. 3 Total Suspended Solids Sensor (AE-1301), AGS Reactor No. 3 Dissolved Oxygen Sensor (AE-1302), AGS Reactor No. 3 ORP Sensor (AW-1303), AGS Reactor No. 3 pH Sensor (AE-1304), AGS Reactor No. 3 Ammonium Sensor (AE-1306), AGS Reactor No. 4 Water Quality Analyzer Point Module (AT-1400). AGS Reactor No. 4 Total Suspended Solids Sensor (AE-1401), AGS Reactor No. 4 Dissolved Oxygen Sensor (AE-1402), AGS Reactor No. 4 ORP Sensor (AW-1403), AGS Reactor No. 4 pH Sensor (AE-1404), AGS Reactor No. 4 Ammonium Sensor (AE-1406), AGS Reactor Effluent Box Water Quality Analyzer Point Module (AT-1005), AGS Reactor Effluent Box Ortho-Phosphate Sensor (AE-1005), AGS Reactor Water Quality Analyzer Display Module (AI-1400)

Function: Monitor the AGS reactor water quality variables.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor and their associated equipment. The water quality variables should be shown on these HMI screens. The AGS reactor water quality variables should be configured to be historically recorded and available for trending. A low and high alarm should be configured for each of the reactor water quality variables and these alarms should be added the Alarm HMI screen and banner.

Operational Descriptions: No control features associated with the water quality analyzers.

Setpoints and Ranges: N/A

Interface Requirements: The AGS control system shall send all of the water quality variables for each of the AGS reactors to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

AGS Reactor Groundwater Basin Drain Valve Piping Level Transmitters

Loop Components: AGS Groundwater Basin Drain Valve Piping Level Transmitters (LIT-1001, LIT-1002, LIT-1003, LIT-1004, LIT-1005, LIT-1006)

Function: Monitor the groundwater level within the AGS reactor groundwater basin drain valve piping.

Suggested HMI Requirements:Create new HMI screens that show each AGS reactor and their
associated equipment. The levels from these level transmitters should be shown on these HMIFour Rivers Sanitation Authority40 68 83 - 10BV Project No. 411752Rockford, IL12/20/2022Aerobic Granular Sludge - Phase I12/20/2022

screens. The levels should be configured to be historically recorded and available for trending. A high alarm should be configured for each level signal and these alarms should be added the Alarm HMI screen and banner.

Operational Descriptions: No control features associated with the level transmitters.

Setpoints and Ranges: N/A

Interface Requirements: The AGS control system shall send all of the level signals to the existing Plant Control System via Ethernet.

P&ID Reference: 01-I-601

K. AGS Reactor Blowers

Loop Components: AGS Reactor Blower No. 1 (BLW-1510), AGS Reactor Blower No. 2 (BLW-1520), AGS Reactor Blower No. 3 (PV-1530), AGS Reactor Blower No. 1 Discharge Valve (BFVI-1515), AGS Reactor Blower No. 2 Discharge Valve (BFVI-1525), AGS Reactor Blower No. 3 Discharge Valve (BFVI-1535), AGS Reactor Blower Discharge Header Air Temperature Transmitter (TIT-1550), AGS Reactor Blower Discharge Header Air Pressure Transmitter (PIT-1550)

Function: Control the operation and speed of the AGS reactor blowers to deliver the required air to the AGS reactors.

Suggested HMI Requirements: Create new HMI screens that show each AGS reactor blower and discharge valve. For the reactor blowers, the HMI should be configured to indicate the blower status signals, alarm signals, and blower variables. For the blower discharge valve, the HMI should be configured to indicate the open or closed positions of the valve. In addition, the HMI Alarm screen and banner should be modified to include each blower's alarms (Blower Fault and Blower Common Alarm). The HMI should also be configured to historically record each blower's speed. The common blower discharge header pressure and temperature variables should also be configured to be historically recorded by the HMI. All of these historically recorded blower variables should be available for trending. A fault alarm signal for each blower should be added to the Alarm HMI screen and banner.

Operational Descriptions: Each AGS reactor blower shall be controlled by the blower manufacturer's local control system and the AGS control system. In general, the AGS control system shall calculate the desired amount of air needed based on the control mode (header pressure/air flow, dissolved oxygen, or ammonia) selected and the setpoints for that control mode in the AGS process control automation. With this value, the AGS control system shall also determine the number of blowers to run and the desired air flow or pressure. Start and speed commands shall be sent from the AGS control system to the desired blower local control panel. Based on these control commands, the blower local control system shall control the operation and speed of its associated blower. To prevent frequent starting and stopping of the blowers, the AGS control system shall keep the lead blower running as much as possible (at a minimum).

Each blower local control system shall also control the position of the discharge valve based on the operation of the associated blower.

Setpoints and Ranges: None

Interface Requirements: The AGS control system shall be configured to send data signals with the existing HMI and with each blower control system via Ethernet. AGS System Supplier shall be responsible for coordinating the data exchanges between all of these control systems.

P&ID Reference: 02-I-601

L. <u>Blower Header Blowoff Valve</u>

Function: Monitor and control the blower header blowoff valve.

Suggested HMI Requirements: The blower header blowoff valve should be shown on the new AGS reactor blower HMI screen. The valve HMI symbol should be configured to indicate the percent open and when the valve is in the full open or full closed positions. No control features for these valves will be available from the HMI screens. The blower header blowoff valve position should be configured to be historically recorded and available for trending.

Operational Descriptions: The blower header blowoff valve shall be controlled from the AGS control system. In general, the AGS control system shall open the header blowoff valve when the reactor blower is operating at its minimum speed and the air flow to the reactor is still greater than the desired air flow. When this occurs, the speed of the blower will be held constant at the minimum operating speed, and a flow control loop will be used to control the position of the valve to deliver the desired amount of air flow to the reactor.

Setpoints and Ranges: None

Interface Requirements: The AGS control system shall send the valve position feedback (percent open), valve fully open and closed (discrete signals) for the blower header blowoff valve to the existing Plant Control System via Ethernet.

P&ID Reference: 02-I-601

M. <u>WAGS/WLC Wetwell</u>

Loop Components: WAGS/WLC Wetwell Level Transmitter (LIT-1600), WAGS/WLC Wetwell Low-Low Level Switch (LSLL-1600), WAGS/WLC Wetwell High Level Switch (LSH-1600), WAGS/WLC Pump No. 1 (SPMP-1610), WAGS/WLC Pump No. 1 High Discharge Pressure Switch (PSH-1610), WAGS/WLC Pump No. 2 (SPMP-1620), WAGS/WLC Pump No. 2 High Discharge Pressure Switch (PSH-1620), WAGS/WLC Pump
No. 3 (SPMP-1630), WAGS/WLC Pump No. 3 High Discharge Pressure Switch (PSH-1630), WAGS/WLC Pump Discharge Header Flow Transmitter (FIT-1650)

Function: Monitor and control the WAGS/WLC pumps.

Suggested HMI Requirements: Create a new HMI screen that shows the WAGS/WLC wetwell and associated equipment. For the WAGS/WLC pumps, the pump HMI symbols should be configured to indicate whether the pump is running or off, if auto control mode is selected at the pump's VFD, and the pump's speed. Selectable targets should be configured on the HMI screen to allow the operator the ability to select the pump's remote-control modes (Manual or Automatic), control the operation of the pump (Start or Stop) when remote-manual control mode is selected, and select the Lead, Lag, and Backup pumps and select the location that the pumps will pump to for remote automatic control mode. Data entry fields shall also be created to allow the operator to enter the remote-manual speed command and remote-automatic control setpoints (Lower Level Deadband Setpoint, Upper Level Deadband Setpoint, Flow Setpoint, Flow Increment Setpoint, Cleaning Cycle Initiation Time, Cleaning Cycle Duration Time Setpoint, and Cleaning Cycle Completion Level Setpoint) for when the pumps are pumping to the Distribution Chamber and to Solids Processing. The HMI should also be configured to historically record each pump's speed, the wetwell level, and the pump discharge header flow. Each of these historically recorded variables should be available for trending. The wetwell high level alarm, wetwell low-low level alarm, and the pump alarm signals (fault, leak detected, high motor winding temperature, and high discharge pressure) should be added to the Alarm HMI screen and banner.

Operational Descriptions: Each pump shall be provided with the following types of control modes. In any control mode, the pumps shall have the following hardwired interlocks:

- High Motor Winding Temperature Interlock
 - If a motor winding high temperature switch detects a high temperature condition for 10 seconds, the pump shall be stopped. A faulted pump will not be allowed to restart until the operator presses the Reset button on the pump's VFD.
- Moisture Detected Interlock
 - If a pump's leak detection switch detects moisture, the pump shall be stopped. A faulted pump will not be allowed to restart until the operator presses the Reset button on the pump's VFD.
- Wetwell Low-Low Level Interlock

All operating pumps shall be stopped if the wetwell low-low level switch detects that the wetwell level has dropped below the level switch for 10 seconds. No pumps shall be allowed to start until the level within the wetwell stays above the Lower Level Deadband Setpoint for 2 minutes (timer value adjusted in field during startup).

- High Pump Discharge Pressure Interlock
 - If a pump's discharge high pressure switch detects a high pressure condition for 10 seconds, the pump shall be stopped. A faulted pump will not be allowed to restart until the operator presses the Reset button on the pump's VFD.

If the selected backup pump is in remote-automatic control mode, the AGS control system shall automatically start the backup pump in place of a faulted pump, and the backup pump will be assigned the pump designation (Lead or Lag) of the faulted pump. When the backup pump is energized due to a pump fault and the faulted pump is reset, the AGS control system shall automatically reassign the recently faulted pump as the backup pump.

Local-Manual Control Mode – From the pump's VFD, the operator shall select "Hand" control mode using the Hand-Off-Auto hand switch, control the operation of the pump using the "Start" and "Stop" hand switches, and control the speed of the pump using the speed controller on the pump's VFD.

Local-Automatic Control Mode - None

Remote-Manual Control Mode – With "Auto" control selected at the pump's VFD using the Hand-Off-Auto hand switch and Remote-Manual control mode selected on the HMI screen, the operator will control the operation of the pump using the Start and Stop HMI selectable targets. The speed of the pump shall be controlled using a HMI data entry field.

Remote-Automatic Control Mode – With "Auto" control selected at the pump's VFD using the Hand-Off-Auto hand switch and Remote-Automatic control mode selected on the HMI screen. the AGS control system shall automatically control the operation of the Lead and Lag pumps based on a desired flow rate. If the lead pump is not running, the lead pump shall be energized when the level stays above the Lower Level Deadband Setpoint for 2 minutes (timer value adjusted in field during startup). Once started, the speed of the lead pump shall be controlled by a flow control loop. This flow control loop shall use a Proportional Integral (PI) control block to control the speed of the pumps to meet and maintain the Flow Setpoint using the flow signal from FIT-1650 as the control variable. As the speed of the lead pump is adjusted to deliver the desired flow, the level within the wetwell will rise and fall. If the level falls below the Lower Level Deadband Setpoint or rises above the Upper Level Deadband Setpoint for 10 seconds, the AGS control system shall automatically adjust the Flow Setpoint to bring the wetwell level within the level deadband setpoints. When the wetwell level falls below the Lower Level Deadband Setpoint, the AGS control system shall subtract the Flow Increment Setpoint from the Flow Setpoint every ten seconds that the level is below the Lower Level Deadband Setpoint and use this new value as the flow control loop setpoint. When the wetwell level rises above the Upper Level Deadband Setpoint, the AGS control system shall add the Flow Increment Setpoint to the Flow Setpoint every ten seconds that the level is above the Upper Level Deadband Setpoint and use this new value as the flow control loop setpoint. If the lead pump is running at full speed and the level rises above the Upper Level Deadband Setpoint for 10 seconds, the AGS control system shall start the Lag pump and control the speed of both pumps together. When both pumps are running at minimum speed and the level falls below the Lower Level Deadband Setpoint for 10 seconds, the AGS control system shall stop the lag pump.

On the HMI screen the operator shall be able to select when the pump discharge is sent to the Distribution Chamber or when it is sent to solids processing. For each of these two pumping scenarios, separate flow control loop tuning parameters and control setpoints shall be provided due to different hydraulic conditions for each scenario.

A cleaning cycle shall also be programmed to be initiated once a day (set when the plant typically experiences the daily low flow conditions). When initiated, the operating pump shall pump the wetwell level lower than the Lower Level Deadband Setpoint and the pump's Flow Setpoint shall remain constant. The cleaning cycle shall remain active until the wetwell level drops to the Pump Minimum Submergence Elevation + 6" or the cycle times out. When the cleaning cycle is completed due to level or time, the operating pump shall be stopped. As the wetwell level rises, the lead pump shall be started as described above, and the controls for normal pump operation shall be activated.

Setpoints and Ranges: The ranges for the WAGS total suspended solids, wetwell level, the pump speeds, and wetwell discharge flow signals shall be scaled to the ranges identified in the I/O Schedule. For the setpoints entered from the HMI screens, the following ranges shall be used:

- Remote-Manual Pump Speed (Low speed setting configured in VFD 100%)
- Pumping to Distribution Chamber
 - Lower Level Deadband Setpoint (Initially set at the Motor Submergence Elev., Setpoint Range = Motor Submergence Elev. – Elev. 687 FT)
 - Upper Level Deadband Setpoint (Initially set at Elev. 692 FT, Setpoint Range = Elev. 687 - 693 FT)
 - Flow Setpoint (initial setting and setpoint range set in the field based on field conditions and the pump manufacturer, gpm)
 - Flow Increment Setpoint (initial setting and setpoint range set in field, gpm)
- Pumping to Solids Processing
 - Lower Level Deadband Setpoint (Initially set at the Motor Submergence Elev., Setpoint Range = Motor Submergence Elev. – Elev. 687 FT)
 - Upper Level Deadband Setpoint (Initially set at Elev. 692 FT, Setpoint Range = Elev. 687 - 693 FT)
 - Flow Setpoint (initial setting and setpoint range set in the field based on field conditions and the pump manufacturer, gpm)
 - Flow Increment Setpoint (initial setting and setpoint range set in field, gpm)
- Cleaning Cycle
 - Cycle Initiation Time (Set by Owner)
 - Cycle Duration Time Setpoint (Initially set at 2 hours, Setpoint Range = 1 4 hours)
 - Cycle Completion Level Setpoint (Initially set at Pump Minimum Submergence Elevation + 6", Setpoint Range = Pump Minimum Submergence Elevation + 6" - Motor Submergence Elev.)

Interface Requirements: The data signals associated with this WAGS/WLC pumps and wetwell shall be sent between the AGS control system and the existing plant control system via Ethernet communication.

P&ID Reference: 01-I-602

N. Distribution Chamber Gate

Loop Components: Distribution Chamber Gate (GSD-1651)

Function: Monitor and control the distribution chamber gate.

Suggested HMI Requirements: The existing distribution chamber with the new gate shown on the new WAGS/WLC wetwell screen described in the previous control description. The gate HMI symbol should be configured to indicate when the valve is in the full open or full closed positions and when remote control is selected on the actuator. A popup window should be configured to allow control of the gate. In this popup window, Open and Close selectable targets should be configured to provide remote manual control of the gate.

Operational Descriptions: The gate shall be provided with the following types of control modes.

Local-Manual Control Mode –From the gate's actuator, the operator shall select "Local" control mode using the Local-Off-Remote hand switch and control the position of the gate using the "Open/Close" hand switch.

Local-Automatic Control Mode - None

Remote-Manual Control Mode –With "Remote" control selected at the gate's actuator using the Local-Off-Remote hand switch, the operator will control the position of the gate using the Open and Close HMI selectable targets.

Remote-Automatic Control Mode - None

Setpoints and Ranges: None

Interface Requirements: The data signals associated with the Distribution Chamber gate shall be sent between the AGS control system and the existing plant control system via Ethernet communication.

P&ID Reference: 01-I-602

End of Section

SECTION 40 71 00 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

- A. The Flow Instrument Section covers the furnishing of flow instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.
- B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.
- C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

- A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.
- B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.
- C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.
- D. Where possible, each instrument shall be factory wet flow calibrated to the full-scale flow range of the sensors or calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures when such procedures exist for the instrument type. Calibration and configuration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or Instrument Device Schedule.

1.3 SUBMITTALS

- A. See Section Instrumentation and Control System section.
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following paragraphs provide minimum device requirements. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.
- B. Interconnecting Cable
 - 1. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated on the Drawings or in the Instrument Device Schedule. The interconnecting cable shall be provided in the length necessary for installation. Splices shall not be allowed in the installed cable.

C. Programming Device

- 1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.
- D. Configuration Software/Serial Interface



Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. As a minimum, an appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 FLOW INSTRUMENTATION.

- A. Magnetic Flow Meters, Signal Converters, and Accessories.
 - 1. Magnetic Flow Meter
 - The magnetic flow meter shall be a completely obstructionless, in-line flow meter a. with no constrictions in the flow of fluid through the meter. The meter shall consist of a metallic tube with flanged ends and with grounding rings. Flange diameter and bolt drilling pattern shall comply with ANSI/ASME B16.5 for line sizes from 0.5 inches to 24 inches or AWWA C207 for line sizes larger than 24 inches. Flange class ratings and meter maximum pressure ratings shall be compatible with the adjoining piping. Flangeless wafer insert style meters may be used for pipe sizes up to 6 inches, where compatible with adjacent piping flanges. Self-cleaning electrodes shall be provided for all meters used for sludge metering. Electrode and liner materials shall be fully compatible with the process fluid as approved by the Engineer and shall comply with the requirements specified in the instrument device schedules. Each meter shall be factory wet flow calibrated to the sensors full flow capacity, at a facility, which is traceable to NIST or other standard acceptable to Engineer, and a copy of the calibration, report shall be submitted as part of the operation and maintenance manual submittal.
 - b. The meter shall be capable of standing empty for extended periods of time without damage to any components.
 - c. The meter housing shall be of a splash-proof and drip-proof design.
 - d. Where indicated on the Drawings or in the Instrument Device Schedule, the meter shall be suitable for use in a Class I, Division 2, hazardous area.
 - e. Meters shall be manufactured by Endress+Hauser or Krohne. (System Supplier)
 - 2. Magnetic Flow Meter Signal Converters
 - a. Separately mounted, microprocessor-based signal converters shall be provided for the magnetic flow meters. The signal converters shall include output damping, selftesting, built-in calibration capability, and an "empty pipe zero" contact input. The overall accuracy of the magnetic flow meter transmitter and signal converter shall be ±0.5 percent of actual flow rate for full-scale settings of 3 to 30 fps. The meter manufacturer shall furnish the signal cable between the converter and the magnetic flow meter. Signal cable shall be continuous and not spliced between the meter and the signal converter. The signal converter shall be housed in a corrosion resistant, weatherproof NEMA Type 4X housing and shall be suitable for operation over an ambient temperature range of -30 to +140°F, and relative humidity of 10 to 100 percent. The converter shall have an analog output of 4-20 mA dc. Transmitters tagged on the Drawings or specified to be of the indicating type shall contain a local indicator with a minimum four-digit LCD type display, scaled to read in engineering units of flow.
 - b. Magnetic flow meter systems shall provide zero flow stability by means of automatic zero adjustment of a DC excited metering circuit. Converters shall be capable of bidirectional flow measurement. Signal converters shall be of the same brand as the magnetic flow meters.

- c. The signal converter shall be diagnosed and recalibrated with the use of a hand-held communicator/calibrator device. One device shall be furnished for all converters provided by a single manufacturer.
- B. Thermal Dispersion Flow Meters
 - 1. Each flow meter shall utilize a thermal dispersion type, explosion-proof, and stainless steel or Hastelloy C sensing element installed in the process piping. The insertion length of the element shall be approximately one-half of the pipe diameter, and all mounting accessories shall be provided. The sensor shall have a 1 inch MNPT mounting connection, and an isolation valve and packing gland that allows insertion and removal while the piping is under pressure.
 - 2. The electronic transmitter shall be remotely mounted within 30 feet of the sensor with interconnecting cable provided. The transmitter shall be of the ac-powered type. The unit shall be housed in a NEMA Type 4X enclosure. The transmitter shall have a 4-20 mA dc analog output and a local indicator with a multi-line LCD display calibrated in engineering units of flow. The transmitter shall also display a totalized flow value and the temperature of the process fluid.
 - 3. Accuracy of the flow meter shall be 1 percent of full scale over a 20-to-1 operating range. Each flow meter assembly shall consist of a Fluid Components International "ST51A" insertion flow meter and a Fluid Components International "Vortab" flow conditioner, or approved equal. (AGS System Supplier)

PART 3 - EXECUTION

3.1 FIELD SERVICES

- A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.
- B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier and AGS System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

SECTION 40 72 00 - PRESSURE AND LEVEL INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of pressure and level instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.
- B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.
- C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

- A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.
- B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.
- C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.
- D. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1.3 SUBMITTALS

- A. See Instrumentation and Control System section.
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following paragraphs provide minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.
- B. Interconnecting Cable
 - 1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings or Instrument Device Schedule.
- C. Programming Device
 - 1. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section.) The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.
- D. Configuration Software/Serial Interface
 - 1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 PRESSURE AND LEVEL INSTRUMENTATION.

- A. Pressure and Pressure Sensing Level Transmitters
- 1.
 Transmitters shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. Process fluid shall be isolated from the Four Rivers Sanitation Authority

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sensing elements by AISI Type 316 stainless steel, Hastelloy-C, ceramic, or cobalt-chromium-nickel alloy diaphragms, and the transducer may use a silicone oil fluid fill. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0° to 180°F, and relative humidity of 5 to 100 percent. All parts shall be cadmium-plated carbon steel, stainless steel, or other corrosion-resistant materials. Transmitters shall have over-range protection to maximum line pressure. Accuracy of the transmitter shall be 0.075 percent of span, and transmitter output shall be 4-20 mA dc without the need for external load adjustment. Transmitters shall not be damaged by reverse polarity. Transmitters shall have an elevated or suppressed zero. For calibrated spans of less than 8 psig a differential pressure type transmitter with side vents shall be utilized. Transmitters shall be provided with brackets for wall and pipe-stand mounting.

- 2. Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.
- 3. Transmitters tagged on the Drawings or specified to be indicating type shall be furnished with LCD type digital indicators.
- 4. Transmitters will have a turndown ratio of 30:1, or more.
- Transmitters shall be ABB "Model 266HSH", Endress+Hauser "Cerabar S", or "Deltabar S Series", Foxboro "Model IGP10S", Rosemount "Model 2051", or Siemens "P320". (System Supplier & AGS System Supplier)
- B. Submersible Pressure Sensing Level Transmitters
 - 1. The level transmitter system shall consist of a submersible pressure sensor/transmitter unit that is suitable for direct submersion into the liquid being measured. Sensor size shall not exceed 1-1/4 inch diameter by 9-inch length. The sensor shall be a solid-state variable capacitance or diffused silicon semiconductor type that shall provide an output signal directly proportional to the sensed pressure over a factory-calibrated range. The sensor assembly shall have a stainless steel or titanium housing and shall be supported by a polyethylene or urethane jacketed cable with a minimum 200 lb. test strength. The sensor cable shall be of sufficient length so that no splice or connector is required in the wet or inaccessible area, and the vent tube termination point is located in an area protected from dirt and moisture. Level transmitter in WAGS/WLC wetwell shall be rated for use in a Class 1, Div. 1 classified area.

The transmitter shall have a two-wire type 4-20 mA dc current output that is proportional to level. The output shall have surge protection and shall not be damaged by reverse polarity. The transmitter shall be suitable for an operating temperature range of 0° to +50°C. Accuracy of the level transmitter shall be ± 0.25 percent "best straight line", with an overall combined accuracy of ± 1 percent over the entire operating temperature/pressure range.

3. Submersible pressure sensing level transmitters shall be PMC VersaLine VL2000 series, or approved equal. (AGS System Supplier)

- C. Weighted Float Type Level Switches
 - Each level switch shall consist of a single-pole, double-throw mercury switch, rated not less than 3 amp [A] ac, sealed and housed in a chemical-resistant polypropylene casing. The switch assembly shall be weighted and suspended on a waterproof, three-conductor, synthetic covered flexible cable with 19 AWG conductors and of such length that no splice or junction box is required in the wet well. Switches shall be suitable for operation at up to 150 V ac within an ambient temperature range of 32° to 140°F. Switches shall be suitable for use in a sanitary wastewater wet well. Adjustable mounting hardware shall be provided for supporting each level switch. Level switches in WAGS/WLC wetwell shall be rated for use in a Class 1, Div. 1 classified area. Switches shall be Ametek B/W Controls "Series 7010", Anchor Scientific "GSI 40NONC", Siemens "LSC", ITT/Flygt "ENM-10", or Gems Sensors & Controls/Warrick Controls "Series M". (System Supplier & AGS System Supplier)
- D. Pressure Switches
 - 1. Pressure switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches mounted inside panels shall have NEMA Type1 housings. All other switches shall have weatherproof housings. Switches shall be differential type where indicated in the Instrument Device Schedule. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or viton and the connection port shall be stainless steel.
 - 2. Panel-mounted and surface-mounted switches shall be provided with 1/4 inch NPT connections. All stem-mounted switches shall be provided with 1/2 inch NPT connections.
 - 3. All pressure switches shall be ranged in psi and all vacuum switches in inches of water. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp [A] at 120 V ac.
 - 4. Each switch shall be provided with a threaded end, ball-type shutoff valve. Shutoff valve materials shall be compatible with the process fluid. Where the process is not specified, valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals. Multi-port valves shall have all unused ports plugged. Shutoff valve construction shall be as detailed in the Miscellaneous Instruments section.

Where indicated on the Drawings or in the Instrument Device Schedule, the switch shall be provided with a pressure snubber. Each snubber shall be of a size and pressure range compatible with the switch served. Snubbers shall be Ashcroft "Pulsation Dampers" or approved equal.

6. Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective switch. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc, or cadmium plated carbon steel upper housing, and stainless-steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the switch with the system under pressure. The lower housing shall be

provided with a tapped and plugged 1/4 inch NPT flushing connection. Each diaphragm seal and the switch served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

- 7. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal.
- 8. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R. (System Supplier & Blower System Supplier)
- E. Radar Level Transmitters
 - 1. Radar level transmitters shall be microprocessor-based electronic units each consisting of a transmitter with integrally mounted antenna cone. The antenna shall be suitable for operation over a temperature range of -20° to +150°F and a relative humidity of 10 to 100 percent. The antenna shall be compatible with the process media being measured and encapsulated with a material such as PTFE and suitable for flange mounting. The transmitter shall be capable of continuous monitoring of solids or liquids. High chloride concentrations (avg. 300 mg/L) will be present within the WAGS/WLC wetwell.
 - 2. The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 0.5 inches. The transmitter shall be designed to ignore momentary level spikes, false targets, or momentary loss-of-echo. The transmitter shall be loop-powered with an isolated 4-20 mA dc output signal linearly proportional to the measured level range. Accuracy of the transmitted signal shall be ± 0.4 inches of the full range. Calibration parameters shall be entered through a keypad on the unit.
 - 3. The transmitter shall be housed in a weatherproof, corrosion resistant NEMA Type 4X enclosure directly coupled to the antenna.
 - 4. Transmitters mounted in hazardous area indicated on the drawings shall be suitable for use in a Class I, Division 1 or 2 area as indicated on the drawings.
 - 5. The System Supplier shall provide an insulation kit (i.e., insulator-sleeved bolts and insulator washers), as required, to prevent corrosion due to dissimilar metals of the transmitter flange and the mounting pipe flange.



7. Radar level transmitters shall be Vega VEGAPULS series, or approved equal. (System Supplier)

F. Field-Mount Pressure Gauges

- 1. Pressure gauges shall be of the indicating dial type, with C-type phosphor bronze Bourdon tube; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.
- 2. Gauge dial shall be 4-1/2 inch size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees or more than 270 degrees of arc.
- 3. Surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stemmounted gauges shall be provided with 1/2 inch NPT connections. Where indicated in the Drawings or on the Instrument Device Schedule, stem mounted gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.
- 4. All pressure gauges shall measure in psi and all vacuum gauges in inches water. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 0.5 percent of scale range.
- 5. Gauges shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All gauges shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at gauge locations prior to installation of the gauge or diaphragm seal.
- 6. Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or the Instrument Device Schedule.
- 7. Unless otherwise indicated, mounting and installation hardware shall be Type 316L stainless steel.
- 8. Pressure gauges shall be Ashcroft "1279 Duragauge", or equal. (System Supplier)
- G. Annular Type Pressure Sensors



Pressure sensors shall be of the wafer type, designed to fit between standard class 150 and class 300 pipeline flanges. Flange material shall be the same as the surrounding pipeline. Sensor shall be flow through design with flexible elastomer sensing ring around the full circumference. The elastomer sensing ring shall be rigidly clamped between metal end cover flanges, and no part of the elastomeric sensing ring shall be exposed to the external face of the sensor. There shall be no dead ends or crevices, and flow passage shall make the sensor self-cleaning.

2. The pressure-sensing ring shall measure pressure for 360° around the full inside circumference of the pipeline. Flexible sensing ring shall have a cavity behind the ring filled with fluid to transfer pressure to the gauge. Sensing ring material shall be

compatible with the process. Fill fluid shall be suitable for use with the process temperatures.

3. Annular pressure sensors shall be Red-Valve "Series 48" or equal. (System Supplier)

PART 3 - EXECUTION

3.1 FIELD SERVICES

- Α. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.
- B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier and AGS System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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SECTION 40 74 00 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of all temperature instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the drawings.
- B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the drawings or the Instrument Device Schedule.
- C. When multiple temperature instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1.2 DESIGN CRITERIA

- A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.
- B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.
- C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.
- D. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1.3 SUBMITTALS

- A. See Section 40 61 11 Instrumentation and Control System
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.
- B. Interconnecting Cable
 - 1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.
- C. Programming Device
 - 1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.
- D. Configuration Software/Serial Interface
 - 1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 TEMPERATURE INSTRUMENTS

A. Resistance Temperature Detectors

 1. Each temperature detector shall be a nominal 100 ohm, three or four wire, hermetically sealed, platinum resistance element. The sensing element shall be enclosed in an AISI

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Type 316 stainless steel outer sheath. Accuracy shall be $\pm 1^{\circ}F$ over the specified operating range.

- 2. Each temperature detector shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel. The approximate process insertion length of the thermowell shall be as indicated on the Drawings or in the Instrument Device Schedule. The temperature element shall be springloaded in the thermowell. Appropriate temperature head hardware shall be provided with the assembly.
- B. Resistance Temperature Transmitters
 - 1. Each transmitter shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. The transmitter shall be designed for a resistance temperature detector input and shall have a 4-20 mA dc output or shall have a Foundation Fieldbus output where indicated on the instrument device schedule.
 - 2. The transmitter shall be of the sensor lead wire compensated type with linearized output to provide an accuracy of \pm 0.2 percent of temperature span. The transmitter shall be housed in a weatherproof enclosure designed for mounting directly on or near the thermowell. Shielded lead wire shall be provided as needed between the transmitter and the temperature detector. Each transmitter shall be coordinated with the sensor and thermowell. Transmitters shall be manufactured by Foxboro "RTT20/25", ABB Model TTH300, or Rosemount "644/3144". (System Supplier & Blower System Supplier)
 - 3. Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.
 - 4. Transmitters tagged on the Drawings or specified to be the indicating type shall be furnished with LCD type digital indicators.

PART 3 - EXECUTION

A. FIELD SERVICES



Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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SECTION 40 75 00 - PROCESS ANALYTICAL INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing of all process liquid analytical instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.
- B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.
- C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

- A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.
- B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.
- C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.
- D. Where possible, each instrument shall be factory calibrated to the calibration ranges on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or in the Instrument Device Schedule.

1.3 SUBMITTALS

- A. See Section Instrumentation and Control System section.
 - 1. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following paragraphs provide minimum device stipulations. The Drawings and/or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.
- B. Interconnecting Cable
 - 1. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings.
- C. Programming Device
 - 1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.
- D. Configuration Software/Serial Interface
 - 1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 PROCESS ANALYTICAL INSTRUMENTATION

- A. Multiparameter Transmitters
 - 1. Multiparameter transmitter systems shall consist of one display module and at least one probe module for each AGS reactor.

- 2. The probe module shall receive the input from each instrument sensor. All the probe modules shall be connected in a "daisy-chain" configuration and all sensor data from all AGS reactors shall be sent via SC1000 bus network. The probe module shall be provided in IP65 enclosure with corrosion resistant finish. The probe module shall include internal 125 VAC power supply and EEPROM memory back-up. SC1000 bus cable shall be provided as required to connect all of the probe modules.
- 3. The single display module shall be portable to allow use with any probe module and shall have a color graphical touch-screen display. The display module shall be provided in IP65 enclosure with corrosion resistant finish.
- 4. The AGS Reactor No. 4 probe module shall be capable of communicating all reactor analytical data with the AGS control system via Modbus RTU.
- 5. All point modules and the display module shall be capable of operation outdoors. Modules shall be capable of operating in the ambient temperatures identified in the Instrumentation and Control System section. If the modules are not capable of operating within the identified ambient temperature range, the necessary heating and/or cooling appurtenances shall be provided.
- 6. The multiparameter transmitter system shall be Hach SC1000 Multi-parameter Universal Controller. SC1000 bus cable shall also be provided to connect all of the probe modules. (AGS System Supplier)
- B. pH and ORP Sensors
 - 1. The pH probes shall utilize two measuring electrodes to compare the process value to a stable internal reference. The sensor shall have a built-in preamplifier and include an integral temperature sensor. The pH sensor shall automatically compensate measured values for changes in temperature.
 - 2. The ORP probes shall utilize two measuring electrodes to compare the process value to a stable internal reference. The sensor shall have a built-in preamplifier and include an integral temperature sensor.
 - 3. The pH sensor shall be Hach pHD differential pH sensor. The ORP sensor shall be Hach pHD differential ORP sensor. (AGS System Supplier)
- C. Dissolved Oxygen Probes

Probes shall be a continuous-reading probe based on the time measured from excitation of a luminescent material by a light source to the time light is emitted by the material. The luminescent material shall be mounted to an oxygen permeable replaceable cap fitted over the end of the probe. The probe shall provide electrolyte-free operation without requiring sample conditioning.

2. The dissolved oxygen sensor shall be Hach LDO sc. (AGS System Supplier)

- D. Suspended Solids Probes
 - 1. Probes shall utilize a light beam that is focused on the liquid surface of the sample at an acute angle. The suspended particles in the sample will scatter the light and a photocell mounted above the liquid surface shall detect the reflected light. The light and photocell sensor shall not come in direct contact with the sample liquid. The sensor shall be equipped with a self-cleaning mechanism.
 - 2. The suspended solids analyzer shall be Hach SOLITAX sc. (AGS System Supplier)
- E. Orthophosphate Analyzer
 - 1. Analyzer shall utilize a photometric method designed for the precise determination of orthophosphate concentration. The analyzer shall include an ASA UV-resistant, lockable housing, rated to IP55. The analyzer shall be equipped with a self-cleaning membrane, automatic calibration, and adjustable extensive self-diagnostics.
 - 2. The orthophosphate analyzer shall be capable of operation outdoors and shall be capable of operating within the ambient temperatures identified in the Instrumentation and Control System section. If it is not capable of operating within the identified ambient temperature range, the necessary heating and/or cooling appurtenances shall be provided. Heat tracing of the sample delivery hose from the sampler system and drain hose shall be provided to prevent them from freezing.
 - 3. The orthophosphate analyzer shall be Hach Phosphax sc. (AGS System Supplier)
- F. Sampling Systems
 - 1. Sampling systems shall consist of a IP55 rated control enclosure, submersible module holder, and sample delivery hose. The sampling system shall include internal 125 VAC power supply.
 - 2. All sampling systems shall be capable of operation outdoors and shall be capable of operating within the ambient temperatures identified in the Instrumentation and Control System section. If the sampling systems are not capable of operating within the identified ambient temperature range, the necessary heating and/or cooling appurtenances shall be provided. Heat tracing of the sample delivery hose shall be provided to prevent it from freezing.

3. The sampling system shall be Hach Filtrax. (AGS System Supplier).

PART 3 - EXECUTION

- 3.1 Field Services
 - A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

Process Analytical Instruments

Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled B. installation. The AGS System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction Notto be used for bilding punpose or cleaning chemicals that may affect instrument operation.

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I

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SECTION 40 78 00 - PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

- A. The Panel Mounted Instruments section covers the furnishing of all panel mounted instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.
- B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.
- C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

- A. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.
- B. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. For "smart" devices, calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1.3 SUBMITTALS

See Section Instrumentation and Control System section.

1. Submittals shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following paragraphs describe minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.
- B. Programming Device
 - 1. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training stipulations. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.
- C. Configuration Software/Serial Interface
 - 1. Devices indicated as requiring a serial interface shall be provided with all accessories to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a laptop computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device need not be furnished.

2.2 PANEL FRONT MOUNTED DEVICES.

- A. Switches, Lights, and Push Buttons.
 - 1. Selector Switches



Selector switches shall be 30.5-mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 V ac. Contact configuration shall be as indicated on the Drawings or for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley "800T", or Square D "9001", or approved equal. (AGS System Supplier)

- 2. Indicating Lights
 - a. Indicating lights shall be 30.5-mm, heavy-duty, oil-tight type, with full voltage LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lights shall be push-to-test type. Indicating lights shall be Eaton/Cutler Hammer

"10250T", General Electric "CR104P", or Allen Bradley "800T", or Square D "9001", or approved equal. (AGS System Supplier)

- 3. Push Buttons
 - a. Push buttons shall be 30.5-mm, heavy-duty, oil-tight type. Legends shall be engraved on the push-button faceplate. Contacts shall be rated 10 amperes continuous at 120 V ac. Push buttons shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley "800T", or Square D "9001", or approved equal. (AGS System Supplier)

2.3 PANEL INTERIOR MOUNTED DEVICES

- A. Power Supplies
 - 1. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of ± 10 percent, and the supply output shall be fused or shortcircuit protected. Output voltage regulation shall be by the instrumentation equipment supplied. Multiloop or multisystem power supplies will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so either the primary or the backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation. Multiloop power supply connections shall be individually fused so a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be oversized for an additional 10 percent future load. Failure of a multiloop supply shall be indicated on the respective instrument panel or enclosure.
 - 2. Power supplies shall be Allen Bradley, Phoenix Contact, PULS, Square D, or equal. (AGS System Supplier)
- B. Relays

1.

Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver cadmium oxide contacts rated 10 amperes at 120 V ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low-level signals. Relays used for computer input, alarm input, or indicating light service shall have contacts rated at least 3 amperes. Time delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of ±2 percent of setting. Latching and special purpose relays shall be for the specific application. Unless otherwise indicated, all relays shall have an integral pilot light that illuminates to indicate an energized condition. Relays shall be Allen Bradley "700-HK", IDEC "Series RR", Potter & Brumfield "Series KRP, CB", Struthers-Dunn "Series 219, 246", or approved equal. (AGS System Supplier and System Supplier)

- C. Intrinsically Safe Relays
 - 1. Relays shall be solid-state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe use in hazardous areas. Relays shall be located in non-hazardous areas. Relays shall be manufactured by Allen Bradley, GEMS, Eaton/MTL, R. Stahl, Inc., Square D, or Turck, or approved equal. (AGS System Supplier and System Supplier)
- D. Electronic Signal Booster/Isolators
 - 1. Electronic signal boosters and isolators shall have all solid-state circuitry and complete electrical isolation between the power supply and the input and output signals. Accuracy shall be ± 0.15 percent of span. Isolators shall be manufactured by Acromag, Moore Industries-International, Inc., or Phoenix Contact. (AGS System Supplier)

PART 3 - EXECUTION

3.1 FIELD SERVICES

Manufacturer's field services shall be provided for installation, field calibration, startup, and Α. training as specified in the Instrumentation and Control System section. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. AGS System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

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SECTION 43 11 15 - HIGH SPEED GEARLESS TURBO BLOWERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of electric motor driven, high speed, gearless, non-contact air bearing type turbo blower packages complete with sound enclosures and all accessories specified herein. The Activated Granular Sludge (AGS) System Supplier shall be responsible for providing the blowers and accessories as specified herein. At Bidder's option and with Owner's approval, the following equipment may be provided outside of the AGS System Suppler scope.

Blower designation.	AGS Blowers
Number of blowers.	3
Blower tag numbers.	BLW-1510, BLW-1520, BLW-1530
Blower location.	AGS Support Facility Blower Area

- B. Each blower package shall be air-cooled or internally circulating self-contained liquid-cooled and furnished complete with integral adjustable frequency drive, electric drive motor, base, acoustical enclosure, power monitoring, controls, and all other accessories or appurtenances indicated on the Drawings, specified herein or otherwise needed for proper operation. Input harmonic filters shall be provided within or remote from the enclosure. Harmonic filters shall be provided within the enclosure if the blower manufacturer has the capability. If harmonic filters are provided remote from the blower enclosure, all required cable and conduit required to connect the harmonic filter to the blower controls shall be provided by the blower manufacturer. Remotely located harmonic filters shall be located as indicated on the Drawings.
- C. The blower manufacturer shall be responsible for blower protection controls including the programming of the blower control panels. The Activated Granular Sludge (AGS) System Supplier shall be responsible for providing single source responsibility for the complete AGS aeration system including the control of blowers, and automatic control of discharge header blow-off valve and AGS Reactor valves, including the Most Open Valve (MOV) control strategy. AGS aeration system controls shall be provided through the AGS system control panel as specified herein. The AGS System Supplier shall supply the discharge header blow-off control valve, header blow-off silencer, control valves and flow meters on the air supply piping to the AGS reactors. Mandatory on-site coordination meetings shall occur between the blower manufacturer and the AGS System Supplier to assist in programming of the AGS aeration system. Refer to the Instrumentation and Control System and Software Control Block Descriptions sections. During the coordination meetings, the blower manufacturer shall provide guidance to the AGS System Supplier to ensure the blower control system operates in a stable and energy efficient manner.
- D. Piping, pipe supports, valves, and accessories that are not an integral part of the equipment or specified herein are covered in other sections.
- E. Air bearing blower package dimensions and pipe routing shown on the drawings are based on Aerzen. Any modifications to the equipment pad, pipe routing, and pipe supports to accommodate

a specified alternate vendor, shall be at no additional cost to the Owner and shall be provided to the Engineer for review.

1.2 GENERAL

- A. Coordination
 - 1. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations furnished by the equipment manufacturer unless exceptions are noted by Engineer.
 - 2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
 - 3. The blower unit shall be a current standard product of the blower manufacturer and shall be a packaged type unit, fully shop assembled by the blower manufacturer. All accessory items shall be furnished by the blower manufacturer.
 - 4. The AGS System Supplier shall be responsible for coordinating the blowers with the equipment specified in the Aerobic Granular Sludge Equipment Section. Contractor shall be responsible for any changes required in the blower design resulting from the diffused aeration equipment design, including pressure losses through the submerged diffusers.
 - 5. Each blower package including the blower unit, control panel, any cooling air or liquid requirements, adjustable frequency drive, sinus filters, input line reactors, and discharge cone shall not exceed the dimensions as shown on the Drawings. Any proposed modifications shall be reviewed by the Engineer and if approved, shall be performed by Contractor at no additional cost to Owner.
 - 6. Unless exceptions are noted by Engineer, the equipment arrangement and piping may be modified in accordance with the recommendations of the equipment manufacturer to suit the equipment furnished. All needed modifications shall be reviewed by Engineer and shall be performed by Contractor at no additional cost to Owner.
- B. General Equipment Stipulations

The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Meteorological and Seismic Design Criteria

- 1. The Meteorological and Seismic Design Criteria section shall apply to all equipment furnished under this section.
- D. Governing Standards
 - 1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and

regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

- 2. All work shall comply with Underwriters' Laboratories (UL) safety requirements.
- E. Power Supply
 - 1. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase. Power supply for controls shall be 120 volt 60 Hz single phase and shall be provided by control power transformers mounted in the control panels as required. The control power transformers on the primary side shall be powered from the 480 volt, 60 Hz 3 phase power supply.
- F. Tagging
 - 1. Each item of equipment and each part shipped separately shall be tagged and identified in accordance with the Equipment and Valve Identification section. Tag number shall be clearly marked on all shipping labels and on the outside of all containers in accordance with the Product Delivery Requirements section.
- G. Nameplates
 - 1. Each blower and accessory component having a tag number as indicated on the drawings or specified herein, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall be at least 1 inch high and shall be black baked enamel on anodized aluminum plate.
- H. Lubrication
 - 1. The blowers shall not require oils or lubricants for adequate operation.

1.3 SUBMITTALS

- A. Drawings and Data.
 - Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. Device tag numbers indicated on the contract drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but not be limited to the following:
 - a. Package
 - 1) Letter from factory confirming blower package is fully shop assembled and will meet the performance requirements specified herein. Any exceptions or deviations to the Contract Documents shall be clearly identified in the letter and subject to acceptance by the ENGINEER.

- b. Blowers
 - 1) Name of manufacturer.
 - 2) Type and model.
 - 3) Full rotative speed at rated condition.
 - 4) Critical speed of the rotor.
 - 5) Type of bearings.
 - 6) Connection sizes.
 - 7) Maximum air temperature at discharge flange.
 - 8) Maximum allowable forces and moments on blower inlet and discharge flanges.
 - 9) Net weight of blower/motor assembly.
 - 10) Weight of entire package.
 - 11) Net weight of heaviest single component requiring removal for maintenance.
 - 12) Overall dimensions.
 - 13) Complete performance curves showing discharge pressure versus capacity, bhp, and package input power at site conditions including minimum and maximum ambient air temperatures, corresponding relative humidities and at standard conditions.
 - 14) Reduced speed performance curve for each 10 percent increment from the speed corresponding to the minimum specified air flow or minimum air flow the blower is capable of, if that is lower, to maximum speed including speed at specified conditions, as well as minimum, and maximum temperatures and corresponding relative humidities.
 - 15) Shop painting data.
 - 16) Anchor bolt location details.
 - 17) Estimated maximum free field noise level at 3 feet.
 - 18) Letter from the blower manufacturer confirming that the free field noise at three feet from the blower enclosure will not exceed the specified sound level while operating at the specified capacity.
 - Vibration isolator base pads.

Motors

19)

- 1) Name of manufacturer.
- 2) Type and model.
- 3) Type of bearings.
- 4) Rated size of motor, hp, and service factor.
- 5) Insulation class and temperature rise.
- 6) Full load rotative speed.
- 7) Motor cabinet heater wattage and data.
- 8) Efficiency at full, 3/4, 1/2 and designed operating load.
- 9) Full load current.
- 10) Locked rotor current.
- 11) Net weight.
- 12) Verification of inverter duty rating.
- 13) Motor temperature switch data.
- 14) Power and control cable data.
- d. Variable Frequency Drives
 - 1) Name of manufacturer.
 - 2) Type and model number.
 - 3) Rated drive input kVA and output kVA.
 - 4) Percent efficiency at 100 percent speed and 50 percent speed.
 - 5) Maximum Btu/h heat release to the room and verification of the drive cooling requirements (including separately mounted components).
 - 6) Total weight and lifting instructions, height, mounting, and floor space required (including separately mounted components).
 - 7) Panel interior and front and side exterior view details showing maximum overall dimensions of transformer, bypass contactor, input harmonic filter, ac line reactor, and drive compartments.
 - 8) Schematics, including all interlocks.
 - 9) Wiring diagrams, including all internal and external devices and terminal blocks.
 - 10) Locations and sizes of electrical connections, ground terminations, and shielded wires.
 - 11) List of diagnostic indicators.
 - 12) List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.
 - 13) List of standard features and options.
 - 14) List of spare parts to be furnished.
 - 15) Input line protection model numbers and manufacturer's data sheets.
 - 16) Output harmonic filter model number and manufacturer's data sheets including dimensional information and power consumption.
 - Certification of conformal coating on all printed circuit boards and conformal coating data sheet.

Harmonic calculations by the harmonic manufacturer at the drive terminals, at the blower common bus and the point of common coupling. Include detailed drawings and information showing how protection is applied to comply with IEEE 519 harmonic limits.

- 19) Blower and/or drive manufacturer shall provide manufacturer's detailed harmonic field testing plan for the Contractor to perform the harmonic field test. The test plan should include instruments to be used, verification of testing locations for voltage and current harmonic metering, verification of maximum allowable voltage and current distortion, and drive load and speed test parameters.
- 20) Power factor verification.

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- e. Controls
 - 1) Blower control panel layout including interior and exterior views and dimensions.
 - 2) Accessory device data including catalog cut sheets on all control components.
 - 3) Bill of Materials.
 - 4) Sequence of operations.
 - 5) Drive memory map for Ethernet communication link with AGS Control System
 - 6) Wiring diagrams.
- f. Instrumentation
 - 1) Manufacturer and model.
 - 2) Catalog instrument data sheets.
 - 3) Materials of construction.
 - 4) Temperature rating.
 - 5) Special requirements.
 - 6) Operation and maintenance manuals
 - 7) Installation details.
- g. In-line Intake Filter Silencer
 - 1) Sound attenuation at each octave band.
 - 2) Filter particle arrestance and efficiency.
 - 3) Filter and housing material including coating information.
 - 4) Filter housing dimensions.
 - 5) Initial pressure drop at rated flow.
 - 6) Final pressure drop at rated flow prior to filter element change.
- h. Blower and Discharge Header Blowoff Silencers
 - Dimensions and connection sizes and types.

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- Sound attenuation at each octave band.
- Materials of construction including packing materials.
- 4) Pressure drop at rated air flow.
- i. Check Valve

1)

- 1) Manufacturer and model.
- 3) Dimensions.
- 5) Materials of construction.
- 7) Pressure drop at rated air flow.
- j. Butterfly Valves and Actuators
 - 1) Manufacturer and model.

- 2) Cv values at 10 degree increments from full open to full closed.
- 3) Materials of construction.
- 4) Temperature rating.
- 5) Power requirements.
- 6) Operating speed.
- 7) Positioner accuracy.
- 8) Wiring diagrams.
- k. Accessories
 - 1) Name of manufacturer.
 - 2) Equipment data.
 - 3) Drawings.
 - 4) Wiring diagrams and schematics.
- 1. Certified Shop Test Reports
 - 1) Performance test plan including dimensioned arrangement drawing, instrument calibration certificates, and data collection sheets.
 - 2) Performance curves.
 - 3) Pressure instrument calibration procedure.
 - 4) Rotor balancing report.
 - 5) Test data.
 - 6) Sample calculations showing correction of test conditions to contract conditions for one operating point, however all points need to be shop tested.
 - 7) Method of wire power measurement and items included.
 - 8) Measured power factor.
- B. Operation and Maintenance Manuals
 - 1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4. DELIVERY, STORAGE, AND HANDLING

Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.5 SPARE PARTS

- A. Availability of Replacement Parts
 - 1. The blower manufacturer shall submit certification that they will have replacement parts available for the blower units supplied by them for a period of 20 years. Replacement parts

available shall include but not be limited to replacement impellers, bearings, and VFDs. The manufacturing method for the replacement impellers shall be identical to that of the original impellers to ensure similar machine efficiency.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. The blowers will provide low pressure aeration air to the AGS reactors. The blowers shall be suitable for the following service conditions:

Seismic design requirements	See Meteorological and	l Seismic Design			
	Criteria section	\mathbf{N}^{-}			
Site Elevation	702	ft			
Barometric pressure	14.3	psia			
Indoor ambient air temperature range	40 to 104	°F			
Summer Primary Design Conditions:					
Temperature	100	°F			
Relative humidity	60	%			
Summer Secondary Design Conditions:					
Temperature	115	°F			
Relative humidity	90	%			
Winter Design Conditions:					
Temperature	0	°F			
Relative humidity	10	%			

- B. Parts shall be interchangeable between units of similar size and capacity to extent practical.
- C. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Blower packages shall be designed for the operating conditions as follows:

Blowers

Blower Designation	AGS Blowers
Blower tag numbers	BLW-1510
	BLW-1520
	BLW-1530
Installation	Indoors

Operation	Parallel	
Maximum Inlet pressure loss	0.3	psi
Inlet pressure at the blower suction flange	14.0	psia
Minimum rated discharge pressure at design conditions	11.0	psig
	25.3	psia
Minimum pressure rise to surge at all specified design points along the constant speed curve	0.3	psi
Summer Design Point (Summer Primary Conditions)		00-
Design Point 1 (DP1)		, Y
Capacity at rated discharge pressure and summer design conditions	2,970	scfm
Maximum guaranteed package Wire-to- Air* power required for DP1	157	hp
Winter Turndown Point		
Design Point 2 (DP2)	S~	
Capacity at rated discharge pressure and winter design conditions	1,680	scfm
Maximum guaranteed package Wire-to- Air* power required for DP2	73	hp
Minimum capacity at rated discharge pressure and summer secondary conditions	2830	scfm
Maximum unfiltered vibration displacement (peak-to-peak), as measured at any point on the blower package	0.75	mils
Maximum package drive motor rating	200	hp
Maximum package overall dimensions	Refer to Drawings	
In-Line Intake Filter (Process Air)		
Type	Cartridge filter/silencer	
Maximum initial pressure drop	2	in wc
Maximum face velocity	50	ft/min
Particle arrestance (removal percentage/size)	99.97/1	%/µm
Sound attenuation		
Octave band 63	10	dB
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Octave band 125	14	dB
Octave band 250	17	dB
Octave band 500	20	dB
Octave band 1000	22	dB
Octave band 2000	21	dB
Octave band 4000	21	dB
Octave band 8000	21	dB
Package Air Filters (process, inverter cooling and electronics cubicle)		S
Туре	Panel	
Maximum initial pressure drop	Per Supplier	in wc
	0	
Maximum face velocity	Per Supplier	ft/min
Particle arrestance (removal percentage/size)	98/10	%/µm
Discharge Flexible Connection		
Number of arches		
Size	10*	inches
Minimum Lateral movement capability	1-1/4	inches
Maximum Lateral spring rates	1052	lbs/inch
Minimum Axial movement capability	1-3/4	inches
Maximum Axial spring rates	1148	lbs/inch
Maximum face-to-face length	8	inches
Temperature rating	300	°F
Blow-off Flexible Connection		
Number of arches	1	
Size Size	6*	inches
Minimum Lateral movement capability	1	inch
Maximum Lateral spring rates	802	lbs/inch
Minimum Axial movement capability	1-3/4	inches
Maximum Axial spring rates	826	lbs/inch
Maximum face-to-face length	6	inches
Temperature rating * Discharge flexible connection and blowoff flexible co	300 onnection sizes shall ma	°F atch the

respective connection sizes for the blower provided. Sizes may vary with vendor. If different sizes are provided, the movement capabilities and spring rates shall be comparable to the specified manufacturers and models.

Blower and D	Discharge Head	er Blow-off Silencers
Dio nei una L	/ibellarge liteau	

Туре	Annular Abso	rption
Sound attenuation		
Octave band 63	8	dB
Octave band 125	10	dB
Octave band 250	14	dB
Octave band 500	19	dB
Octave band 1000	30	dB
Octave band 2000	33	dB
Octave band 4000	30	dB
Octave band 8000	28	dB

B. Each blower package shall comply with the following maximum guaranteed Performance power guarantee table:

		Barometric			Design	Guaranteed
Guarantee		Pressure	Inlet	Discharge	Conditions	Package Wire-
Points	Capacity		Pressure	Pressure		to-Air Power*
#	scfm	psia	psia	psia	°F / %RH	hp
DP1	2,970	14.3	14.0	25.3	100/60	157
DP2	1,680	14.3	14.0	25.3	0/10	73

- 1. *Measured power and guaranteed power shall be wire-to-air and shall include all losses associated with package electrical input power, including, but not limited to, the motor, adjustable frequency drive, harmonic filter, and cooling system. Harmonic filter losses shall be included even if the harmonic filter is mounted external to the blower package.
- 2. Standard cubic feet per minute, scfm, is defined as air at 14.7 psia, 68°F and 36 percent relative humidity. Blowers shall be capable of providing the specified mass flow in scfm throughout the entire operating range including at the specified summer conditions.
- 3. Blower performance curves shall be matched for units operating in parallel. Each performance curve shall be sloped so that the discharge pressure is continuously decreasing with increasing flow. Blowers shall be designed to be capable of coming online against a fully pressurized discharge header.

2.3 ACCEPTABLE MANUFACTURERS

- A. Air bearing blowers shall be manufactured and packaged by Aerzen or APG Neuros, without exceptions.
- B. Blower packages shall be UL 1450 or UL 508 listed.

2.4 MATERIALS

Flexible connection

Blow-off valve

Blow-off Silencer Discharge header blow-off silencer Discharge header blow-off valve Check Valve Elastomeric, arched type

Steel body with manufacturer's standard internals

Steel, ASTM A36 Steel, ASTM A36 Refer to Industrial Butterfly Valves section Cast iron body, Aluminum split disc, Viton seat, full port, elastomeric hinge.

2.5 CONSTRUCTION

- A. Casing
 - 1. The casing shall be of aluminum alloy ASTM 356. Suitable lifting lugs shall be provided for ease of handling and installation.

B. Impellers

1. Impellers shall be cast or milled stainless steel or aluminum alloy construction and shall be of the backswept three dimensional high efficiency configuration designed using Computational Fluid Dynamics (CFD) with two stages in one (axial and centrifugal) and with first lateral critical speed at least 120% of the maximum allowable operating speed. Cast impellers shall be accurately formed and machined on all exterior surfaces. Each impeller shall have uniform sections, smooth surfaces, shall be free from cracks and porosity, and shall be dynamically balanced.

C. Shaft and Seals

- 1. Blower and shaft shall be machined from heat-treated, forged steel, titanium alloy, or aluminum and suitably ground. Any responsive lateral critical speed of the rotating assembly shall be at least 5 percent from the normal operating speed. Any torsional resonance of the package shall be at least 20 percent above or 20 percent below normal operating speed. All rotating elements shall be dynamically balanced and conform to ISO 1940 or ISO 14839, as required.
- 2. The shaft seals shall be of a non-contact type, and operated dry.

D. Bearings

- 1. Bearings shall be the non-contact air foil type, producing minimal wear, minimal friction, and minimal vibration. Regardless of theoretical bearing life calculations, the bearings shall be sized for a minimum of expected 10 years between major overhauls.
- 2. Air bearings shall be designed for a minimum of 20,000 touchdowns at high speeds. Blower manufacturer shall submit test data verifying the minimum number of touchdowns or hard landings.

E. Enclosure

- 1. Each blower shall be supplied with an acoustical enclosure, complete with frame, walls, roof, and vent panels to provide an estimated overall free field sound level over the operating range as specified herein. The enclosure shall cover the entire blower package. The sound enclosure shall be designed for easy inspection and maintenance of all blower package components. Quick release panels, each less than 60 lbs shall provide easy and quick access for routine maintenance of the blower and the package components. Should the panels be heavier than 50 lbs, hinged doors must be supplied, with the appropriate frame, reinforcements and supporting elements. Electrical components, instrumentation and instrument connections shall not be mounted or interface with moving panels of the sound enclosure. Operator shall not be required to reach over any component of the blower package to perform maintenance. The sound enclosure shall be airtight at rated operating conditions.
- 2. The blower manufacturer shall be responsible for attenuating noise and vibration in the blower package such that no special installation base shall be required nor shall any vibration from the blower package be transmitted to the base or the piping.
- 3. The blower package shall be anchored to the concrete equipment base to resist seismic loads.
- 4. The blower manufacturer shall be responsible for providing an adequate ventilation system as part of the enclosure to provide adequate air movement and cooling inside the enclosure at the specified ambient temperature conditions.
- 5. The blower enclosure shall include process air connections for intake, discharge, blowoff, and equipment cooling. The blower air intake connection shall be piped directly to the impeller casing inlet flange. Inlet air connections which discharge into the package without being piped directly to the impeller casing inlet flange are not acceptable. All process connections shall be flanged with diameter and drilling conforming to ANSI B16.5, Class 150.
- 6. If the electrical compartment is open to the blower side of the enclosure, the compartment filters shall be metal frame, pleated, synthetic, as manufactured by Endustra without exception and shall fit tightly within the filter frame to prevent air bypass. If the electrical compartment is isolated from the blower such that no air can pass between it and the blower compartment, panel filters may be the manufacturer's standard metal frame pleated filter or as manufactured by Endustra. No penetrations into the blower side of the enclosure will be acceptable other than those which are specifically required for process connections, unit cooling, and maintenance access panels. All penetrations shall have proper air filtration as specified herein or be fully sealed to prevent air bypass of main air filter. Penetrations for wiring or other equipment that pass into the blower compartment of the enclosure will be fully sealed to prevent air flow bypass.
- 7. Each enclosure shall be provided with a safety switches to shut down the blower if an enclosure door is opened.
- F. Lubrication
 - 1. No lubrication shall be allowed, blower shall be oil-less.

2.6 ACCESSORIES

- A. The blower package electronics, including but not limited to the VFD and the harmonic filter shall be factory coated with a conformal coating that complies with the IEC60721-3-3 3C2 environmental classification condition.
- B. In-line Intake Filter Silencer
 - 1. Each blower package shall be provided with an individual cartridge type, in-line intake filter silencer with side access. In-line intake filter silencer shall be shipped loose for installation by the Contractor, in the piping as indicated on the Drawings. Each individual intake shall be piped from outdoors, as indicated on the drawings. The blower package shall be provided with a flanged connection to allow connection of the inlet air piping.
 - 2. Each inline-intake filter silencer shall be of all-welded steel construction with a powder coated epoxy exterior, replaceable, dry, hydrophobic synthetic polyester filter element, and flanged inlet and outlet connections with diameter and drilling conforming to ANSI B16.1, Class 125.
 - 3. Each inline-intake filter silencer shall be provided with adjustable support legs and any necessary mounting accessories.
 - 4. Filter silencer shall be Endustra "Tri-Vent Series K08" without exception.
- C. Package Panel Filters
 - 1. The electrical/electronics cubicle panel filters, inverter cooling and package process air filters shall be pleated synthetic media of a type similar to the cartridge filters. Media shall be glued into the steel frame, gasketed into the housing, and shall be carefully sized for a tight fit to prevent and eliminate the bypass of unfiltered air. The frame shall not be deformed and the corners shall be square. Panel filter elements shall include full-faced neoprene gaskets and 98% efficient at 10-micron. Panel filters shall be manufactured by Endustra, no exceptions.
- D. Flexible Connections
 - 1. Elastomeric, arched type flexible connections shall be provided in the inlet, discharge and blow-off piping adjacent to each of their respective blower connections as specified herein and as indicated on the Drawings.

2. Minimum piping movements allowed for each discharge and blow-off flexible connection shall be as specified herein. The number of arches shall be as specified herein or as needed to meet the specified spring rates and movement capabilities. The inlet flexible connection shall be suitable for 7 psi [50 kPa] vacuum service. The discharge and blow-off flexible connections shall be suitable for a pressure of 15 psig and temperature of 300° F. Inlet flexible connections shall be single arch, General Rubber Type 1100, or equal. Discharge and blow-off flexible connections shall be General Rubber Type 1100 with retaining rings and Kevlar reinforcement, or equal, with the number of arches, spring rate, and movement as indicated herein.

- E. Pressure Transmitters
 - 1. Pressure transmitters shall be provided and installed on the suction and discharge side of each blower within the blower enclosure. Pressure transmitters shall conform to the requirements specified in the Pressure and Level Instruments section.
- F. Differential Pressure Switch
 - 1. A differential pressure switch shall be furnished to Contractor for installation at the outlet of the inline-intake filter. The switch shall have an adjustable range from 0 to 10 inches water column vacuum. The pressure switch shall be used for annunciation of high pressure across the filter on the blower control panels.
 - 2. Each switch shall be field adjustable and shall have a trip point repeatability of better than 1 percent of actual pressure. Contacts shall close for alarm annunciation. Differential pressure switches shall conform to the requirements specified in the Pressure and Level Instruments section.
- G. Draft Gauge
 - 1. A draft gauge having a range from 0 to 10 inches water column shall be furnished to Contractor for installation across the inline-intake filter silencers.
 - 2. The gauge shall have minimum 3-1/2 inch dial, pressure taps, fittings for 1/4 inch metal tubing, vent valves, mounting brackets, and an adjustable signal flag.
 - 3. The draft gauge shall be "Dwyer 2000 Series Magnehelic Differential Pressure Gages" manufactured by Dwyer Instruments, Inc. or equal.
- H. Temperature Transmitters
 - 1. A temperature transmitter shall be provided and installed on the suction and discharge piping of each blower within the blower enclosure. Temperature transmitters shall conform to the requirements specified in the Temperature Instruments section.
- I. Resistance Temperature Detectors
 - Each temperature detector shall be a nominal 100 ohm, three or four wire, hermetically sealed, platinum resistance element. The sensing element shall be enclosed in an AISI Type 316 stainless steel outer sheath. Accuracy shall be ± 1°F over the specified operating range.
 - >2. Each temperature detector shall be provided with a thermowell. Unless otherwise indicated in the drawings or the Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel.

- J. Resistance Temperature Transmitters
 - 1. Each transmitter shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. The transmitter shall be designed for a resistance temperature detector input and shall have a 4-20 mA dc output.
- K. Blower Blow-off Silencers
 - Individual air blow-off silencers shall be provided for each blower by the blower supplier as shown on the Drawings and shipped loose for installation by the Contractor, if the silencer is external to the blower enclosure. Silencer shall be annular absorption style employing a single or multi-stage diffuser, and containing an acoustic core to decrease high frequency noise. The silencer shall attenuate 35 dB at 1000 hertz. Packing for the blowoff silencer shall be suitable for low pressure air velocity of up to 6,500 fpm and continuous operation at 300° F. The silencer shall be of all-welded steel construction with prime painted exterior surfaces and flanged connections with diameter and drilling conforming to ANSI B16.1, Class 125. Blowoff silencers shall be sized as indicated on the Drawings. Silencers shall be Stoddard, Universal, or equal.
- L. Blower Blow-off Valve
 - 1. Each blower shall be supplied with one electrically or pneumatically operated blowoff valve to be furnished by the blower supplier. Power supply to the blowoff valve shall be provided by the blower control panels, and all power supply and control wiring between the blower control panels and the valve actuator shall be provided by the blower manufacturer. If the manufacturer's standard blowoff valve is pneumatic, the air supply shall be supplied from the blower discharge. The blowoff valve shall be the blower manufacturer's standard and shall be located as shown on the Drawings. If the manufacturer's standard blowoff valve has the capability of being used with limit switches, open and close position limit switches shall be provided.
- M. Discharge Header Blow-off Silencer
 - A discharge header blow-off silencer shall be provided at the common discharge header blow-off line as shown on the Drawings and shipped loose for installation by the Contractor. Silencer shall be external to the blower enclosure. Silencer shall be annular absorption style employing a single or multi-stage diffuser, and containing an acoustic core to decrease high frequency noise. The silencer shall attenuate 30 dB at 1000 hertz. Packing for the blowoff silencer shall be suitable for low pressure air velocity of up to 6,500 fpm and continuous operation at 300° F. The silencer shall be of all-welded steel construction with prime painted exterior surfaces and flanged connections with diameter and drilling conforming to ANSI B16.1, Class 125. Blowoff silencers shall be sized as indicated on the Drawings. Blowoff silencer orientation and connection locations as shall be as shown on the Drawings. Silencer shall be provided with minimum 3 adjustable support legs and mounting accessories. The silencer shall be all valves section. Silencers shall be as specified in Miscellaneous Ball Valves section. Silencers shall be Stoddard, Universal, or equal.
- N. Discharge Header Blow-off Valve
 - 1. The header blowoff piping shall include an electric, modulating type butterfly valve. Butterfly valves shall be lugged wafer type as specified in the Industrial Butterfly Valves

section. Motorized actuators shall be as specified in the Valve and Gate Actuators section. The position of the header blow-off valve shall be automatically controlled by the AGS System PLC based on required blower header pressure or air flow setpoint. When the total required air flow to the AGS reactor tank is less than the maximum turndown capability of one blower, the header blowoff valve shall automatically modulate to blowoff excess air flow.

- 2. If air bearing blowers are provided, the blower supplier shall be responsible for controlling the blow-off valve such that minimum required system backpressure is maintained to protect the air bearing blowers.
- O. Valves and Actuators
 - 1. Motorized blower discharge isolation valves and check valves shall be furnished by the blower manufacturer and shall be as specified in the Industrial Butterfly Valves Section, Check Valves Section, and the Valve and Gate Actuators Section, respectively.

2.7. NOISE EMISSIONS

- A. The blower unit, including the enclosure and openings, shall be designed to limit the noise to approximately 80 dBA free field at 3' from the enclosure.
- 2.8. BALANCE
 - A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibrations shall be sufficient cause for rejection of the equipment. Vibration limit shall not exceed the value specified herein. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided.

2.9 DRIVE UNITS

- A. Each blower shall be the direct drive type driven by a high speed, permanent magnet synchronous motor and an adjustable variable frequency drive.
- B. Electric Motors
 - 1. Each blower shall be supplied with a motor rated 460 volts ac, 3 Phase, 60 Hertz. The motor shall have a 1.15 service factor. The motor shall be inverter duty rated and be able to start under the starting conditions required. Blower manufacturer shall be responsible for coordinating the starting torque requirement of the blower and the motor. Certified tests shall be submitted to the Engineer prior to shipment of the equipment.
 - 2. Additional requirements for the blower motors include the following:
 - a. Maximum HP: 200 HP, continuous duty.
 - b. Terminal Boxes: Cast iron, gasketed, separate boxes for motor leads and heater leads. Boxes shall have a ground lug. There shall be a neoprene lead seal separator gasket.
 - c. Stator Temperature Detector: Two thermal protectors in the stator windings (one each end). Rod and tube type or similar that is sensitive to rate of rise as well as temperature.
 - d. Standards: Must be listed by a Nationally Recognized Testing Laboratory (NRTL).

- e. Ground Pad: There shall be a grounding pad near the base of the motor.
- f. High Temperature Shutoff: Control logic shall be provided that monitors the blower discharge temperature and shuts off the blower when the discharge temperature exceeds a high temperature alarm condition for a period of time.
- g. Vibration Detection System: A solid state vibration detection system shall be provided for each blower motor. The system shall monitor and transmit the vibration of the blower motor to the blower control system. Alarm and shutdown alarm shall be provided for remote indication to alert the operator of high vibration conditions and shut off the blower to protect it from damage.
- h. Insulation: Epoxy coated or varnished class H limited to Class H rise.
- i. Ambient temperature: 104° F ambient
- j. Bearings: Air foil bearings rated as specified herein.
- 3. Each motor terminal box shall be sized to accommodate the installation of a current transformer, and all incoming power and control cable as indicated on the Drawings. Current transformers shall be furnished as required for proper control and operation of the blower motors.

2.10 CONTROLS AND CONTROL PANELS

- A. Control System Supplier.
 - 1. The AGS System Supplier shall provide and program the AGS control system to control the blowers to deliver the desired air flow to the AGS reactors. The blower supplier shall provide a blower local control panel for each of the blowers for blower protection controls and automated speed adjustment based on air flow/discharge pressure requirement.
 - 2. Refer to the control description in the Software Control Block Descriptions section for the required aeration controls functionality.
- B. AGS Control System.
 - The AGS control system shall be used to control and monitor each individual gearless turbo blower through the blower local control panels in order to achieve the desired air flow/pressure setpoint. The AGS control system shall be programmed by the AGS System Supplier to integrate, control, and monitor the blowers, the AGS reactor air control valves, discharge header blowoff control valve, AGS reactor manifold blowoff control valve, the AGS reactor aeration air flow through the thermal dispersion flow meters, and the dissolved oxygen concentrations from the AGS reactor's DO analyzer network, and other I/O. Each blower PLC shall communicate with the AGS control system via Ethernet communication as shown on the Control Block Diagram. Programming shall meet the general requirements of the Software Control Block Descriptions section. This specification provides a general description of the blower control strategies as well as other pertinent control strategies used to program each blower PLC. Blower supplier shall coordinate with the AGS System Supplier for more specific control requirements for the blowers.

C. Blower Control Panel

- 1. Each turbo blower shall be equipped with a control panel that includes a PLC or microprocessor controller, a UPS, an integral OIT, a power monitor and integral variable frequency drive (VFD) controller for motor speed control. Each control panel shall be integral to the blower package and shall be suitable for the conditions specified herein. Each control panel shall be preassembled with the blower unit and pre-tested at the factory as a complete assembled unit. Each blower control panel shall contain all necessary controls to open and close the associated blowoff valve when required. Blower controls shall be accessible through the OIT. The blower PLC/microprocessor shall communicate with the AGS control system via a CAT6 connection. The Ethernet communication protocol shall be coordinated with the AGS System Supplier.
- 2. A main thermal magnetic circuit breaker with external operating handle, lockable in the off position, shall be provided. A defeatable door interlock shall be provided such that the portion of the control panel which contains 480 VAC components cannot be opened with the main circuit breaker energized. The circuit breaker shall have a 65,000 amp interrupting rating at 480 VAC.
- 3. Each blower control panel shall be provided with a microprocessor-based, digital power monitor for incoming line metering. Currents, voltages, active power, reactive power, power factor, watt-hours, frequency, and demand values shall be available for display. Total harmonic distortion waveforms shall also be available. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. All current transformers, voltage transformers, and control power transformers required for connections to the power monitor shall be provided and mounted in each blower control panel. The digital power monitors shall be GE PQM II with GE Multinet module without exception.
- 4. The power monitors shall be provided with Modbus/TCP communications capabilities such that all measured and calculated values within the power monitor can be monitored by the AGS Control System and Plant Control System. Power monitors shall be connected to the Ethernet switches located in the blower local control panels by CAT 6 cable. For additional information see Control Block Diagrams.
- 5. Each panel shall be provided with a LOCAL REMOTE selector switch. When in the LOCAL position the blower, the blower speed, and blower blowoff valve shall each be controlled separately using panel mounted START & STOP, INCREASE & DECREASE, and OPEN & CLOSE pushbuttons, respectively. When in the REMOTE position the blower shall be started and stopped by commands from the blower PLC/microprocessor, and the blower speed and blower blowoff valve shall each be controlled by signals from the AGS control system.
- 6. Each control panel shall provide one isolated, maintained 'run' relay contact, rated 5 amps minimum at 120 VAC, to the VFD controller to start and stop the blower motor. When the selector switch is in the LOCAL position, the 'run' contact shall close when the blower START pushbutton is pushed, and open again when the STOP pushbutton is pushed. When the selector switch is in the REMOTE position, the 'run' contact shall open and close to start and stop the blower motor in response to changes in state of the blower RUN command from the AGS control system.

- 9. The operator interface terminal shall indicate at least the following:
 - a. Control power on indication.
 - b. Blower running, remote and blower off indication.
 - c. Approaching surge and surge indication.
 - d. Approaching overload and overload indication.
 - e. High intake filter differential pressure alarm.
 - f. Startup/shutdown sequence failure alarm.
 - g. Blower speed, airflow and pressure indication.
 - h. Blower/motor vibration warning and blower/motor vibration shutdown.
 - i. Blower blowoff valve open/close indication.
 - a. Blower fail
- 12. All alarm conditions that result in blower shutdown shall require a manual reset from each blower control panel. All remote annunciation contacts alarming a shutdown condition shall stay in the alarm state until manually reset.
- 13. Blower controls shall include built-in temperature and pressure sensors.
- 14. When running, the blower shall shutdown on the following conditions:
 - a. When initiated by pushing the local OIT stop button, pushing the local hardware stop button if available or by stop signal from the AGS control system.
 - b. When blower abnormal conditions are detected by software shutdowns programmed into the blower PLC/microprocessor controller such as high inlet air temperature, high motor temperature, sequence failure, discharge valve is not fully open within manufacturer's recommended time period after blower has started, blowoff valve is not fully closed within manufacturer's recommended time period after blower has started, high discharge pressure or temperature, high differential pressure across the intake air filter, high motor amps, surge.
 - b. When an emergency stop condition is detected by hardware components of the blower package such as by pushing "Emergency Stop" button, surge, vibration danger, cabinet door open, or PLC/microprocessor controller failure. "Emergency Stop" button shall be equipped with a cage.
- 15. Each blower control panel shall limit the number of starts per hour and the minimum time period between starts to values acceptable to the blower and motor manufacturers.

D. Surge Control

1. The surge system shall sense unbalance/surge conditions through the PLC/microprocessor controller by pressure and flow-sensing devices, or through a combination of inlet, discharge and surge temperature sensing devices, specified herein or in the manner which is the blower manufacturer's standard, to prevent a surge condition from damaging the blower. The control system shall prevent an approaching surge condition. Detection of surge conditions shall shut down the blower.

- E. Panel Fabrication Requirements
 - 1. Each of the blower control panels shall be NRTL Listed and shall be a NEMA Type 12 enclosure constructed of 14 gauge steel minimum, with doors on the front. The enclosures shall be the standard product of a manufacturer specializing in electrical enclosures. Enclosure doors shall be essentially full height, gasketed, continuously hinged with chrome-plated 3 point latches and single oiltight operating handles with provisions for locking. The panels shall be sized by the blower manufacturer to house the electrical and control devices described herein and as required to provide a complete controls installation. Additional requirements for the control panel components and construction of the control panels are specified in the Panel Mounted Instruments section and the Panels, Consoles and Appurtenances section.
 - 2. Indicating lights on control panels and symbols displayed on the OIT screens shall meet the Owner's color designation standard.

<u>Color</u>	Meaning
Red	Associated equipment or device is "running", "open", or is in an "unsafe" state or position.
Green	Associated equipment or device is "stopped", "closed", or is in a "safe" state or position.
Amber	Associated equipment or device has "failed" or a process alarm condition is present or imminent.

- 3. Illumination of each blower control panel interior shall be provided by ceiling-mounted LED lamp fixtures. Fixtures shall be provided with a plunger switch inside the enclosure door. A duplex grounded receptacle shall also be provided within the control panel. The light and receptacle circuits shall be fused independently from other panel circuits.
- 4. Power and Control Wiring
 - a. The control panels shall be completely wired with provisions for terminating all remote wiring on IEC rated terminal blocks. Multi-tier terminal blocks shall not be used. The terminal blocks shall be marked to agree with the manufacturer's wiring diagram. Control terminal shall be sized for No. 14 AWG copper wire. All interconnecting wiring and wiring to terminals for external connections shall be not less than No. 14 AWG copper for control and No. 12 AWG for power, insulated for not less than 600 volts with a moisture and heat-resistant material and flame-retardant nonmetallic covering. All wiring shall be grouped or cabled and firmly supported to the panel and shall be numbered at each termination with permanent labels corresponding to the schematic. Not less than 10 percent spare terminals shall be provided. All conductors used within the control panel shall be type MTW stranded copper wire, no exceptions.
- F. Controllers and Displays
 - 1. Programmable Logic Controllers
 - a. The blower control panels shall be provided with programmable logic controllers (PLCs).

BV Project No. 411752 12/20/2022 PLCs shall conform to the requirements specified in the Programmable Logic Controllers section.

- b. Programming/configuration services, startup, and commissioning of the PLC shall be provided by the blower manufacturer. The PLC shall use non-volatile flash memory card or SD memory card for storage of the PLC program. The processor shall automatically download the PLC program from the memory card upon startup after an extended period without power. The memory card shall be programmed by the PLC or PLC software. In addition, the PLC processor shall be equipped with a USB port that allows the PLC program to be downloaded or uploaded from a thumb drive.
- c. As shown on the P&IDs and control system block diagrams, each blower PLC\microprocessor controller shall communicate with the AGS control system over an Ethernet communication link. The necessary communication ports or modules for this Ethernet communication shall be provided.
- d. The blower manufacturer shall assemble the data into data packets that can be easily transferred over the Ethernet link. The blower manufacturer shall coordinate the data transfer with the AGS System Supplier by providing a list of signals and addresses of the status and alarm data. I/P addresses for the blower system devices shall be coordinated with the Owner.
- e. The blower manufacturer shall provide complete electronic copies of all PLC\microprocessor controller, graphics, I/O and configuration program data after the acceptance of the system.
- f. The minimum PLC/microprocessor controller inputs and outputs are provided in the I/O List and shown on the P&IDs.
- 2. Operator Interface Terminal (OIT)
 - a. Each blower control panel shall be provided with an OIT to monitor and control the operation of the blower equipment. OITs shall conform to the requirements specified in the Programmable Logic Controllers section.
 - b. Graphic screens that access all functions and setpoints necessary for comprehensive control of the blower system shall be configured. The blower equipment that is monitored by the blower PLC/microprocessor controller shall be displayed on graphic screens. In addition, a screen on the OIT shall be developed that lists all of the alarms and interlocks that would prevent the blower from operating. From this screen, the operator can quickly identify the reason why the system shutdown. The blower manufacturer shall configure, establish communication with the associated blower system PLC/microprocessor controller, startup, and commission the OIT.
 - c. At a minimum, the blower data, status conditions, and alarms that are listed above (data transferred to the AGS control system) shall be individually displayed and/or annunciated on each Blower Control Panel OIT. The data associated with an individual blower shall be displayed on that blower's control panel OIT.

G. Ethernet Switches

 A panel mounted, managed Ethernet switch shall be provided in each blower control panel. The Ethernet switches installed in each blower control panel shall be used to establish communication between the blower PLC/microprocessor controller, each blower control panel OIT, the blower power monitor, and the AGS control system. These switches shall support the quantity of 10/100Base TX ports to meet the functionality indicated on the drawings, with a minimum of 20% spare 10/100Base-T, RJ-45 ports. A minimum of four UTP ports shall be provided. The switches shall be suitable for installation in industrial environments and shall be DIN-rail mounted. All necessary memory upgrades, software feature sets, and cables needed for proper operation shall be furnished with the switches. The blower manufacturer shall configure the managed Ethernet switch and establish communication with all of the connected devices. Switch hardware shall conform to the requirements specified in the Network Systems section.

H. Uninterruptible Power Supply (UPS)

- UPS units shall be provided in each control panel to power the PLC/microprocessor controller, OIT, and Ethernet switch for at least 30 minutes when power is lost to the panel. The blower manufacturer shall be responsible for ensuring the UPS is properly sized and installed and all necessary CPT's and interconnection wiring are provided to ensure a fully functional 120 VAC UPS backup system. For additional UPS requirements, blower manufacturer shall refer to the Panels, Consoles and Appurtenances section.
- I. Variable Frequency Drives
 - 1. Each blower shall be provided with an variable frequency drive (VFD) integral to the blower package. The blower manufacturer shall be responsible for furnishing the variable frequency drive, for matching the motor and drive, and for coordinating the collection of data and the design effort to limit harmonics to the levels specified below. The VFD shall be factory coated with a conformal coating that complies with the IEC60721-3-3 3C3 environmental classification condition.
 - 2. Each VFD furnished in the integral blower control panel shall include an input circuit breaker. VFDs shall be UL, TUV or ETL listed and shall comply with the latest applicable standards of ANSI, NEMA, IEEE, and the National Electrical Code.
 - 3. The variable frequency drive unit shall be an adjustable frequency converter which will convert 480 VAC ($\pm 10\%$), 3 phase, 60 Hz ($\pm 2\%$), input power into an adjustable frequency output in an ambient temperature of 40 to 120°F. Each drive shall be of sufficient capacity and shall produce a quality output wave form for stepless speed control. The controller shall be suitable for, and coordinated with, the thermal, electrical, and mechanical characteristics of the motor furnished.
 - 4. Six-pulse drives shall be furnished. Drives shall be of the pulse-width modulated type and shall consist of a full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage. VFDs shall be equipped with an input line reactor contained within the blower control panel and an externally or internally mounted input harmonic filter.

- 5. The VFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.
- 6. The drive shall have self-diagnostics for detection of failed electronic circuitry. All printed circuit boards shall have status indicating lights, or status of each board shall be available from the diagnostic indicators on the drive's LCD display. The drive shall include fault detection and trip circuits to protect itself and the connected motor against line voltage transients, overtemperature, power line undervoltage and overvoltage, and output overcurrent. The drive shall be protected by fast-acting, current limiting input fuses. The drive shall be capable of sustaining 110 percent of motor rated full load current. The drive shall have a current limiting feature to prevent output currents greater than 100 percent of rating. Upon return of power after outage, the drive shall not automatically restart. Remote or local manual restart shall be required. The drive shall provide electronic isolation between control/logic and power circuits.
- 7. The blower supplier shall provide phase monitoring to quickly open the blowoff valve and protect the blower if a voltage spike greater than 110% occurs.
- 8. Each drive shall have a membrane keypad with integral 2-line, 24 character minimum, LCD display mounted through blower control panel door. The keypad shall be capable of setting all drive parameters and controlling drive operation, including manual/automatic operation modes, start/stop control and alarm/trip reset.
- 9. The drive shall have microprocessor-based digital logic control fully programmable from the front panel display with nonvolatile memory for the programmed functions. Maximum speed shall be field adjustable. The speed shall increase or decrease at a linear time ramp, independently adjustable for acceleration and deceleration control. The minimum speed (zero point), and the maximum speed (span) shall be independently field adjustable. Local set points shall be entered to the controller via the front panel controls.
- 10. The input circuit breaker shall be instantaneous-trip type, and shall have an interrupting rating of at least 65,000 amperes at 480 VAC.
- 11. Six-pulse adjustable frequency drives shall be protected from incoming voltage transients with an input ac line reactor. AC line reactors shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the drive input power devices. Ac line reactors shall be K-rated per IEEE C57-110 and shall be TCI "Model KLR", or equal.
- 12. The blower manufacturer shall supply input harmonic filters for all blowers with suitable amperage rating at 480 VAC. Harmonic filters shall be selected for a THD maximum of five percent (5%) at the VFD input terminals when the drive is operating at 100% capacity. The Harmonic Filters shall be installed either in each blower control panel or in an area adjacent to the blowers as shown on the Drawings. Remotely located harmonic filters are acceptable if they are the blower manufacturer's standard. Harmonic filters shall be used on adjustable frequency drives that are not 18-pulse. The filter shall utilize an interlocking contactor which shall be automatically operated by the drive run circuit. The harmonic filter shall be protected

from corrosion by a factory applied 3C3 coating. Harmonic filters shall be sized to match the motor size and shall not be oversized. Harmonic filters shall be 480 VAC, 3 phase, delta connection and an industrial wiring harness shall be supplied. Harmonic filters shall be TCI "Harmonic Guard Series", or equal.

- 13. The Harmonic Filter shall be factory coated with a conformal coating that complies with the IEC60721-3-3 3C3 environmental classification condition.
- 14. The variable frequency drive shall have a Displacement Power Factor of at least 0.95 throughout the entire operating speed range, measured at the drive input terminals.
- J. Panel Factory Test
 - 1. Before shipment, the blower local control panels shall be electrically tested by the manufacturer.
- K. Phase Monitor
 - 1. Each blower core shall be provided with a phase monitor integral to the blower package. The phase monitor shall monitor all 3 phases on the power supply and shall trip the blower cores if the phase imbalance is greater than 110% or less than 90% of the nominal value and cause the package to shut down in a controlled manner. The phase monitor shall also open both the package blow-off valve immediately upon detection of a phase imbalance.

2.11 SHOP WITNESS TEST

- A. Blowers shall be shop tested over the capacity range from surge to maximum rated flow adequate to verify package wire-to-air power (hp). At least 60 days in advance of shop testing, test procedures shall be submitted to the Engineer for review and acceptance. Procedures shall include calibration certificates for instruments verifying calibration within the 12 months prior to test date and test setup drawings as well as blank data sheets. Following testing and prior to shipment of blowers to the site, test reports shall be submitted for review and acceptance. Reports shall include data collected, performance curves, equations for adjusting test data to contract conditions, and a sample calculation for one test point as well as flow measurement instrument data.
- B. Balancing and Overspeed Testing
 - 1. Impellers shall be dynamically balanced. If impellers are cast or welded, they shall be subjected to an overspeed test of not less than 115 percent of the maximum operating speed. Following the overspeed test, each impeller shall be carefully inspected for defects using the dye penetrant method or another equivalent method. Rotor assemblies shall be dynamically balanced. Overspeed and rotor balancing reports shall be delivered to the Engineer at least 21 days prior to the shipment of the blowers from the manufacturer.
- C. Operational Test
 - 1. Each blower shall be shop witness tested for vibration and pressure developed.

D. Performance Test

- 1. All blowers shall be shop tested for capacity and total wire power requirements at the design capacities, and at as many other capacities as necessary for accurate performance curve plotting. The isentropic head shall be converted to discharge pressure for the report. In addition the surge margin shall be verified as specified herein. The tests shall be performed in accordance with the manufacturer's standard methods, to the intent of ASME PTC-13 Wire To Air Performance Test Code for Blower Systems. Flow shall be measured in strict accordance with ASME PTC-13 and 19.5 and shall be measured on the discharge side of the blower. Test procedure information as well as test results shall be submitted in accordance with the requirements of the Submittals Procedures section. The test arrangement drawing shall include pipe sizes, instrument locations including dimensioned spacings of instruments, instrument ranges types, and models. A differential pressure sensor shall be used across the flow measurement device. Separate inlet and outlet pressure sensors shall not be acceptable. Instrument ranges shall be such that the readings are near the midpoint of the range. Dynamic pressure shall be determined downstream of the discharge cone. The test shall include measurement of discharge pressure and discharge air temperature. Piping from the blower discharge to the discharge temperature measurement location shall be insulated with a minimum of 1" thick mineral fiber insulation with a maximum thermal conductivity value of 0.24 Btu in/hr ft² °F at 75°F and shall comply with ASTM C547.
- 2. The equipment shall be tested with the contract motor, harmonic filter and VFD. If the harmonic filter is located remotely from the blower package and the harmonic filter is not included during testing, the harmonic filter losses shall be included in the wire-to-air power consumption calculations. Certified calculations from the harmonic filter vendor shall be provided to verify the power consumption of the VFD at each design point.
- 3. Input wire power shall be measured using a calibrated wattmeter. For inverter applications, the power measuring device shall have the ability to measure the corrupted sine wave through the 13th harmonic and shall not be based on normal 50/60Hz RMS sine wave for power analysis. Measured total power shall be wire-to-air and shall include all losses associated with electrical shaft power, including, but not limited to the motor, inverter, harmonic filter, and cooling system, if used.
- 4. The enclosure cooling system shall be operational during shop performance testing. Any electrical power required for cooling shall be measured as part of the input power measurement and the effect of any increased inlet process air temperature due to its being used for cooling shall be taken into consideration in determining system mass flow rate.

5. Adequate operating points, while the speed, depending on the manufacturer, is held constant, shall be recorded to generate a test curve through DP1. ASME PTC-13 requires a 5-point curve. Operating point DP2 shall also be recorded. In addition, the minimum air flow point shall be verified. For each test operating point used to generate the test curve, three readings shall be taken at four measurement locations 90 degrees apart around the circumference of the pipe for each of the following, as required by ASME PTC-13:

- a) Atmospheric pressure
- b) Ambient temperature
- c) Relative humidity
- d) Inlet pressure
- e) Inlet temperature
- f) Discharge pressure

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- g) Discharge temperature
- h) Temperature upstream or downstream of flow measurement device
- i) Pressure upstream of flow measurement device
- j) Differential pressure across flow measurement device
- 6. During testing, the speed required to produce the specified actual inlet volumetric flow (acfm) and design isentropic head shall be determined for each design guarantee point. For the 5 point curve, the speed shall be held constant. The machine shall be operated at the required speed so that a speed correction is not needed. The specified actual inlet volumetric flow (acfm) and design isentropic head for the design guarantee point being tested shall also be matched during testing. If this is not possible at shop conditions due to inadequate motor size, the motor may be operated at reduced speed while using dimensionless parameters for flow, pressure, and efficiency as described in PTC-13. Isentropic head established during testing shall include inlet filter and package losses, in addition to inlet losses as required per contract.
- 7. The surge margin shall be determined for DP2 by holding the speed constant required at that point constant and determining the surge pressure. If the surge margin cannot be achieved at a constant speed, the speed may be increased as long as the flow is not also increased.
- 8. Steady state is defined as the condition in which changes in temperature rise and isentropic efficiency within a five minute interval is less than 0.5°C (0.9°F) and 0.5%, respectively.
- 9. Failure to comply with ASME PTC-13 and testing requirements specified herein shall be sufficient cause for rejection of the equipment.
- 10. At least 30 days prior to the test, notice shall be given by Contractor to the Engineer.
- 11. The equipment shall be performance tested as a package in the manner it will operate when installed. The equipment shall be performance tested with the contract motor and VFD with the enclosure doors closed. The test results shall be adjusted by taking into account the specified inlet filter pressure loss. Any losses from the inlet filter to the package inlet shall be accounted for in the test report and head evaluation during testing. The contract harmonic filter shall also be tested if it is integral to the blower package. If the harmonic filter is remotely located from the package, the harmonic filter can be tested by the harmonic filter manufacturer and the losses shall be included in the blower performance test calculations. All power consuming components shall be included in the wire power measurement.
- 12. The Engineer and Owner will witness shop tests, inspect and check testing equipment used, and observe the calibration of pressure gauges and transducers. Pressure measurement devices calibrated at a location remote from the factory will not be acceptable. All readings are to be read manually from the certified and/or calibrated instruments. The use of computer data acquisition systems shall not be acceptable. As an alternative if used, a local direct readout shall be provided at each measurement location and direct readings shall match the data acquisition system readings within the tolerances of ASME PTC-13.
- 13. The AGS System Supplier shall furnish all air and ground transportation, lodging, miscellaneous travel expenses, and meals for two engineers and Owner for the duration of the testing of the blowers and panels and any necessary subsequent testing necessitated by failed tests.

- 14. Calibration certificates for all other instruments shall be submitted and shall indicate calibration within the previous 12 months. Calculations shall be performed to correct test data to the specified site conditions. Corrected data shall be used to plot performance curves. Curves shall include inlet cfm versus discharge pressure, and inlet cfm versus package power. Curves shall be plotted using specified site conditions for both summer and winter inlet air temperature and relative humidity conditions specified. The blower serial number shall be indicated on the corresponding performance curve. The Reynolds number correction shall be excluded in this case.
- 15. Performance testing shall be done using the contract motor and drive.
- 16. During shop testing, power factor shall be recorded, certified by the testing technician, and submitted to verify compliance with the specification.
- 17. No minus tolerance on discharge pressure and flow shall be allowed. Wire-to-air package power draw, including remotely mounted harmonic filters, shall be guaranteed ± 4 percent, respectively, or to the manufacturer's standard tolerance, whichever is more stringent. In no case shall the package power draw indicated by shop tests and corrected to specified site conditions exceed the motor nameplate rating. Exceeding the motor nameplate rating shall be sufficient cause for rejecting the equipment.
- 18. Six certified copies of the test report complete with performance curves, data, and all calculations shall be submitted in accordance with the Submittals Procedures section. The test reports shall be delivered to the Engineer at least 21 days prior to the shipment of the blowers from the manufacturer.
- E. Harmonic Mitigation Equipment
 - 1. Harmonic mitigation equipment shall be supplied to meet the harmonic standards of IEEE 519. Harmonic mitigation shall be provided by the blower supplier for each blower unit and shall comply with the requirements specified herein.
 - 2. The blower manufacturer shall supply input harmonic filters for all blowers with suitable amperage rating at 480 VAC. Harmonic filters shall be used on adjustable frequency drives that are not 18-pulse. The filter shall utilize an interlocking contactor which shall be automatically operated by the drive run circuit. Harmonic filters shall be TCI "Harmonic Guard Series", or equal.
- F. Electrical Harmonic Analysis

Submit detailed electrical calculations demonstrating compliance with the harmonic requirements specified herein.

- 2. For the purposes of the harmonic analysis, assume all units are operating excluding any standby units not required to achieve rated system capacity.
- 3. Voltage distortion for each condition shall comply with the IEEE 519 total harmonic distortion and notching criteria for General Systems. Current distortion limits shall comply with the individual harmonic order limits indicated in IEEE 519, Table 10.3.
- 4. Location of the points of common coupling shall be the MCC bus where the blowers are connected.

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- 5. The harmonic analysis shall include:
 - a. All input data and assumptions. Provide an impedance diagram illustrating the simulated system.
 - b. Explanation of methods used to perform the study.
 - c. Explanation of study results with specific recommendations on harmonic mitigation measures that will be implemented to achieve the specified limits.
 - d. All calculations and computer printouts used to arrive at the conclusions and recommendations. Include one sample hand written calculation and define all variables and constants.
 - e. Individual blower harmonic content and the combined total drives harmonic content reflected in the system supply voltage as a percent of the 60 Hz fundamental under actual load conditions from no load to full load in 10 percent load increments.
 - f. Provide a bar chart graph(s) comparing the harmonics produced by the VFD without the input filter and with the input filter at 60 and 100 percent speeds.
 - g. Analysis shall be stamped and signed by a registered electrical engineer.
- 6. Blower manufacturer or their sub (harmonic filter manufacturer or drive manufacturer) shall provide a detailed harmonic field testing plan for the Contractor to perform the harmonic field test. The test plan should include instruments to be used, verification of testing locations for voltage and current harmonic metering, verification of maximum allowable voltage and current distortion, and drive load and speed test parameters.
- G. Remedies/Liquidated Damages
 - 1. In the event that any part(s) of the aeration blower system fail(s) to meet the guaranteed or other specified performance requirements, the blower manufacturer shall guarantee that at their sole expense, they will exercise one or both of the following options:
 - a. Provide all necessary material and personnel to modify the system to meet the specified performance requirements and rerun the performance tests until satisfactory results are achieved.
 - b. Remove the part(s) of the system that is not operating properly and replace it with equipment that meets the necessary performance criteria.
 - 2. In the event that, after exercising options 1 and 2 of this paragraph any part(s) of the aeration blower system still fail(s) to meet specified performance requirements, the blower manufacturer shall provide additional equipment or replace provided equipment with higher capacity or efficiency units capable of meeting the specified performance requirements and rerun the performance tests. All costs associated with additional or replacement equipment including the cost of any required modifications to the building or any building, piping systems, other related systems, and electrical and control systems including retesting costs shall be borne entirely by the blower manufacturer.
 - 3. If the aeration blower system fails to meet the specified performance requirements after these modifications, the system shall continue to be modified until, at a minimum, full compliance is achieved with all air flow, discharge pressure, and power consumption requirements.

- 4. Should the system fail to operate at the specified performance including power consumption as indicated by the shop test, the system shall be modified through exercising options 1 or 2 of this paragraph. Failure to meet the performance shall not be remedied through a present worth penalty, except at the option of the Owner.
- 5. In the event that, after exercising the above remedies, the system fails to meet the guaranteed power consumptions but is in compliance with all other requirements, the blower manufacturer shall pay a penalty equal to the estimated present worth difference in power cost of the total factored power draw (weighted sum) of the specified operating points for each blower as calculated below:

Guarantee Design Points	Guaranteed Wire Power	Weighting Factor	Tested Package Wire-to-Air Power Corrected to Specified Site Conditions
#	HP		HP
DP1	157	0.5	
DP2	73	0.5	

$$PP = \sum_{i} ((P_a - P_g) \times W_f \times PW_f \times PC \times t)_i$$

PP = Power penalty for the total factored power draw, \$/per blower

 P_a = Actual wire power consumption as determined from performance test, kWh/day

 P_g = Guaranteed wire power consumption, kWh/day

W_f=Guaranteed point weighting factor

 $PW_f = Present Worth factor, 20 years at 5 percent discount rate = 12.46$

PC = Power Cost = \$0.08/kWh

t = Annual operation period = 365 days

i = Number of guarantee design points

a. Horsepower of the units shall be converted to kWh/day by using a multiplying factor of 17.9.

The above equation is only valid for PP>0, such that no credit shall be given for a negative power penalty. Each blower or blower package shall be analyzed individually, and it will not be acceptable for a better performing package to offset a poorer performing one.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Each blower unit will be installed in accordance with Equipment Installation section. The Contractor shall furnish, install, and place in service each blower and all appurtenances in accordance with the manufacturer's recommendations. The blower supplier shall supply blower packages shipped completely pre-assembled. Only the electrical connections and pipe connections shall be performed on site by the Contractor.
- B. Contractor shall install anchor bolts per the manufacturer's instructions and calculations.
- C. Blowers shall be installed level and plumb on 6" concrete housekeeping pads and rubber cork pads shall be installed between the blower unit baseplate and the concrete base for vibration isolation. Blowers shall be handled and installed in accordance with the manufacturer's recommendations. Anchor bolts shall be used as locating pins. Nuts shall be installed but threads shall be dislocated (stripped) to prevent tightening of anchor bolts beyond "finger tight".
- D. The equipment shall be protected after installation, but prior to final acceptance by Owner. Protection provisions shall be as recommended by the manufacturer, and shall include provisions to prevent rust, mechanical damage, and foreign objects entering the equipment.
- E. Contractor shall be fully responsible for installing all equipment in this section and conducting startup and testing in accordance with the blower supplier's written recommendations and/or requirements specified herein. The Contractor shall include in his costs all assistance required of the manufacturer to ensure proper installation; provide startup and testing assistance; and train the Owner's personnel.

3.2 FIELD QUALITY CONTROL

- A. Installation Supervision
 - a. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.

Functional Testing

- c. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- D. Performance and Other Testing
 - d. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

3.3 SYSTEM SOFTWARE CONFIGURATION

- A. The AGS System Supplier shall be responsible for the following configuration tasks:
 - 1. Program the PLC or microcomputer and OIT in each blower control panel to monitor and control the blower and any ancillary equipment associated with the blower.
 - 2. Configure the hardware and provide any necessary firmware or software programming associated with the blower system hardware configuration such as PLC device address assignments.
 - 3. Provide configuration information to AGS System Supplier at least two months before the shipment of equipment for configuration. Include specific I/O address numbering schemes for all field I/O points, database tag numbering format, address numbers of points for internal use, and other information necessary for programming the AGS control system.
 - 4. Provide complete startup, checkout, and calibration of all blower system hardware and I/O specified herein. Startup and checkout include coordination with the AGS System Supplier to ensure network communications with the AGS control system.
 - 5. Provide any programming requisite to implementing the features and functions described herein that are not a standard part of the system software.
 - 6. Provide complete electronic copies of the configured PLC programs and OIT application developed for this project after the acceptance of the system.

3.4 FIELD RUN TESTING

- A. Each blower shall be mechanically checked for proper operation. Each alarm and safety shutdown shall be checked by artificially simulating an alarm condition. Defective equipment and controls disclosed by the tests shall be replaced or corrected, and the packages placed in satisfactory operating condition. The following items shall be measured, recorded, and submitted in a field test report:
 - 1. Inlet pressure, each blower.
 - 2. Discharge pressure, each blower.
 - 3. Discharge temperature, each blower.
 - 4. Differential pressure across each filter or filter silencer.
 - 5. Pressure and temperature at downstream end of piping system and at any measurement taps provided.
 - 6. Flow measurements at any flowmeters provided.
 - Outdoor ambient temperature.
 - 8. Indoor ambient temperature.
 - 9. Barometric pressure.
- B. Test reports shall verify that the specified tests have been performed and shall state results.
- C. After installation of the units and all appurtenances, each unit shall be subjected to a field running test under actual operating conditions. The field tests shall be made by the Contractor in the

presence of and as directed by the manufacturer's field representative. The field tests shall demonstrate that under all conditions of operation each unit:

- 1. Has not been damaged by transportation or installation.
- 2. Has been properly installed.
- 3. Has no mechanical defects.
- 4. Is in proper alignment.
- 5. Has been properly connected.
- 6. Is free of overheating of any parts.
- 7. Is free of all objectionable vibration.
- 8. Is free of excessive noise.
- 9. Is free of overloading of any parts.
- 10. Shall operate as specified with the control system.
- D. Any defects in the equipment or failure to meet the requirements of the Specifications shall be promptly corrected by the blower manufacturer.
- E. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.
 - 1. The manufacturer's representative shall verify:
 - a. Each blower discharge isolation valve is fully open when operating.
 - b Each check valve is properly installed.
 - c. Piping is installed such that excessive force is not being exerted on the blower flanges.
 - 2. All costs for these services shall be included in the contract price.

3.5 WARRANTIES.

A. Manufacturer's standard one year minimum complete parts and labor warranty shall be provided for each blower for all components located within or on the enclosure including external harmonic filters and blowoff valves. The warranty shall start at the time of blower startup.

B. If selected by the Owner, a five year complete parts and labor extended warranty shall be provided for each blower for all components located within or on the enclosure including external harmonic filters and blowoff valves. The extended warranty shall start at the time of blower startup.

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High Speed Gearless Turbo Blowers

3.6 72 HOUR PARTS GUARANTEE.

A. The blower manufacturer shall provide a 72 hour parts guarantee indicating that any standard parts required for blower repair or replacement will be shipped within three working days of receipt of order, or the parts will be provided at no cost to the Owner.

3.7 TRAINING.

- A. A qualified field service technician for the manufacturer shall conduct on-site training to instruct ee. .ee. hat see used for biddings print the Owner's staff on operation and maintenance for the equipment provided herein. Specific requirements for training services are included in the Startup Requirements section and the

SECTION 43 25 13.23 - SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing guiderail mounted, single-stage, submersible, non-clog, end suction centrifugal pumping units and controls as indicated herein or on the Drawings

Pump application.	WAGS/WLC pumps
Number of pumps.	3 (2 duty $+ 1$ standby)
Pump tag numbers.	SPMP-1610, -1620, -1630
Pump location.	WAGS/WLC Wetwell

- B. Each pumping unit shall be complete with a close-coupled, submersible electric motor, variable frequency drive and all other appurtenances specified, or otherwise required for proper operation.
- C. Each pumping unit, including motor and all integral controls, shall be rated and labelled for use in a Class 1, Division 1, Group D area as defined by the National Electric Code.
- D. Each pumping unit shall be supplied with a NEMA 4X stainless steel enclosure to house all controlling equipment supplied by the pump manufacturer excluding the variable frequency drive. The enclosure shall include but not be limited to:
 - 1. Terminals to connect the premanufactured submersible cable to the field installed main power cable.
 - 2. Terminals for landing all additional submersible cable conductors as well as field conductors for signals as indicated on the Drawings.
 - 3. Control power transformers, as required for any control voltage inside the enclosure.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards (HIS).

- B. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

- C. Tagging
 - 1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag numbers shall be clearly marked on all shipping labels and on the outside of all containers.
- D. Power Supply
 - 1. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.
- E. Identification
 - 1. Pumps shall be identified in accordance with the Equipment and Valve Identification section.
- F. Coating
 - 1. Immersed supports, guiderails, and pump bases shall be coated according to Section 09 96 11 Protective Coatings. Contractor to coordinate with Pump Supplier and Engineer.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:
 - a. Pumps
 - 1) Name of manufacturer.
 - 2) Type and model.
 - 3) Tag number.
 - 4) Pump designation.
 - 5) Pump location.
 - 6) Rotative speed.
 - 7) Size of suction nozzle.
 - 8) Size of discharge nozzle.
 - 9) Net weight of pump and motor only.
 - 10) Net weight with pedestal, when specified.
 - 11) Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire-to-water efficiency, and pump input power.
 - 12) Data on shop painting.
 - b. Motors
 - 1) Name of manufacturer.
 - 2) Type and model.
 - 3) Type of bearings and method of lubrication.

- 4) Rated size of motor, hp [kW], and service factor.
- 5) Insulation class and temperature rise.
- 6) Full load rotative speed.
- 7) Efficiency at full load and rated pump condition.
- 8) Full load current.
- 9) Locked rotor current.
- c. Variable Frequency Drives
 - 1) As specified in the Variable Frequency Drives section.
- d. Moisture Detection System
 - 1) Name of manufacturer.
 - 2) Type and model.
 - 3) Enclosure rating and layout if an enclosure is specified.
 - 4) Electrical schematics and wiring diagram.
 - 5) Published descriptive data on each item of equipment and all accessories, indicating all specific characteristics and options.
- e. Control Components
 - 1) Type and manufacturer.
 - 2) Model.
 - 3) Enclosure rating.
 - 4) Published descriptive data on all components, indicating all specific characteristics and options.
 - 5) Where liquid level sensors are provided, provide mounting details.
- f. Seismic Design Requirements
 - 1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
- B. Operation and Maintenance Data and Manuals
 - 1. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE

A. Balance

All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including top of motor, shall not exceed the maximum velocity as indicated in Figure 11.6.9.4 of the governing standard.

2. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

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Submersible Pumps

1.5 SPARE PARTS

Not used. A.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- 1. Flygt
- 2. ABS/Sulzer
- 3. Grundfos

2.2 SERVICE CONDITIONS

	ACC	EPTABLE MANUFACTURERS:		Ċ
	1.	Flygt		603
	2.	ABS/Sulzer		57
	3.	Grundfos		
2	SERV	/ICE CONDITIONS	QU.	
A.	The e condi	quipment provided under this section shall be s tions:	uitable for the following serv	ice
	Maxi	mum liquid temperature.	70	° F
	Maxi	mum solids concentration, by weight.	0.2	%
	Pump	os start and stop against a closed valve.	No	
	Site e	levation.	See Meteorological and Seismic Design Criteria section	
	Chlor	ide concentration	300	mg/L

All equipment furnished shall be designed to meet all specified conditions and to operate Β. satisfactorily at the elevation indicated.

PERFORMANCE AND DESIGN REQUIREMENTS 2.3

Pumping units shall be designed for the performance and design requirements as follows: A. SPMP-1610, Pump tag numbers.

$\langle O \rangle$		1620, -1630		
Rated head.		26	ft	
Capacity at rated head.		300	gpm	
Secondary head.		38	ft	
Minimum capacity at secondary head. Operating head range for full speed continuous operation.		115	gpm	
		6 to 38	ft	
Minimum shutoff head.		44	ft	
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С.

Pump tag numbers.	SPMP-1610, 1620, -1630	
Maximum nominal pump speed.	1760	rpm
Minimum head at reduced speed.	4	ft
Capacity at minimum head at reduced speed.	240	gpm
Approximate minimum pump speed.	600	rpm
Maximum power required at pump input shaft at any point from minimum operating head to shutoff head.	4.2	bhp
Efficiency at rated head, pump.	63	%
Variable Frequency Drive losses included in the efficiency calculation	No	JP I
Maximum liquid depth in wetwell (guide-rail mounted).	16.5	ft
Minimum liquid depth in wetwell (guide-rail and skid mounted)	3	ft
Pump designed for reverse rotation at rated head.	No	
Maximum vibration velocity.	HIS	
Minimum pump discharge nozzle/elbow size.	4	in
Minimum test sphere diameter.	3	in
All specified conditions shall be at rated speed un	less otherwise i	ndicated.
Overall (wire-to-water) efficiency for variable speed pumps shall include losses in the pump, motor, and if required, variable frequency drive, and any transformers supplied as part of the variable frequency drive equipment.		

- D. The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.
- E. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.01 inch or 1 mil per inch of casing wearing ring diameter, whichever is greater.

2.4	MATERIALS		
	Stator Housing, Oil Chamber Housing, and Impeller Casing	Cast iron, ASTM A48.	
	Impeller (if semi-open)	25% chrome cast iron, ASTM A-532; or Duplex stainless steel.	
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Bottom Wearing Plate	Hardened cast iron, ASTM A48 with spiral grooves, Brinell Hardness of 650+; 25% chrome cast iron, ASTM A-532; or Duplex stainless steel.	
Shaft	Alloy steel, hard chrome plated; or martensitic stainless steel, AISI Type 416 or 420.	
Mechanical Seals	2 tandem single type, oil lubricated with silicon or tungsten carbide seal rings at all points, except the upper rotating seal, which shall be carbon.	
Discharge Base	Cast iron or fabricated steel.	
Guiderails	316 Stainless steel pipe, ASTM A312, Schedule 40S.	
Upper guiderail bracket, cable hooks, and chain hooks	AISI Type 304 stainless steel.	
Epoxy Coating		
Primer & Finish Coat	Carboline "Carboguard 891"; Tnemec "Series N140 Pota-Pox Plus."; or manufacturer's standard epoxy coating.	

2.5 PUMP CONSTRUCTION

- A. Impeller Casing
 - 1. The discharge nozzle shall be flanged, with dimensions and drilling conforming to ANSI B16.1, Class 125.
 - 2. The discharge nozzle shall be flanged and sufficiently rigid to support the pumping unit under all operating conditions.

B. Impeller

1. The impeller shall be an enclosed or semi-open one-piece casting with not more than two nonclog passages.

2. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced and securely locked to the shaft by means of a key and self-locking bolt or nut.

C. Wearing Rings

- 1. Renewable wearing rings shall be provided in the casing and on the impeller for pumps with enclosed impellers. Wearing plates shall be provided on the casing for pumps with semi-open impellers.
- 2. For pumping units less than 100 hp a renewable wearing ring or an axially adjustable wearing plate shall be provided in the casing. Casing wearing ring shall be securely
fastened to the impeller casing front cover to provide either an axial or radial running clearance. Axially adjustable wearing plate shall be arranged to permit adjustment of the axial running clearance between the impeller and plate. The wearing plate shall have an outward spiralling groove designed to force stringy solids outward and away from the impeller.

- D. Oil Chamber Housing
 - 1. The oil chamber shall contain a drain plug and a vent plug.
- E. Mechanical Seals
 - 1. Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and running in an oil chamber. Each interface shall be held in contact by an independent spring system designed to withstand maximum suction submergence. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement.
 - 2. Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended periods while pumping under load.
- F. Sealing of Mating Surfaces
 - 1. All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is needed. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.
- G. Guiderail Mounted Base
- A discharge base and discharge elbow shall be furnished by the pump manufacturer. The base shall be sufficiently rigid to firmly support the guiderails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the wetwell. The face of the discharge elbow inlet flange shall be perpendicular to the floor and shall make contact with the face of the pump discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ANSI B16.1, Class 125.
- 2. The pump and motor assembly shall be automatically connected to and supported by the discharge base and guiderails so that the unit can be removed from the wetwell and replaced without the need for operating personnel to enter the wetwell.
- 3. Sliding Bracket

- a. Each guiderail mounted pumping unit shall be provided with an integral, self-aligning guiderail sliding bracket. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions. The sliding bracket shall be nonsparking where the pump is installed in a hazardous area.
- 4. Guiderails
 - a. Each guide rail mounted pumping unit shall be equipped with one or more guiderails. Guiderails shall be sized to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to the location indicated on the Drawings. An upper guiderail bracket shall be provided at the pump access opening.
- 5. Lifting Chain
 - **a.** Each guide rail mounted pumping unit shall be provided with a chain suitable for removing and installing. The chain shall be stainless steel. Lifting chains shall have a tested yield point of at least 7 times the working load and shall be provided with durable permanent identification tags indicating the load rating. A suitable chain hook shall be provided at the top of the wetwell.
- H. Shop Painting
 - 1. All iron and steel parts which will be in contact with pumped liquid or submerged after installation, including the inside of the casing and the discharge elbow, shall be shop cleaned in accordance with the coating manufacturer's recommendations. The exterior of the pump shall be painted with the epoxy coating system specified. The coating shall have a dry film thickness of at least 10 mils and shall consist of a prime (first) coat and one or more finish coats. At least 1 quart of the finish coat material shall be furnished with each pump for field touch-up.
 - 2. All iron and steel parts inside the pump, including the surfaces of cast iron impellers, shall be painted with a suitable rust protective coating to protect the impeller during shipment, storage, and installation.
 - 3. The shop painting of other surfaces shall be in accordance with the shop painting requirements in the General Equipment Stipulations.
 - For potable water applications, all coatings shall be NSF approved.

Hoist Assembly

1. A manual winch assembly shall be provided for each installed unit to raise and lower the pumps for installation and service. Each winch assembly shall consist of a lifting davit, winch, and 40 feet of Type 316 stainless steel lifting cable. The lifting davit assembly shall be constructed of Type 316 stainless steel and shall be mounted in mast wells as indicated on the Drawings. The boom arm shall be adjustable and the length shall be suitable for the pump installation. The boom shall provide a rotation of 270 degrees. The

winch assembly shall provide a minimum working capacity of at least 50 percent greater than the pumping unit weight.

2. The hoisting assembly shall utilize a positive means of submersible propeller pump recovery, similar to the Flygt "Grip Eye" system. The grip eye shall be connected to the end of the winch lifting cable. A stainless steel guide cable shall be attached to the pump lifting chain and to a stainless steel eyebolt attached to the basin wall via a quick disconnect clip.

2.6 ELECTRIC MOTORS

- A. Each pump shall be driven by an air-filled, totally submersible electric motor provided by the pump manufacturer. Motor nameplate rating shall exceed the maximum power required by the pump in the operating head range. Each motor shall be rated for the power supply provided to the pump and shall have a service factor of 1.15. The stator housing shall be an air-filled, watertight casing. A cooling jacket shall encase the motor housing for each pump where needed to maintain adequate cooling. The cooling jacket shall require no external source of cooling water. Motor insulation shall be moisture resistant, Class H, 155° C. Each motor shall be NEMA Design B for continuous duty at 40° C ambient temperature and designed for at least 10 starts per hour.
- B. The motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The bearings shall have a calculated ABMA L_{10} Life Rating of 40,000 hours when operating at maximum operating head. Maximum shaft runout at the mechanical seals shall not exceed 2 mils at any point in the operating head range.
- C. Each motor installed in a wetpit shall be capable of continuous operation in air (unsubmerged) for at least 24 hours under pump full load conditions, without exceeding the temperature rise limits for the motor insulation system.
- D. Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. Cable sizing shall conform to NEC requirements.
- E. All cables for wetwell mounted pumps shall be of sufficient length to terminate in a junction box outside the wetwell as indicated on the Drawings, with 10 feet of slack which will be coiled on a cable hook at the top of the wetwell. Each cable shall be supported by AISI Series 300 corrosion-resistant stainless steel Kellems or woven grips to prevent damage to the cable insulation. Mounting of cable supports in the wetwell shall be coordinated by Contractor to prevent damage to the cable.
- F. The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

Submersible Pumps

- G. Motors shall be specifically selected for service with an variable frequency type speed controller and shall be derated to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation so that the motor does not exceed Class B temperature rise when operating in the installed condition at load with power received from the variable frequency drive. All motors driven by variable frequency drives shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.
- H. Variable Frequency Drives
 - 1. Variable frequency drives shall be provided and shall be coordinated with the requirements of the pumping unit. The pump manufacturer shall be responsible for furnishing the variable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.
 - 2. Variable frequency drives shall be designed as specified in the Variable Frequency Drives section.

2.7 CONTROLS

- A. Pump Controls
 - 1. Each motor shall be protected by one motor temperature switch embedded in each phase winding. Each switch shall be designed to operate at 140° C (\pm 5° C). Each switch shall be normally closed automatic reset type rated 5 amps at 120 volts ac. The switches shall be wired in series with end leads wired to terminals within the motor housing.
 - 2. Each motor housing shall be provided with a moisture detection system complete with all sensors, control power transformers, intrinsically safe control modules, and relays. The moisture detection system shall be rated for a 120 volt ac supply. The moisture detection system shall provide two normally open dry output contacts rated 5 amps at 120 volts ac. The contacts shall close when moisture is detected in the motor housing. All moisture detections system components shall be furnished by the pump supplier and shall be mounted in a NEMA 4X stainless steel enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Each pumping unit shall be installed in accordance with the Hydraulic Institute Standards, the Equipment Installation section, and as specified herein.
- B. Power and control cables shall be supported to prevent tension and damage. Mounting of cable supports in wetwells shall be coordinated by the pump supplier.

3.2 FIELD QUALITY CONTROL

- A. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
- B. Installation Check
 - 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.
- D. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.

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SECTION 46 43 55 - AEROBIC GRANULAR SLUDGE SYSTEM EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the furnishing, installing, testing, and placing into operation the Aerobic Granular Sludge (AGS) System equipment.
- B. Principal items to be furnished by the AGS System Supplier shall include the following:
 - 1. Influent Distribution System.
 - 2. Effluent Weir Assembly.
 - 3. Solids Waste System (except valves).
 - 4. Fine Bubble Diffuser System.
 - 5. Reactor Control System, including blower and aeration system controls, and Computer.
 - 6. Supports for internal trough, manifold, and pipe within reactors.
- C. The following items may be furnished by the AGS System Supplier as part of their scope or at the Bidder's option may be supplied outside of the AGS System Suppliers scope.
 - 1. Influent Plug Valves.
 - 2. Solids Waste System Valves.
 - 3. Air Control Valves.
 - 4. Actuators associated with Influent Plug Valves, Solids Waste System Valves, and Air Control Valves.
 - 5. Blowers and associated equipment as specified in Section 43 11 15 High Speed Gearless Turbo Blowers.
- D. The following items, which shall also be provided by the AGS System Supplier as part of the AGS System, are specified in other sections:
 - 1. Internal process system piping, valving, and actuators for AGS Reactor operation.
 - 2. Instrumentation.
 - 3. Programmable Logic Controllers.
 - 4. Network Hardware to Allow Etherent Communication with Plant Control System.

- E. This listed equipment is part of the Base Bid as indicated in the Bid Form. Other components required for a complete functional system shall be provided by the AGS System Supplier.
- F. Equipment and related work as indicated on the Drawings shall be provided by Contractor for a complete and functional installation, and are covered under other sections.

1.2 GENERAL

- A. The AGS System equipment shall be specially designed for the effluent requirements specified herein. The AGS System, including all equipment and appurtenances, shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the AGS System Supplier, unless exceptions are noted by Engineer.
- B. Equipment shall be furnished complete with all mechanical and electrical components and accessories required for proper operation, including complete drive units and controls; and any additional materials or construction required by the AGS System Supplier's design.
- C. General Equipment Stipulations
 - 1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- D. Power Supply
 - 1. Power supply to the equipment will be 480 volts, 60 Hz, 3 phase.
 - 2. All single phase components shall be 120 volt, 60 Hz, 1 phase.
- E. Identification
 - 1. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.
- F. Piping and Valves
 - 1. The threads for oil fill and drain piping and fittings shall be NPT standard. Sludge piping is covered in the Ductile Iron Pipe section. Miscellaneous piping and miscellaneous valves are covered in the piping and valve sections, respectively.

1.3 SUBMITTALS

- A. Drawings and Data
 - 1. Complete assembly and installation drawings, together with detailed specifications and data covering materials, power drive assemblies, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. Drawings shall indicate all dimensions and structural member sizes, and shall be certified by an officer of the company manufacturing the equipment that the design is in

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compliance with all local laws and codes for the location where the equipment will be installed. Data and specifications for each unit shall include, but shall not be limited to, the following:

- a. Descriptive information, including catalog cuts and manufacturers' specifications for major components.
- b. Detailed narrative on the AGS System operation.
- c. Dimensions and installation requirements.
- d. Equipment weights.
- e. All loads imposed by the reactor internals to the foundation.
- f. Structural drawings, including anchor bolt details sealed by a Professional Engineer registered in the State of the project.
- g. Electric motor data in accordance with the submittal requirements of the Common Motor Requirements for Process Equipment section
- h. Electrical control equipment.
- i. Complete drawings and data showing plans and elevations and details for reactor internals not shown on Drawings.
- j. Equipment List, including equipment HP.
- k. Electrical schematics, connection and interconnection wiring diagrams, and layouts.
- 1. Process Performance Guarantee with supporting calculations.
- m. Hydraulic Profile through the AGS reactors.
- n. Ancillary utility requirements (flow and pressure) including air, potable water, non-potable water, final effluent, etc.
- o. Process drain requirements and estimate of flow.
- p. Pipe support plans and elevations including support types, details, materials, and complete product data.
- q. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
- r. Layout drawings and wiring diagrams for the AGS control system panel. Catalog cuts and manufacturer installation documentation for control panel components.
- s. Catalog cuts and manufacturer installation documentation for instrumentation.
- t. Calibration sheets for each piece of instrumentation.
- u. Maximum pressure requirement (psig) at the top of the diffused aeration system drop legs.
- v. Procedure for local passivation treatment (where required)
- 2. Any exceptions or deviations to these specifications shall be listed and fully described in the submittal.

B. Operation and Maintenance Manuals

- 1. Adequate operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
- 2. In addition to the requirements in the Submittal Procedures section, the operation and maintenance manual shall include the following:
 - a. General projection information

- b. Installation and start-up
- c. Process design and operational control description
- d. Mechanical, electrical, and field instrumentation component descriptions
- e. Maintenance and troubleshooting
- f. Mechanical and electrical drawings

1.4 QUALITY ASSURANCE

- A. AGS System Supplier Qualifications
 - 1. The AGS System Supplier shall have the experience in the design and manufacture of Granular Sludge Systems for a minimum of five (5) years and shall be able to demonstrate a minimum of four (4) AGS installations within the United States in municipal wastewater applications with granular sludge.
 - 2. The AGS System Supplier shall complete or have completed onsite piloting for 1 season of 4.5 months with primary filtration system as a pre-treatment to the granular sludge system.
 - 3. The manufacturer of the AGS System shall be completely responsible for the proper design of their system, including but not limited to internal process piping, diffused aeration equipment, and controls. All equipment shall perform as specified and the completed installation shall operate in accordance with the requirements of the plans and specifications.
 - 4. The selected AGS System Supplier shall have a free troubleshooting help line available 24 hours a day, 365 days per year for the life of the plant. The line shall connect to a live service technician who shall have the capability of connecting to the control panel via internet, with the operator's permission.
 - 5. Any SUPPLIER wishing to bid other than Aqua-Aerobic Systems, Inc. shall provide the following:
 - a. A letter signed by an officer of the company certifying compliance with the specifications without exception. In addition, the SUPPLIER must certify the proposed motors will be Warranted by the motor SUPPLIER as outlined in the specified Warranty.

A field test report documenting the proposed or similar units have been field tested.

- Proof of manufacturing and testing facilities.
- Installation list with contacts and phone numbers for a minimum of twenty-five installations in operation.
- 6. FAILURE OF THE CONTRACTOR TO SUPPLY THIS INFORMATION WITH THE BID WILL BE CAUSE FOR DISQUALIFICATION OF THE CONTRACTORS BID.

b.

d.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. The equipment provided under this section shall be suitable for the following service conditions, except where specified in individual equipment sections:



- B. Biological phosphorus removal performance and targets shall be coordinated with AGS System Supplier and Engineer at startup, with target biological phosphorus removal performance of 1 mg/L effluent TP. 0.5 mg/l effluent TP limit assumes chemical polishing.
- C. Design requirements shall be as follows:

Reactor Influent Flow, mgd	10
Maximum Manifold Loss, in	Provided by AGS System Supplier
Maximum Fouling Loss, in	Provided by AGS System Supplier
MLSS at Process Level, mg/L	8,000
Cycle Duration, hrs/cycle	4.7
Fill/Draw Phase, hrs	1.17

React Phase, hrs	3.2	
Settling Phase, hrs	0.33	
Hydraulic Retention Time, days	0.36	
Solids Retention Time, days	30.70	
Oxygen Requirements, lbs O2/lb BOD5 applied	1.25	
Oxygen Requirements, lbs O2/lb TKN applied	4.6	
Alpha factor	0.7	
Beta factor	0.95	Ċ

2.3 ACCEPTABLE MANUFACTURERS

- A. The AGS System shall be:
 - 1. AquaNereda® Aerobic Granular Sludge System manufactured by Aqua-Aerobic Systems, Inc, or engineer approved equivalent.

2.4 ACCEPTABLE TECHNOLOGIES

- A. Only offers based on Aerobic Granular Sludge technology are acceptable, as defined further below:
- B. The AGS system shall be designed to comply with the following requirement:
 - 1. Aggregates of microbial origin: Aerobic granules need to contain active microorganisms and can only consist of components of microbial origin (as proteins, EPS, etc.). No carrier material is intentionally involved or added;
 - 2. No coagulation under reduced hydrodynamic shear; and
 - 3. The majority of the biomass (>50%) in the Aerobic Granular Sludge Reactor has a minimum mesh size of 200 micro meter (to be determined by washing a sample through a 200 micro meter mesh); and,
 - 4. The AGS Reactor shall have no moving decanters and operate in batch mode. Each batch mode cycle shall consist of an unaerated feeding step with simultaneous decant, an aeration step and a sludge settling step.
- C. Contractor to note AGS technology from selected AGS System Supplier is proprietary. Nondisclosure agreements (NDAs) and End User agreemens (EUAs) are required prior to the disclosure of confidential information.

2.5 AGS REACTORS

A. AGS REACTOR STRUCTURE

1. The AGS Reactors shall be concrete tanks field erected as shown on the Contract Drawings. Design requirements are summarized below:



B. INFLUENT PLUG VALVES

 Plug valves shall meet the requirements of Section 40 05 62.16 – Eccentric Plug Valves and Section 40 05 51.13 – Valve Installation. Actuators shall meet the requirements of Section 40 05 57 - Valve and Gate Actuators. Furnish electrically operated flanged plug valve(s) for each basin to control the influent flow.

No. of Valves	4
Tags	PV-1110, 1210, 1310,
	1410
Size, in	30
Actuator	Electric

C. INFLUENT DISTRIBUTION SYSTEM

1. Furnish (1) influent distribution system for each basin. System shall be of PVC and HDPE construction. Supports and anchors of 316 stainless steel construction shall be supplied. Please refer to Drawings for more details on quantity.

D. EFFLUENT WEIR ASSEMBLY

1. Furnish (1) effluent weir system for each basin. System shall be of 316 stainless steel construction. Supports and anchors of 316 stainless steel construction shall be supplied. Please refer to Drawings for more details on quantity.

E. SOLIDS WASTE SYSTEM

1. Furnish (1) solids waste system for each reactor. Manifold shall be of HDPE construction. Supports and anchors of 316 stainless steel construction shall be designed and supplied by the AGS System Supplier. Refer to Drawings for more details on

quantity. Industrial Butterfly valves shall meet the requirements of Section 40 05 64.22 - Industrial Butterfly Valves. AWWA Butterfly valves shall meet the requirements of Section 40 05 64.11 - AWWA Butterfly Valves. Valves shall be installed in accordance with Section 40 05 51.13 - Valve Installation. Actuators shall meet the requirements of Section 40 05 57 - Valve and Gate Actuators and respective valve schedules.

Sludge (WAGS) Valve Quantity, per basin 1 BFV-1120, -1220, -1320, Tags -1420 Valve Size, in 14 Valve Type AWWA Butterfly Actuator Electric WLC Valve Quantity, per basin BFV-1122, -1222, -Valve Size, in 14 Valve Type AWWA Butterfly Actuator Electric Sludge Air Valve Quantity, per basin 2 Tags BFVI-1101, -1102, -1201, -1202, -1301, -1302, -1401, -1402 Valve Size, in 4 Valve Type Industrial Butterfly Actuator Electric Sludge Air Throttling Valve Quantity, per 1 basin BFVI-1104, -1204, -Tags 1304, -1404 Valve Size, 4 Valve Type Industrial Butterfly Actuator Manual Sludge Isolation Valve Quantity, per basin 1 Tags BFV-1121, -1221, -1321, -1421 Valve Size, in 14 Valve Type AWWA Butterfly Actuator Manual WLC Isolation Valve Quantity, per basin 1 Tags BFV-1123, -1223, -1323, -1423 Valve Size, in 14 Valve Type AWWA Butterfly Actuator Manual

Four Rivers Sanitation Authority Rockford, IL Aerobic Granular Sludge - Phase I 2. Furnish one set of metal sieves for the analysis of AGS granule size. The sieve set shall include the following sizes: ASTM #10, 14, 30, 40 and 70.

F. FIXED FINE BUBBLE DIFFUSER SYSTEM

1. Aeration system shall be designed to transfer the following minimum amount of oxygen per day at standard conditions in clean water, at the specified submergence, air rate, and pressure.

Airflow per basin	2482 SCFM
Pressure @ Top of Drop Pipe	9.7 PSIG
Diffuser Submergence	20 feet
Diffuser quantity	2550 disks per basin
Diameters	
Individual Basin Air Pipe	10 inches
Individual Basin Air Valve	10 inches
Individual	
Isolation Valve Manufacturer	Refer to Industrial Butterfly Valve section
Materials of construction	Refer to Industrial Butterfly Valve section
Tank Connection	 316 SS anchors

- 2. Materials and Fabrication
 - a. Fabricate all welded parts and assemblies from sheets and plates of 316L stainless steel for non-submerged piping and Duplex 2205 stainless steel for submerged piping with a 2D finish conforming to ASTM A240, 554, 774, 778. Fabricate non-welded parts and flanges from sheets, plates or bars of 316 stainless steel conforming to ASTM A240 or ASTM A276. Weld in the factory with ER 316L filler wire using MIG, TIG or plasma-arc inert gas welding processes. Provide a cross section equal to or greater than the parent metal. Clean all welded stainless steel surfaces and welds after fabrication to remove weld splatter and finish clean all interior and exterior welds by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3. All subsurface connections, including supports and fasteners, shall be free from protrusions and sharp angles to which rags or stringy materials may become attached.
 - All supports and its components in the tank shall be stainless steel. See specification 05 50 13, Section 2.2 for material requirements. All post installed and cast in place anchor bolts shall be stainless steel. See specification 05 81 00, Section 2.1 for material requirements.

Drop Pipes

- a. Provide a minimum Schedule 10s stainless steel drop pipe from the air main connection to a point 3 feet above the manifold. Provide a stainless steel flange with a 150-pound drilling at the top connection. Provide a stainless steel gasketed coupling for connection to the manifold. Gaskets shall be rated for 300 °F.
- b. Each riser pipe shall include a manually operated isolation butterfly valve for connection to the main air supply piping by the installing contractor. Valve gaskets and hardware are to be provided by the installing contractor.

- c. Isolation valve shall be a wafer or lug style butterfly valve with cast or ductile iron body, and one piece stainless steel shaft.
- 4. Manifolds
 - a. Provide a manifold for connection to the air distribution headers. Fabricate maximum 30 feet long manifolds with threaded union or flanged joints to connect manifold sections and to connect to the air distribution headers to prevent rotation and blow apart.
 - b. If sufficient cooling of the process air can be achieved in the drop pipe, the air distribution manifolds and the diffuser header laterals shall be ultraviolet-resistant PVC, and shall be sized by the AGS System Supplier to evenly distribute the flow to all diffusers with a minimum pressure drop.
 - c. If cooling of the air to the maximum operating temperature of the PVC pipe under all specified conditions cannot be achieved in the drop pipe, stainless steel shall be extended into the manifold and laterals in sufficient length to achieve the required cooling, and PVC pipe shall be installed for the remainder of the air distribution system. Alternatively, ultraviolet-resistant CPVC pipe may be used. The AGS System Supplier shall engage a professional engineer registered in the state where the Project is located, to certify that under all specified operating conditions:
 - 1) The design provides sufficient cooling in the stainless steel portion of the pipe in each drop leg, so the temperature of the inside wall at any point in the PVC or CPVC pipe to be installed, is below the rated continuous operating temperature of the pipe, and
 - 2) The design provides sufficient cooling to reduce the air temperature to the rated continuous operating temperature of PVC diffuser components.
 - d. Fabricate manifolds of Schedule 40 conforming to ASTM D1784, D1785 and D2466. Design piping, pipe joints and supports to resist expansion/contraction thrust forces of the air distribution headers over a temperature range of 125° F. PVC components to be produced from PVC compound with a minimum tensile strength of 7000 psi. Design manifolds to withstand 125° F mean wall temperature. PVC components shall have minimum 1.5 percent titanium dioxide to minimize ultraviolet light degradation. Factory solvent weld all PVC joints and diffuser holders.
- 5. Air Distribution Headers and Diffuser Holders
 - Fabricate maximum 24 feet long air distribution headers with diffuser holders factory solvent welded to the crown of the pipe for positive air seal and strength. Fabricate minimum 4 inch diameter air distribution headers conforming to ASTM D3915 and D3034. Connect air distribution header sections with threaded union or flange joints to prevent blow apart and rotation. Design joints with mating halves factory solvent welded to the ends of the air distribution header. Design threaded union joints with spigot and socket ends joined with a threaded ring and sealed with an O-ring gasket. Design union joints with threads of a minimum of 0.013 square inches to provide adequate strength of the socket and retainer ring. Design flange joints with an angle face ring, follower flange with 150 lb drilling and stainless steel hardware. Diffuser holders shall have a continuous contact area of 13 square inches minimum to insure structural integrity. Air distribution headers

and diffuser holders to resist a dead load of 200 lbs applied vertically to the outer edge of the diffuser holder. Provide end caps at the end of each air distribution header.

- 6. Pipe Supports
 - a. Provide each section of manifold and air distribution header with a minimum of two supports. Support spacing to be limited to a maximum of 5.5 feet for 4 inch diameter headers, see Pipe Supports section for support spacing for other diameter piping. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125° F and to minimize stress build up in the piping system. Design supports shall be adjustable without removing the air distribution header from the support. Design supports shall include hold down guide straps, support structure and two anchor bolts. Design guide straps with a 2 inch minimum width to eliminate point load on manifold and minimize binding. Design support for a total of 4 inch vertical adjustment for leveling of manifold within ¼ inch of a common plane.
- 7. Air Distributor and Manifold Supports
 - a. Provide guide and fixed type supports to allow expansion/contraction. Design supports to include hold down straps, support structure, locating plate and single anchor bolt. To prevent improper installation, the locating plate shall be able to be installed in either of two directions relative to the support. Design support for a total of 3 inch vertical adjustment for leveling air distribution headers within ¹/₄ inch of a common plane. Guide straps shall have 1 1/2-inch wide top and bottom contoured bearing surface with chamfered edges to minimize binding and resistance to movement of air distributor under full buoyant uplift load. Design strap with 1/8 inch clearance around distributor so strap is self-limiting and cannot be over tightened
- 8. Diffuser Assemblies
 - a. Furnish diffuser assemblies including diffuser, holder, retaining ring and air flow control orifice. Incorporate an integral check valve into the membrane diffuser.
 - b. Test diffuser using primary sampling criteria outlined in Military Standard 105E. Manufacture circular membrane diffuser with integral O-ring of EPDM synthetic rubber compound with precision die formed slits. Add carbon black to the material for resistance to ultraviolet light. Design diffuser as one piece injection molded part with a minimum thickness of 0.080 inches for 9 inch diameter unit. Extractable oil content shall not exceed 10%. Limit the maximum tensile strength of the diffuser to 10 psi when operating at 2.4 SCFM/sq. ft. of material.
 - Visual Uniformity: Observe diffusers for uniform air distribution across the active surface of the diffuser at 1.0 SCFM/diffuser and 2 inches submergence. Active surface shall be defined as the perforated horizontal projected area of the diffuser. Factory test diffusers for a dynamic wet pressure (DWP) of 12 inches \pm 20% water column @ 1.0 SCFM/diffuser and 2 inches submergence.
 - d. Diffuser design should prevent backflow of mixed liquor during routine periods where air is turned off.



- 9. Diffuser Holders
 - a. Design holder with air flow control orifice, integral diffuser support plate and removable retainer ring. Holder shall provide support for the diffuser and seal the diffuser in the holder to prevent air leakage around the O-ring. Design retainer ring threads with minimum cross section of 1/8 inch and allow for one complete turn to engage threads.
- 10. Anchor Bolts
 - a. Design a mechanical or adhesive anchor bolt system for embedment in 4000 psi concrete with a pullout safety factor of 4. Condensate evacuation system shall be provided to substantially drain the submerged aeration piping system for each aeration grid.

G. BLOWERS

- 1. Blowers shall meet the requirements of Section 43 11 15 High Speed Gearless Turbo Blowers. Blowers shall provide low pressure process air to the AGS Reactors.
- 2. Blowers shall be provided with accessories as specified in the High Speed Gearless Turbo Blower section.
- 3. The installing contractor shall provide all air piping from the diffuser termination(s) at the basin(s) to the blowers as shown on the Contract Drawings. Supply of electrical wiring and junction box/disconnects shall be the responsibility of the installing contractor.

H. AIR CONTROL VALVES

1. Air control valves shall meet the requirements of Section 40 05 64.22 – Industrial Butterfly Valves and Section 40 05 51.13 – Valve Installation. Valves will control the air flow to each AGS reactor. Actuators shall meet the requirements of Section 40 05 57 - Valve and Gate Actuators.

	Valve (quantity) (BFV-1103, -1203, -	4	1 per reactor
	1303, -1403) Valve Size	10	inch
	Connection type	Flanged	
X	Materials of Construction	Refer to the Industrial	
		Butterfly Valve	
		section.	
/	Valve Actuator	Electric	

2. Furnish electrically operated modulating butterfly valve(s) as specified above to deliver the required airflow. Valve actuator shall include motor winding protection, manual override, and limit switch feedback in the open and closed position. Actuator(s) include local controls consisting of pushbutton(s), selector switch(es), and light(s). Field wiring and junction/box disconnect shall be provided by the installing contractor. Valve actuators shall meet the requirements of Section 40 05 57 – Valve and Gate Actuators.

- 3. The AGS system supplier shall size and provide air release valves if required by the AGS system. Air release valves shall meet the requirements of Section 40 05 86 Air Valves.
- I. MOTORS
 - 1. Motors shall be provided in accordance with Section 40 05 93 Common Motor Requirements for Process Equipment, and the requirements specified herein.

2.6 CONTROLS

A. PROGRAMMABLE LOGIC CONTROLLER

- 1. The AGS Supplier Reactor Control Panel shall be equipped with a Programmable Logic Controller (PLC). The PLC shall provide automatic operation of the AGS system. The PLC shall meet the requirements of the Programmable Logic Controllers section. The PLC components shall consist of a power supply, CPU, discrete input and output modules and analog input and output modules. The processor unit shall include built-in USB and two (2) Ethernet IP communication ports. PLC shall be provided with the necessary communication modules or protocol converters to allow communication with the Plant Control System via Modbus TCP/IP. All input and output points supplied (including unused) shall be wired to terminal blocks.
- 2. The equipment manufacturer shall be responsible for configuring, testing, and startup of the PLC. Refer to Section 40 64 00A Input/Output List for a listing of the minimum I/O signals.

B. ETHERNET SWITCH

1. A managed Ethernet switch shall be provided inside the control enclosure to provide connectivity between the PLC, Operator Interface Terminal (OIT), AGS computer, WAGS/WLC Pump VFDs, local blower control panels, and the Plant Control System. The managed Ethernet switch shall meet the requirements of Section 40 66 11 – Network Systems.

C. OPERATOR INTERFACE TERMINAL

- 1. An OIT shall be provided and installed on the face of the control panel. The OIT shall be configured, tested, and started up to allow the operator to monitor and control the AGS system equipment. OIT screens shall be configured with graphical representation of the AGS equipment. Programmed selectable targets or data entry fields shall be configured on these screens to allow the operator to send commands (Start/Stop, Open/Close, etc.) or enter setpoints as required to control the equipment. The OIT shall meet the requirements specified in Section 40 64 00 Programmable Logic Controllers.
- 2. For the configuration of the PLC and the OIT, the equipment manufacturer shall follow the requirements specified in Section 40 68 83 Software Control Block Descriptions. General control descriptions for the AGS system equipment are also provided in this specification. In addition, control descriptions are provided in this same specification for the ancillary equipment that the AGS PLC shall monitor and control.

- 3. Prior to shipping the control panel to the job site, the control panel shall be factory tested to confirm that the control panel and its internal components, including the PLC, OIT, and Ethernet switch, are configured and operating correctly.
- 4. The operator interface shall be a NEMA Type 4X rated, 12.1" diagonal, color touchscreen display with Ethernet and serial communications. The interface shall be a liquid crystal display (LCD). The display type shall be color active matrix thin-film transistor (TFT) with 1280 x 800 pixel resolution. The rated operating temperature shall be 32° to 131° F (0° to 55° C).

D. CONTROL PANEL WITHOUT MOTOR STARTERS

- 1. A control panel shall be provided to monitor and control the AGS System equipment and ancillary systems as specified herein and/or shown on the Drawings. The control panel shall be constructed to meet the requirements specified in Section 40 67 11 Panels, Consoles, and Appurtenances, and the control panel components shall meet the requirements specified in Section 40 78 00 Panel Mounted Instruments.
- 2. The control system shall be designed to optimize the AGS process while minimizing operator attention and to accommodate the continuous maximum daily flow without adjusting cycle structures. The control software program shall be factory tested prior to installation at the jobsite.
- 3. The control system shall be a timer based system with level overrides and shall provide control, sequence, monitoring, and alarm annunciation capabilities. The operator shall be able to access the timer values and set points through the operator interface panel to allow for adjustment of cycle times and system flexibility. The control system shall be designed to automatically accommodate the plant's full range of loads and flows.
- 4. A complete control system shall be provided as described in the following and as shown on the contract drawings. The control system shall include 120 volt control circuit breaker, microprocessor control, operator interface display, and HAND-OFF-AUTOMATIC selector switches.
- 5. The incoming service of the control system shall be 120 volt, 60 hertz, single-phase. Controls for the equipment listed below shall be provided within the AGS control panel. Elapsed time indication shall be provided through the operator interface of the AGS control panel for equipment indicated by an asterisk(*).

X	AGS EQUIPMENT DESCRIPTION
	(3) 200 HP Blowers*
	(4) 30" Influent Valve(s)
,	(4) 14" Water Level Correction Valve(s)
	(4) 14" Sludge (WAGS) Valve(s)
	(4) 10" Air Control Valves
	AGS EQUIPMENT DESCRIPTION (cont).
	(8) 4" Sludge Air Valves
	(4) D.O. signal(s) (Modbus)
	(4) TSS signal(s) (Modbus)
	(4) pH signal(s) (Modbus)
	(4) ORP signal(s) (Modbus)

(4) NH3/NH4 signal(s) (Modbus)
(1) Ortho-Phosphate signal(s) (Modbus)
(4) 4-20 mA Pressure Transmitter(s)

Level Sensors
Common Alarm

ANCILLARY EQUIPMENT DESCRIPTION
Primary Influent Distribution Gate (Onsite)
WAGS/WLC Pumps

E. CONTROL PANEL WIRING AND ASSEMBLY

- 1. All control enclosures shall be custom assembled and wired in an Underwriters Laboratories (UL) certified cabinet shop using quality materials and labor. Short circuit rating of control enclosure shall be 5 kA RMS symmetrical @ 120VAC maximum.
- 2. All control panel single conductor wire shall be 16 AWG multi-strand machine tool wire (MTW) minimum, with PVC insulation.

F. CONTROL PANEL QUALITY ASSURANCE

1. All Control panels shall be UL certified. Testing by manufacturer's electrical engineering prior to releasing for shipment shall be completed. Testing shall consist of the following:

Point to point testing of all wiring prior to application of power Intended supply voltage shall be applied to the enclosure All components shall be tested for proper operation and calibration The PLC and operator interface program shall be loaded and functionally checked All components shall be checked to confirm proper mounting specifications have been followed Enclosure shall be inspected for defects and repaired if necessary All labeling of wires and devices are correct, properly installed and clean

- 2. The manufacturer shall finalize the factory checkout by completing a control panel checklist to document all testing completed above.
- 3. Upon the successful completion of the control testing of the enclosure assembly, all applicable documentation (i.e. finalized drawing set, signed control checklist cover page, device data sheets, etc.) shall be placed in the drawing pocket of the enclosure.

CONTROL ENCLOSURE

The automatic controls shall be provided in a UL listed, NEMA Type 12 mild steel (12 gauge) floor mount enclosure that provides a degree of protection for electrical controls and components from dust, dripping water and external condensation of non-corrosive liquids. The enclosure is intended for indoor installation. Enclosure shall include gasketed overlapping doors with a 3-point latch mechanism operated by an oil tight keylock handle. The enclosure shall have white polyester powder paint inside with ANSI 61 gray polyester powder paint outside over phosphatized surfaces. The enclosure shall include a painted white mild steel (10 gauge) sub-panel mounted with collar studs. Enclosure shall be manufactured by Hoffman or approved equal.

2. The control enclosure shall be mounted remotely.

H. REMOTE ACCESS TO AGS COMPUTER

- 1. AGS System Supplier shall provide a data diode that provides a secure transfer of data from the AGS computer. The data diode shall be manufactured by Waterfall or equal. The data diode shall be provided to the Owner for installation and configuration.
- 2. AGS System Supplier shall provide a minimum of 4 hours to attend a Cyber Security workshop with the Owner and Engineer after the award of the project to establish the requirements and limitations of remote access to the AGS computer. Additional requirements for the data diode will be discussed and determined within this workshop.

2.7 INSTRUMENTATION

- 1. The AGS System Supplier shall provide instrumentation as required to operate the AGS System equipment. At a minimum, the following types of instruments shall be provided:
 - a. Air Flowmeters Installed on the discharge piping of the Blowers at each reactor. These thermal dispersion flowmeters shall meet the requirements of the Flow Instruments section. A flow conditioner shall also be provided with each flowmeter.
 - b. Pressure Transmitter Transmitter, mounting hardware, pipe, supports, and anchors shall be provided for each reactor. The transmitter shall meet the requirements of the Pressure And Level Instruments section.
 - c. Level Sensors Submersible pressure sensing level transmitter and weighted float type level switch shall be installed in each reactor. Sensors shall meet the requirements of the Pressure And Level Instruments section .
 - d. Reactor Instrumentation Provided in each reactor to ensure AGS process is adequately functioning. Multiparameter transmitters and sensors shall meet the requirements of the Process Analytical Instruments section. At a minimum, the following shall be provided for each reactor:
 - 1) DO probe
 - 2) TSS probe
 - b) pH sensor
 - 4) ORP sensor
 - 5) Nitrate probe
 - 6) Ammonium Analyzer
 - 7) Ortho-Phosphate Analyzer
 - 8) Sampling System
 - 9) Multi-Parameter Analyzer and Controller
 - e. All mounting hardware shall be provided by the equipment manufacturer. For any instrumentation that will be installed by the contractor, the equipment manufacturer shall provide detailed installation drawings and/or written instructions on the proper installation requirements of the instrumentation. Once installed, the equipment manufacturer shall be required to calibrate each instrument as required. Installing Contractor shall be responsible for the Modbus connection from the controller probe module to the Modbus card in the PLC enclosure, as shown on the drawings.

2.8 STRUCTURAL DESIGN

- A. The ratio of unbraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (for angles about the Z-Z axis). For simple spans, deflection shall be less than or equal to L/360 for the total load. For cantilever spans, deflection shall be less than or equal to L/240 for total load. In addition, all structural members and connections shall be designed so that the unit stresses will be less than 90 percent AISC yield stresses when subject to a loading of two times operational loads. Structural design shall consider all requirements for smooth equipment operation including equipment vibration loads, long term fatigue effects on members, hydrodynamic loads from operational water flow etc.
- B. Inaccessible welds and welding of angles back-to-back shall be avoided.
- C. Stainless steel components shall not be fabricated from sections with a hollow cross-section, such as pipe or tubular sections; only bars, plates, angles, channels, and other rolled sections shall be used.
- D. Anchor bolts shall be adhesive type, and shall be designed and detailed in accordance with all applicable provisions of ACI 318.
- E. Noise Level
 - 1. All motor driven components shall be designed and constructed so that the maximum noise level measured at 3 feet from the installed equipment drives and motors does not exceed 80 dBA.

2.9 BOLTS AND NUTS

- 1. The bolts, nuts, and washers shall be suitable for field assembly, and be provided for each item of equipment.
- 2. All field assembly bolts, nuts, and washers, including anchor bolts in submerged locations shall be stainless steel. Field assembly bolts, nuts, and washers in other locations shall be hot-dip galvanized. A washer shall be installed under each nut.

Assembly Bolts and Nuts.	
Carbon Steel	ASTM A307 or ASTM A36.
Stainless Steel	Bolts ASTM F593, Alloy Group 2; Nuts ASTM F594, Alloy Group 2.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM F2329.
Flat Washers	ANSI B18.22.1; of the same material as the bolts and nuts.

3. Anchor bolts shall comply with the Anchorage in Concrete and Masonry section.

4. Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2.10 CONSTRUCTION

- A. Fabrication
 - 1. The materials of construction for the AGS in-tank support structure, solids manifold, , and all components in contact with liquidshall be 316L stainless steel. Welded joints shall be sealed watertight with continuous welds. Fillets and corners must be accessible for grinding. Bolts that are provided at connections to facilitate field weld joints shall be removed and the holes shall be plug welded before painting. Faying surfaces of bolted joints shall be shop coated.
- B. Edge Grinding
 - 1. All cut or sheared edges shall be ground smooth to a 1/8 inch minimum radius for all material 1/4 inch thickness and larger. For material thickness less than 1/4 inch all cut or sheared edges shall be ground smooth to a radius equal to 1/2 the material thickness. Grinding of rolled edges on standard shapes with a minimum radius of 1/16 inch will not be required.
- C. Surface Preparation
 - 1. In preparation for painting, all ferrous metal surfaces shall have all welds ground smooth and free of all defects in accordance with NACE Standard SPO178, Appendix C, Designation C and sharp edges ground smooth, if not previously prepared in the shop. Instead of blending of the weld with the base metal as specified by the NACE standard, it will be acceptable to furnish a welded joint that has a smooth transition of the weld to the base metal. All welds shall be ground smooth to ensure satisfactory paint adhesion.
- D. Shop Coating
 - 1. Iron and steel surfaces of the equipment that will be in immersion service shall be cleaned to SSPC-SP10 and primed with manufacturer's standard shop coating which will be removed prior to field coating. All other iron and steel surfaces of the equipment shall be cleaned to SSPC-SP10 and prepared as recommended by the coating manufacturer for the intended service, and then shop coated with one or more coats of a universal epoxy primer. The General Equipment Stipulations include further shop coating requirements.

. Stainless Steel

- 1. Minimizing Surface Iron Contamination and Disrupted Surfaces
 - a. Handling, transportation, and storage practices that minimize the potential for contamination shall be used. Fabrication and erection practices that minimize disrupted surfaces (e.g., disruption from excess grinding, coarse grit blasting, or excessive, heavy power brushing) shall be used. Materials shall be protected from steel tools and materials. Whenever possible, protective barriers such as wood or nylon slings, stainless tools, poison pads, etc., should be used. Alloy materials are

required to be stored, off the ground or concrete, and stored to minimize contact with stagnant water. Control methods shall be implemented, as necessary, to prevent contamination of surfaces from nearby welding and grinding operations on carbon steels. The use of antispatter or other suitable methods may be considered to prevent the adherence of spatter from welding, grinding, or arc gouging activities. Base materials for new construction are normally supplied with a pickled mill surface (without dark oxides). Grinding and wire brushing of smooth, base material mill surfaces outside of the immediate weld joint area should be avoided. Except for the localized removal of heat tint, mechanical cleaning of uniform, millsupplied pickled base material surfaces should be minimized, and mechanical preparation of weld joints limited only to the faces of the joint.

- b. One of the most common causes of iron contamination is the performance of unnecessary grinding and wire brushing of alloy materials using contaminated tools. Supervisors shall monitor all grinding operations to ensure that grinding is kept to a minimum and that only proper tools are used.
- c. Unless otherwise specified, rough-ground surfaces shall be final finished with a 100 grit or finer, flexible-backed abrasive (e.g., sanding disk, flap drum, flap wheel). Burnishing of surfaces with clogged or excessively degraded abrasives is not permitted.
- d. Except for labels intended for permanent equipment identification, all labels and tape on high alloy surfaces (including stainless steels) shall be removed prior to service. Mechanical removal by grinding or wire brushing is not allowed. All markings and tape and label adhesive residues shall be solvent removed and any remaining oily residues from cleaning solvents removed using a suitable non chlorinated cleaner with clean cleaning cloths.
- e. Contractor is responsible for removing iron contamination (e.g. rusting).
- f. For materials considered to have been contaminated with "free iron", Owner may request a ferroxyl test or wet/dry test to identify areas of iron contamination. Unless otherwise specified, iron contamination identified by the ferroxyl or wet/dry test or by other identification means (e.g., visible rusting) shall be removed by mechanical or chemical cleaning. Mechanical cleaning methods, when used, shall be capable of removing the contamination without smearing or redepositing contaminants on the material surface. Chemical cleaning methods, when used, shall be performed in accordance with ASTM A380, Paragraph 6.4 and Annex A2. If requested, a ferroxyl or wet/dry test procedure and cleaning procedure shall be submitted to Purchaser for review.

2. Visual Inspection and Local Treatment

A visual inspection of the equipment should be performed at site to identify regions with dark heat tint colors and/or rusting that would require cleaning. Paint markings, tape and tape residues shall be removed by solvent cleaning prior to service. The final cleaning step of the paint and tape residues shall be with a low halogen content cleaning solution. Acceptable cleaning solvents include new or redistilled acetone (acetone reclaimed by other methods shall not be used), alcohol (ethyl, methanol, or isopropanol), methyl ethyl ketone, or toluene (toluol). Halogenated cleaning solvents shall not be used for cleaning or degreasing. Grinding discs shall not have been previously used on carbon or low alloy steels. Wire brushes shall be stainless steel and not previously used on carbon or low alloy steels. All tools used in fabrication shall be protected to minimize contact with steels or free iron. Grinding wheels and brushes shall be identified and controlled for their use on these materials only to ensure that iron contamination of welds and base materials does not occur.

- b. When removal of welding heat tint is required for service reasons, acceptable removal methods include chemical or electrochemical, media blasting, or abrasive methods. The fabricator shall submit a heat tint removal procesdure to Owner for review and approval prior to treatment.
- F. Field Painting
 - 1. Iron and metal surfaces of the equipment that will be in immersion service shall have the shop coating removed prior to field painting and the surfaces field painted as specified in Protective Coatings section. The electric motors, speed reducers, and other drive components shall be completely protected during blasting operations. Also, equipment components that are shop primed and top coating in the field shall be painted as specified in the Protective Coating section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the Equipment Installation, Electrical Equipment, and Instrumentation Control sections, and manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

- A. Installation Supervision
 - 1. The equipment manufacturer shall furnish installation supervision services when indicated in the Equipment Schedule section.
 - 2. The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of 5 trip(s) and 20 eight-hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.
 - 3. If additional service is required due to the AGS system equipment not being fully operation at the time of service requested by the Contractor, the additional service days will be at the Contractor's expense.

- 1. The equipment manufacturer shall provide a certificate of proper installation when indicated in the Equipment Schedule section.
- C. Functional Testing.
 - 1. The equipment manufacturer shall provide functional testing assistance when indicated in the Equipment Schedule section.

B. Installation Check

- D. Performance and Other Testing
 - 1. The equipment manufacturer shall provide performance and other testing services when indicated in the Equipment Schedule section.
 - 2. The manufacturer shall provide the services of a supplier service technician to check and verify the PLC program functionality. Instruments and other devices that require calibration and checkout will be carried out after the Contractor has the equipment installed and verified continuity. Instruments and devices shall be configured and demonstrated to function prior to start-up. A document indicating the set points and calibration shall be furnished for documentation records.
 - 3. The Contractor, under the manufacturer's field service technician's supervision, shall complete pressure testing for all piping included in the system. Include testing of influent, effluent, wasting, and water level correction piping.
 - 4. The Contractor, under the manufacturer's field service technician's supervision, shall complete testing for individual components of the system specified in other specification sections.
 - 5. Functional acceptance testing of the AGS system shall at a minimum encompass a complete batch cycle (fill, react, settle) for each reactor, which shall include a water level correction and wasting cycle for each reactor.

E. PROCESS PERFORMANCE GUARANTEE AND TESTING

- 1. Performance Guarantee
 - a. The single source supplier of the AGS System equipment shall provide a written Process Performance Guarantee to guarantee the AGS System will meet the effluent criteria specified under this specification section. The guarantee period shall commence at time of plant start-up, once the system has reach equilibrium (or within six months of equipment shipment whichever first shall occur), and shall be in force for a period of one year. The Process Performance Guarantee shall be submitted as part of the engineer's submittal data.
- 2. Process Performance Testing



The effluent performance requirements of the system will be demonstrated by a performance test during the first twelve months of operation, following stabilization of the process. The performance test will demonstrate that the manufacturer has complied with the effluent criteria specified herein. Guaranteed performance is based upon a process designed in accordance with the flows and criteria in Section 2.2.

b. The Owner shall be responsible for carrying out the performance testing, for collecting all samples, for carrying out all laboratory tests and for keeping such detailed records as may be necessary for determining whether the performance guarantees have been met. Copies of the laboratory results and records shall be submitted to the manufacturer and Engineer. For the duration of the performance test, the Owner shall maintain daily log sheets, operator notes, sample inspections,

and instrument charts produced in operation of the system. AGS System Supplier shall review the records and laboratory results and provide guidance to the Owner regarding the system operation.

- c. The performance test shall be subject to the following general conditions; all volumes specified shall be measured by tank gauges or calibrated meters, all laboratory analysis methods will be performed by the Owner or Owner's representative laboratory and a list of methods will be provided to the manufacturer prior to the start of the performance test, the Owner shall furnish all materials, utilities, services and personnel as required to operate the plant during the performance tests, and the Contractor will notify the manufacturer in writing thirty days in advance of beginning the performance test.
- d. The duration of the performance test shall be 4 weeks. The following recordings and samples shall be taken and analyzed by Owner to be used for evaluation of the system during the performance test and all samples shall be taken once daily for purposes of performance test; System Flow: Influent (gallons per day), TSS: Influent/Effluent (mg/l), NH4-N: Influent/Effluent (mg/l), Ortho-P: Influent/Effluent (mg/l), pH: Influent/Effluent (S.U.), BOD Influent/Effluent (mg/l), NO3 Influent/Effluent (mg/l), and Temperature: Influent (°C)
- e. The AGS System Supplier and Owner will jointly review performance of the process system to determine compliance with performance guarantees. Review will include, but not be limited to, a comparison of influent and process design basis with the actual performance results.
- f. The Owner will promptly notify the AGS System Supplier of the failure to meet any process guarantee and specify the respect in which such guarantee has not been met. If the manufacturer disputes any claimed failure, notice of such dispute shall be furnished promptly to Owner.
- g. In the event that the system does not achieve the required level of performance during the test period, the AGS System Supplier shall be permitted to conduct two additional tests to meet the specified process guarantee criteria. If the system fails to achieve the required effluent loadings during the performance test period and fails any additional tests, the AGS System Supplier shall pay for modifications to improve the performance to meet the specified performance criteria.

End of Section