PROJECT MANUAL

BUFORD WATER WORKS REPLACEMENT

VOLUME II

FOR THE

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SECTION 144001 - BRIDGE CRANES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electric, top running, single girder bridge cranes.

1.2 RELATED REQUIREMENTS

A. Section 144002 - Hoists, Trolleys, and Monorails.

B. Section 013000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

C. Section 014000 - Quality Requirements: Procedures for testing, inspection, mock-ups, reports, certificates; use of reference standards.

D. Section 017800 - Closeout Submittals: Project record documents, operation and maintenance (O&M) data, warranties and bonds.

1.3 REFERENCE STANDARDS

A. Crane Manufacturers Association of America, Inc. (CMAA):

1. 70, Specifications for Electric Overhead Traveling Cranes
2. 74, Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist.

B. American Gear Manufacturers Association (AGMA) Standards.

C. American Welding Society (AWS) Standards.

D. OSHA Section 1910.179 - Overhead and Gantry Cranes

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturers cutsheets and loading information for all bridge crane components.

C. Shop Drawings:

1. Girder layout including supports, connections, and appurtenances.
2. Load test results.

D. Manufacturer's Qualification Statement.

E. Installer's Qualification Statement.

F. Manufacturers Standard Operation and Maintenance Data.

G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

C. Welding shall be conducted by certified welders in conformance with the applicable AWS standards.

D. Coordinate installation to assure proper operation within the confines dictated by structural, equipment, mechanical, and electrical installations.

E. Verify hook and lifting heights for each application to assure each system is completely operational over range intended. Notify Engineer of conflicts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. American Crane and Equipment Corp: www.americancrane.com

B. Kone Cranes: www.konecranes.com

C. Gorbel Inc: www.gorbel.com

D. Acco Material Handling Solutions: www.accomhs.com

E. Columbis-McKinnon: www.columbusmckinnon.com

F. Substitutions: See Section 016000 - Product Requirements.

2.2 MANUFACTURED UNITS

A. Product Performance and General Configuration Requirements

1. Location: Water Treatment Building, Main Process Room

a. Duty cycle rating: Class B

b. Type: Top-running, single girder, dual-drive electric, direct drive end trucks.

c. Rated capacity: 3 Tons (6,000 lbs).

d. Span: As indicated on drawings.

e. Crane overhead clearance: 3 inches minimum to the nearest obstruction.

f. Color Scheme: Safety yellow bridge crane with a contrasting colored trolley unit for positioning contrast.

B. Design load carrying parts, except structural members and gears, so that the calculated stress in the material, based on rated load, shall not exceed 20 percent of the published average ultimate strength of the material.

C. Comply with CMAA # 70 and #74.

D. Trolley and hoist as specified in Section 144002 - Hoists, Trolleys, and Monorails, shall be compatible with the specified bridge crane. Manufacturer to verify and notify engineer of conflicts.

E. Runway Rails:

1. Track for top running.

2. Straight, parallel, and level.

3. Sufficient strength and rigidity to prevent detrimental lateral or vertical deflection.

F. Bridge Girder:

1. Flanged girder for bottom-running trolley.

2. Design girder to resist vertical, lateral, and torsional forces and stresses as defined by CMAA #74.

3. The maximum vertical deflection of the girder produced by the dead load, weight of the trolley and hoist, and the rated load shall not exceed 1/600 of the span.

4. Locate safety stops at each end of bridge girder to prevent over travel of trolley hoist.

G. End Trucks:

1. Carry crane bridge on end trucks sized to carry the rated load when it is lifted at one end of the crane bridge.

2. End truck wheel base minimum required to prevent the bridge binding.

3. One end truck per pair shall allow the bridge to move to account for runway misalignments.

4. Construct from stamped steel body, non-articulating type.

5. Assure proper alignment of axles.
6. Design so that drop of truck is limited to 1 inch in case of axle or wheel failure.

H. Crane Wheels:
1. Suited for use with the top running bridge rail and runway.
2. Double flanged, constructed of nodular iron.
3. Factory lubricate and seal bearings.
4. Replaceable in the field without having to replace entire trolley.

I. Crane Drives:
1. Provide each end truck with a helical gear motor reducer.
2. Motors integral with fully enclosed oil splash lubricated gear reducers.
3. Support gear reduction shaft by precision ball or roller bearings.
4. Design motors and drive to supply the crane speed specified.
5. Permanently lubricate and seal motor ball-bearings.

J. Bearings: 5000 HRS B-10.

K. Gearing:
1. All gearing except the final reduction at the wheels shall run in oil or be splash lubricated.
2. Comply with AGMA specifications for load ratings.
3. Gears not enclosed in gear boxes shall have:
a. Safety guards.
b. Provisions for lubrication and inspection.

L. Bridge Brake:
1. Capable of stopping bridge crane within a distance in feet equal to 10 percent of full load speed (in fpm) when traveling at full speed with full load.

M. Bumpers and Stops:
1. Capable of stopping the crane at a rate of deceleration not to exceed three feet per second when traveling in either direction at 20 percent of rated speed.
2. Sufficient energy absorbing capacity to stop the crane when traveling at full speed with full load.
3. Stops designed to resist full load speed.
4. Locate stops at limit of bridge travel.
5. Runway stops shall not engage wheel treads.

N. Electrical:
1. Provide disconnect device mounted on crane with over current protection for the controllers.

2.3 ACCESSORIES

A. Controls and Electrical Requirements:
1. Provide electrical power to the motor-driven hoists and trolleys using festoon tag-line system:
a. Equip with plastic wheels in areas with an NEC classification of Class 1, Division 1 or 2, Group D.
b. Include all components needed for a complete and operable system.
2. Controls:

a. Enclosure shall be NEMA 4X rated.

b. Pendant push button control stations with reversing type contractors for electric hoists and/or trolleys.

c. Single control station to hoist and trolley.

d. Suspend control stations from trolleys.

e. Clearly mark function of each button.

f. Suspend station in a manner that will protect the electrical conductors against strain.

g. Control station shall be operable from 115V power supple, derived from control transformer mounted on trolley.

h. Ground control station to hoist.

i. Provide control cable lengths of 1 ft less than distance to nearest floor.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install runways rails with center to center distance and elevation within 1/8 inch.

C. Warning Signs:

1. Maximum 10 feet intervals along rails with electrical conductors.

2. At stairs or ladders location 6 feet of less from the rails.

3. Warning sign legend and colors:

a. DANGER (red)

b. HIGH VOLTAGE (black)

c. 480 VAC (black)

d. KEEP OFF (red)

3.2 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Test each crane using 110 percent of rated load.

3.3 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. Employ and pay for services of equipment manufacturers field service representative to:

1. Inspect equipment covered by these Specifications.

2. Service pre-start up adjustments and installation checks and all field tests.

3. Conduct initial startup of equipment and perform operational checks.

4. Provide a written statement that manufacturer's equipment has been installed properly, stated up, and is ready for operation by owner's personnel.

C. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of 4 hours of training.

3. Instructor: Manufacturer's training personnel.

4. Location: At project site.

END OF SECTION

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SECTION 144002 - HOISTS, TROLLEYS, AND MONORAILS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hoists, trolleys, and monorails.

1.2 RELATED REQUIREMENTS

A. Section 144001 - Bridge Cranes.

B. Section 013000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

C. Section 014000 - Quality Requirements: Procedures for testing, inspection, mock-ups, reports, certificates; use of reference standards.

1.3 DEFINITIONS

A. Hook Height: The minimum acceptable distance in feet from bottom of hook in full raised position to the nearest floor surface.

B. Lift Height: The distance in feet from the bottom of the hook in full raised position to the surface of the lowest floor from which items may be hoisted.

C. Ultimate Load-Carrying Capacity: Live load, weights of all equipment and an allowance for impact.

D. Total Trolley Capacity:The ultimate load-carrying capacity of the trolley based on the ultimate strength of the material used (with a 5:1) safety factor and the bearing life.

1.4 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

B. ASME/ANSI B30.11 - Safety Standards for Monorails and Underhung Cranes.

C. ASME/ANSI B30.16 - Safety Standards for Overhead Hoists.

D. ASME/ANSI HST-4M-2016 - Performance Standard for Overhead Electric Wire Rope Hoists.

E. ANSI C1 - National Electric Code

F. American Gear Manufacturer Association (AGMA) Standards.

G. National Electric Code (NEC) Standards.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings to include the following:

1. Acknowledgement that products submitted comply with the requirements of the referenced standards.
2. Equipment Installation details:
    a. Location of anchorage.
    b. Type, size, and materials of construction of anchorage.
    c. Anchorage setting templates.
    d. Manufacturers installation instructions.
3. Equipment area classification rating.
4. Shipping and operating weight information.
5. Physical characteristic including dimensions and materials of construction.
6. Factory primer and coating data.

7. Product data on brakes, bumpers, load block and hook, hoist, trolley, motors, limit switches, radio control handset, pendant pushbutton station, wire rope, and overload protection.
8. Indicate track layout including supports, splices, connections, switches, and end trucks.
9. Information regarding system controls including layout, panel information, and wiring.

C. Test Reports: Indicate tests verifying strength of inserts and rail, and load test results.

D. Operation and Maintenance Data:

1. Provide manufacturers operation and maintenance data.

E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Comply with requirements set forth in ASME/ANSI B30.11 and B30.16.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least five years of documented experience.

C. For hoists and trolleys provided for bridge crane mounting, the hoists, trolleys, and bridge crane components shall all be provided by the bridge crane supplier.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. American Crane and Equipment Corporation: www.americancrane.com

B. Kone Cranes: www.konecranes.com

C. Gorbel Inc: www. gorbel.com

D. Acco Material Mandling Solutions: www.accomhs.com

E. Columbus McKinnon Corp: www.columbusmckinnon.com

F. Substitutions: See Section 016000 - Product Requirements.

2.2 MANUFACTURED UNITS

A. Trolleys:

1. Motor driven.
2. Completely compatible with hoists, cranes, and monorails specified.
3. Trolleys shall meet NEC standards according to classifications indicated.
4. Minimum B-10 bearing life of 5,000 hours based on 75 percent of the wheel load, excluding impact.
5. Motor Driven:
    a. Operate at a single speed as scheduled.
    b. Enclose internal gears in oil tight housing.
    c. Design motors to operate with 460 V, 3 PH, 60 Hz power supply.
6. Plain Trolleys:
    a. Frame consisting of thick rolled steel sections extending beyond wheel flanges to protect wheels.
    b. Alloy steel hardened axles, ball-bearings, and pressed steel wheels.
        1) Carburized and hardened ball tread wheels.
        2) Factory lubricated requiring no additional lubrication.

c. Under-running single flanged wheels of forged steel.

B. Hoists:

1. Electric wire rope hoists:

a. Duty cycle classification B or HMI class H2.

b. Hoist frames of welded heavy steel plate construction.

c. Oil tight gear casing for oil bath lubrication of gears.

d. Construct rope drum and surrounding units to minimize abrading, crushing, or jamming of the rope during usage.

e. Drum diameter not less than 18 times the diameter of the rope used.

f. Assure that two (2) complete wraps of rope remain on the drum after lowering the load hook through the specified lift distance, unless a lower limit device is provided in which case provide a minimum of one (1) complete wrap.

g. Double reeving for hoists with total lift height greater than hook height.

h. Sheave and drum grooves shall be smooth and free from surface irregularities which could cause rope damage.

i. Provide running sheaves with means for lubrication.

j. Bearings:

1) Antifriction type.

2) Minimum B-10 life of 1,250 hours for class H1, 2,500 hours for class H2, and 5,000 hours for class H3, based on full rated speed and mean effective load K of 0.65.

k. Mechanical load brake.

l. Lower limit switch to stop hoist when hook reaches its lower limit.

m. Motor:

1) Motor brake.

(a) Internal disc magnetic type.

(b) Rated for 150 percent of motor torque.

2) TENV motors operable on 460 V, 3 PH, 60 Hz power.

3) Meets specified area classification.

4) Permanently lubricate and seal motor ball-bearings.

5) Provide an upper limit switch to stop the hoist motor and apply the holding brake when the hook reaches its upper limit.

n. Controls:

1) Motor starters, electrical conduit, control stations, magnetic reversing contactors, and low-voltage transformers necessary for a complete and totally functional conveying system.

2) Provide two-speed controls for the trolley drive and hoist drive meeting requirements of NEMA ICS8. Ensure that an energized drive motor initially rotates only in the direction selected by the operator by activating the corresponding direction.

o. Operator Controls: Provide crane, trolley, and hoist system equipped with radio control system portable transmitter unit handset with rechargeable batteries and belt/harness. Provide a pendant pushbutton station suspended from the trolley as a backup to the radio control system.

p. Hoist shall be marked with the following information:

1) Name and address of manufacturer.
2) Manufacturer's unit identification number.
3) Rated load.
4) Voltage of AC or DC power supply, phase, and frequency of AC power supply.
5) Rated amperage.

C. Bridge Crane Components:
1. See Specification Section 144001 - Bridge Cranes.

D. Furnish and install a hoist and trolley at each location shown on the Drawings capable of lifting the capacity over the lift height shown in the Schedule below.

2.3 ACCESSORIES

A. Trolley stops designated to engage the trolley frame rather than trolley wheels.

PART 3 EXECUTION

3.1 INSTALLATION

A. Arrange supports for easy removal of track for repair or replacement.

B. Align track true and level.

C. Warning Signs:
1. Affix to the hoist or the lower load block or the controls in a readable position a durable label or labels displaying the following information concerning safe operation procedures:
a. The word "WARNING" or other legend designed to bring the label to the attention of an operator.
b. Cautionary language against:
1) Lifting more than rated load.
2) Operating hoist when hook is not centered under hoist.
3) Operating hoist with twisted, kinked, or damaged rope or chain.
4) Operating damaged or malfunctioning hoist.
5) Operating hoist with a rope that is not properly seated in its groove (if applicable).
6) Lifting people or lifting loads over people.
7) Removing or obscuring warning label.

3.2 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

3.3 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform the following:
1. Inspect equipment covered by these Specifications.
2. Supervise pre-startup adjustments and installation check and all field tests.
3. Conduct initial start up of equipment and perform operational checks.
4. Provide a written statement that manufacturers equipment has been installed properly, started, and is ready for operation by Owner's personnel.
5. Instruct Owner's personnel for four (4) hours at job site on operation and maintenance of the hoist, trolley, monorail, and crane equipment.

3.4 SCHEDULES

A. Hoist, trolley, and monorail systems include but are not necessarily limited to the following:

Location	Loading (Tons)	Hoist	Trolley	Hook Height (FT)	Lifting Height (FT)	Lifting Speed (FPM)
Water Treatment Building, Main Process Room	3	WR, EH	ET	18'	26'	ARM

1. Hook height and lifting height distances are approximate and may vary based on the hoist and trolley selection.
2. Abbreviations:
    a. ET: Electric Trolley
    b. WR: Wire Rope
    c. EH: Electric Hoist
    d. ARM: As recommended by manufacturer for specific application

END OF SECTION

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SECTION 21 1313
WET PIPE FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 SCOPE
A. Work covered by this Section:
   1. Wet pipe sprinkler systems
   2. Underground fire service mains
   3. System design, installation, testing, and certification

B. Work not covered by this Section:
   1. Installation of portable fire extinguishers
   2. The wiring and monitoring of alarm switches and supervisory signaling system - (To be coordinated with the General Contractor)
   3. All electrical installations - (To be coordinated with the General Contractor)

1.02 RELATED SECTIONS
A. Section 28-31-13 Fire Alarm System

B. The conditions of the Contract, including the General Conditions and Supplementary Conditions, and Division 1 - General Requirements, apply to work covered by this Section.

C. Comply with Mechanical, Electrical and Civil Division Sections, as applicable. Refer to other Divisions for coordination of work.

1.03 DEFINITIONS
A. Equipment and materials shall be approved for their designed use and performance. The term “approved” shall mean Underwriters Laboratories (UL) listed and/or FM Global (FM) approved and/or acceptable to the approval authorities.

B. Approval authorities shall include the Owner, authorized representative Harrington Group, Inc. (Engineer), insurance provider, the General Contractor, and the local fire/code official(s), where applicable, (Authorities Having Jurisdiction).

C. The term “Contractor” as used within this specification refers to the private underground fire service mains and/or fire sprinkler system subcontractor(s).

1.04 INTENT
A. It is the intent of this specification section to provide the Owner’s minimum design and construction requirements relative to the fire protection systems described herein. The Contractor shall comply with the provisions of this section to the maximum extent possible while still complying with the provisions of the local codes and standards.

B. It is not the intent of this specification to provide complete design and construction requirements as may be stipulated by the applicable building and fire codes enforced in the local jurisdiction. The responsibility to identify and comply with all provisions of the local building and fire codes, including all applicable standards, rests with the design-build Contractor.

1.05 DESIGN-BUILD RESPONSIBILITY
A. The design-build Contractor is responsible for the design, installation, and testing of all fire protection systems specified herein so that the final work product is complete and usable to the Owner. The Contractor is responsible to prepare all plans, calculations, and permit applications; to affix all required certifications and seals; to pay all required fees; and to perform all other work necessary to secure a construction permit and to obtain final approval of the work.

1.06 REFERENCES
A. State of Georgia
   1. 2018 International Building Code w/ Georgia Amendments
   2. 2018 International Fire Code w/ Georgia Amendments
   3. 120-3-3 State Minimum Fire Safety Standards (Effective 01/01/20)

B. National Fire Protection Association (NFPA)

1. NFPA 13 (2019) – Standard for the Installation of Sprinkler Systems
2. NFPA 24 (2019) – Standard for the Installation of Private Fire Service Mains and Their Appurtenances
3. NFPA 70 (2017) – National Electrical Code®
4. NFPA 72 (2019) – National Fire Alarm and Signaling Code
5. NFPA 1963 (2019) – Standard for Fire Hose Connections

C. Underwriters Laboratories, Inc. (UL)
1. Fire Protection Equipment Directory (most current edition including supplements)
2. Building Materials Directory (most current edition including supplements)
3. Electrical Construction Materials Directory (most current edition including supplements)

D. FM Global (FM)
1. FM Global Research Approval Guide (most current edition including supplements)
2. Property Loss Prevention Data Sheet 2-0 (most current edition) – Installation Guidelines for Automatic Sprinklers

E. American National Standards Institute (ANSI)
1. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose
2. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
3. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300
4. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250
5. ANSI/ASME B16.5 - Steel Pipe Flanges and Flanged Fittings
6. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttweld Fittings
7. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-Welded and Threaded
8. ANSI/ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges
9. ANSI/ASME B16.25 - Buttwelded Ends for Pipe, Valves, Flanges, and Fittings
10. ANSI/ASME B36.10M - Wrought Steel Pipe

F. American Society for Testing and Materials (ASTM)
1. ASTM A53 - Welded and Seamless Steel Pipe
2. ASTM A126 - Gray Iron Castings for Valves, Flanges, Pipe Fittings
3. ASTM A135 - Electric-Resistance-Welded Steel Pipe
4. ASTM A183 - Carbon Steel Track Bolts and Nuts
5. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
6. ASTM A194 - Carbon and Alloy Steel Nuts and Bolts for High Pressure and High-Temperature Service
7. ASTM A197 - Cupola Malleable Iron
8. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
9. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
10. ASTM F436 - Hardened Steel Washers
11. ASTM A536 - Ductile Iron Castings

G. American Welding Society (AWS)
1. WS D10.9 - Specification for Qualification of Welding Procedures and Welders for Piping and Tubing

H. American Water Works Association (AWWA)
1. AWWA C104 - Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water
2. AWWA C110 - Ductile Iron and Gray Iron Fittings, 3 in. through 48 in., for Water and Other Liquids
3. AWWA C111 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings
4. AWWA C115 - Flanged Ductile Iron Pipe and Threaded Flanges
5. AWWA C150 - Thickness Design of Ductile Iron Pipe
6. AWWA C151 - Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
7. AWWA C153 - Ductile Iron Compact Fittings, 3 in. through 12 in., for Water and Other Liquids
8. AWWA C502 - Dry-Barrel Fire Hydrants
9. AWWA C509 - Resilient-Seated Gate Valves for Water and Sewerage Systems
10. AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances

11. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
12. AWWA C900-16 - Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 in. through 60 in., for Water

1.07 SYSTEM DESCRIPTION

A. Underground Fire Service Mains

1. Fire service water mains shall be provided and installed as indicated on the fire protection drawings and civil utility drawings and in accordance with this specification and Division 33. Where a conflict may exist between the civil and fire protection plans, the contractor shall submit a Request for Information (RFI) to both the civil and fire protection engineer's attention for resolution.
2. Maximum working pressure for underground fire service mains upstream of the fire pump shall be in accordance with NFPA 24 (i.e., not less than 175 psi).
3. Where underground mains pass through building walls, or require a vertical rise or drop, the pipe shall be cement-lined ductile iron (DIP) unless specifically noted otherwise. All fire water lead-ins (i.e., fire sprinkler) from 1 ft. above the finished floor to 5 ft. outside the exterior wall shall be cement-lined DIP. All other piping shall be as specified by the civil engineer on civil utility drawings and specifications.
4. Fire hydrants shall be provided and installed as indicated on the fire protection drawings and civil utility drawings. The connection of each private hydrant to the fire main shall have a nominal diameter of 6 in. as indicated on the fire protection drawings, and shall include an underground gate valve equipped with a grade (roadway) box provided not more than 20 ft. from the hydrant it serves. Hydrant control valve is permitted to shift slightly (i.e., 1-3 ft.) in order to avoid other aboveground items, such as curbs.
5. The top of all underground fire service mains shall have a minimum depth of cover below earth grade as required by local building codes, or NFPA 24, whichever is greater.
6. Underground mains shall be mechanically restrained against movement at all pipe joints, including all changes in direction, behind tees, hydrants, dead end lines or capped tees, and pipe-to-pipe joints. Alternatively, minimum required pipe lengths shall be mechanically restrained at all changes in direction (as noted) or thrust blocks used if, and only if, calculations are provided proving the minimum restrained length or minimum bearing area of thrust blocks. Mechanical joint restraints and/or thrust blocks shall be designed in accordance with NFPA 24 based upon a working pressure of 175 psi and the soil resistance (i.e., horizontal bearing strength) as determined by the geotechnical/ soils engineer, using a minimum safety factor of 1.5.
7. All fire water lead-ins into aboveground structures shall be provided with both mechanical joint restraints and concrete thrust blocks. Each thrust restraint method shall be individually provided in accordance with NFPA 24 as if it were the only restraint method being utilized for the fire water lead-in.
8. All rods, nuts, bolts, and washers shall be coated with an acceptable corrosion-retarding material. Corrosion protection shall meet the requirements of NFPA 24.
9. Guard posts shall be provided around all aboveground fire sprinkler system components subject to vehicular damage, including, but not limited to, on-site hydrants, post indicator valves, and freestanding fire department connections. The posts shall be a minimum of 6-in. Schedule 40 pipe filled with concrete. The top of each post shall be 4 ft. above grade level and shall extend a minimum of 3 ft. below grade. Posts shall be anchored in concrete. A minimum clear space of 3 ft. shall be maintained between each post and the component being protected.

B. Sprinkler Systems

1. Sprinkler system designs for the facility shall be in accordance with the Sprinkler Design Schedule on the fire protection drawings.
2. Sprinkler system zones shall be as indicated on the fire protection drawings.
3. Sprinkler system piping within the warehouse areas, with the sole exception of sprinkler system risers, shall be installed so that no part of any feed mains, cross mains, or branch lines is located lower than the minimum clear height specified by the Architect and as indicated on the contract documents.

4. Each system riser shall be equipped with a control valve, riser check valve, waterflow switch, pressure gauges (one each installed above and below the clapper of the riser check valve), and main drain.
5. Each riser manifold shall include a minimum 6-in. grooved end cap on each end to facilitate the flushing of the underground lead-ins.

C. Hydraulic Design Requirements
1. Sprinkler Discharge Area: The size, shape, and location of the discharge area for each system shall be as defined in NFPA 13 or FMDS 2-0.
2. Friction Losses: Losses in pipe shall be calculated in accordance with the Hazen-Williams formula with "C" values in accordance with NFPA 13.
3. Hose Stream Allowances: Include an allowance for hose streams as required by NFPA 13 and as indicated on the Sprinkler Design Schedule. Inside hose stream allowances shall be taken at the base of the riser. Outside hose stream allowances shall be taken at the nearest hydrant.
4. The water supply to be utilized for hydraulic calculation purposes shall be the city water main connection as indicated on the fire protection drawings.
5. The effective point for the water supply shall be as indicated on the fire protection drawings.
6. A safety margin between the available water supply residual pressure and the calculated system demand pressure of the hydraulically most remote area of each system shall be incorporated into all hydraulic calculations. The minimum safety margin shall be 10 psi or 10 percent of the design basis water supply static pressure at the effective point, whichever is greater.

D. Location of Sprinklers

Location of sprinklers in relation to the ceiling and the spacing of sprinklers shall not exceed that permitted by NFPA 13, FMDS 2-0, and the listing of each sprinkler. The spacing of sprinklers on the branch lines for open areas shall be essentially uniform.

E. Alarm and Supervisory Devices
1. Provide and install the following alarm and supervisory switches that shall be connected to the building Fire Alarm Control Unit (FACU) by the fire alarm contractor.
   a. Tamper Switches: All valves directly controlling water to fire sprinklers, including those associated with the backflow prevention device, shall be provided with tamper supervisory devices. An off-normal signal shall be initiated during the first two revolutions of a hand wheel or when the stem of the valve has moved one-fifth of the distance from its normal position, whichever is less. Each tamper switch shall initiate a distinct supervisory indication. Underground key operated valves are exempt from this requirement. The OS&Y valves associated with the backflow preventer are additionally to be secured with a substantial chain and padlock.
   b. Waterflow Switches: Each wet-pipe sprinkler system shall be provided with a vane-type waterflow device. Waterflow signals shall be priority signals that shall identify the flow device that is activated.
2. The fire sprinkler contractor shall provide no other fire alarm related components.

Drain pipes and valves shall be installed on each system to allow drainage. Each system shall drain to the maximum extent possible through the main drain valve. Discharge from drain pipes shall be to the building exterior, directed away from the building and stairs. The discharge from each drain pipe shall be piped to within 8 in. of grade. Concrete splash blocks under each drain outlet shall be provided where necessary to prevent soil erosion.

1.08 SUBMITTALS

Only complete submittal packages, which include all required drawings, calculations, and product data sheets, shall be submitted for approval. Partial submittal packages may be returned to sender without being reviewed.

A. Shop Drawings
1. Prepare and submit an electronic set (in PDF format) of detailed shop drawings indicating the proposed layout of equipment, fire service mains, risers, hangers, pipes and sprinklers. Shop drawings shall clearly indicate the locations and dimensions (to scale) of all potential obstructions or other interference to the sprinklers, including (but

not limited to): bar joists, bottom chord bridging, x-bracing, lighting fixtures, ceiling fans, duct work, roof-top exhaust fans, HVLS fans, etc.

2. Prepare working drawings at a scale not less than 3/32 in. = 1 ft., on sheets not smaller than 24 in. x 36 in., in accordance with all requirements for "Working Drawings (Plans)" as specified in NFPA 13 and NFPA 24. Submittal must be approved in writing by the Engineer and the Authorities Having Jurisdiction prior to starting work.
3. A complete set of one-half scale shop drawings shall be submitted to the Engineer upon final approval and prior to the Engineer's first site review.
4. The contractor shall utilize the project software selected by the Architect to coordinate the installation of systems and equipment to prevent interferences. The components should be detailed as follows:
    a. All spaces shall detail for each sprinkler riser, fire protection equipment, and piping that may impact access or clearances within each space.
    b. Items not to be included are sprinklers, branch lines, accessories, drains, gauges, seismic restraints, etc.

B. Product Data

Submit an electronic set of descriptive data (in PDF format) annotated to show the specific model, type, and size of each item proposed. Full descriptive data shall be submitted for all components essential to proper installation, including, but not limited to: sprinklers, pipe, fittings, gate valves, butterfly valves, check valves, test-and-drain valves, vent valves, relief valves, hangers, flow switches, tamper switches, indicator posts, underground pipe, devices, materials and associated equipment. Submittal must be approved in writing by the Engineer and the Authorities Having Jurisdiction prior to starting work.

C. Hydraulic Calculations

1. Prepare and submit an electronic set of hydraulic calculations in PDF format. A separate hydraulic calculation must be submitted for each sprinkler system. Nodes or reference points must be clearly identified on the shop drawings. Submittal must be approved in writing by the Engineer and the Authorities Having Jurisdiction prior to starting work.
2. At a minimum, hydraulic calculations shall include the following: cover sheet, water supply data, aggregate flow data, node data including elevations, pressures, K-factors, and discharges, fittings table of equivalent lengths used in the calculation, node-to-node hydraulic calculation data, flow diagrams, and pressure/flow curves.

D. Submittals to the Authorities Having Jurisdiction

Submit shop drawings, product data, and hydraulic calculations directly to the Authorities Having Jurisdiction for approval. Do not commence work until approval is obtained. Provide proof of approval to Owner. Coordinate with the local authorities' field inspecting representatives and make all adjustments or changes required to obtain approval without added cost to the contract.

E. Project Record Documents

1. Sprinkler Contractor's Superintendent shall prepare, on a daily basis, redlined shop drawings to record as-built conditions. Submit completed redline drawings to the Engineer at project completion.
2. Prepare and submit record shop drawings, product data, and hydraulic calculations reflecting final as-built conditions at completion of project, but before final acceptance of the work. These documents shall be prepared in accordance with the requirements for the initial submittal. Freehand sketches or mark-up documents are not acceptable. Record drawings shall be submitted in pdf and AutoCAD electronic formats.

F. Operation and Maintenance Data

Furnish two (2) sets of instruction manuals containing complete operation and maintenance instructions for the specific make and model of all check valves, control valves, waterflow and pressure switches, valve supervisory switches and other components supplied. Include maintenance data relative to components of system, servicing requirements, inspection data, replacement part numbers and availability, and location and numbers of service depot.

G. Contractor's Material and Test Certificates

Upon completion of required testing, submit completed and signed Contractor's Material and Test Certificates, for aboveground and underground piping, certifying systems meet or exceed the specified requirements.

1.09 QUALITY ASSURANCE

A. Qualifications
   1. Contractor shall be certified by the material/equipment manufacturer as trained in, and as knowledgeable of, the manufacturer's standard practices and procedures relating to installation of sprinkler systems. The Contractor shall be certified and licensed by the state and local jurisdictions, as applicable.
   2. Contractor shall be a firm specializing in performing work of this Section with a minimum of three years of experience and must be regularly engaged in making such installations.
   3. Contractor shall have successfully installed automatic fire sprinkler systems of the same type and design as specified herein. The Contractor shall provide evidence of such qualifications. The data shall include names and locations of at least three installations where the Contractor has installed such systems. The Contractor shall indicate the type and design of each system and certify each system has performed satisfactorily in the manner intended for a period of not less than 18 months. The Contractor shall submit a copy of a valid state sprinkler contractor certificate and license, as applicable.
   4. Contractor shall provide workers normally employed in the field and as otherwise specified in NFPA 13 and local ordinances.
   5. All material shall be new and in good condition, free of defects, scratches, corrosion and contamination. Used equipment shall not be permitted.

B. Equipment and components shall bear the markings indicating the equipment or component is UL-listed and/or FM-approved.

C. Regulatory Requirements
   1. The design, equipment, materials, installation, and workmanship shall be in strict accordance with the required and advisory provisions of NFPA 13 and NFPA 24, to other applicable NFPA standards, to all Local, State and Federal codes, and to all other requirements specified herein. The advisory provisions (Appendices/ Annexes) of the NFPA publications referred to herein, shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears. If there are any conflicts between these specifications and the referenced standards and publications, the most stringent requirement shall apply, as determined by the Engineer.
   2. Shop drawings, product data, and hydraulic calculations shall bear the stamp of approval of Authorities Having Jurisdiction, including the Engineer and the Fire Marshal's office.
   3. Deviations from the contract documents and the contractor's approved submittal documents will not be permitted without written consent from the Engineer.
   4. Compliance with the contract documents shall not relieve the Contractor from any specification section including strict compliance with NFPA 13, FMDS 2-0, Local, State, or Federal requirements, and the requirements of the Authorities Having Jurisdiction.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place. Maintain in place until installation.

B. Provide temporary protective coating on cast iron and steel valves.

1.11 SEQUENCING

A. Flushing of the underground mains and lead-ins must be completed in accordance with the requirements of NFPA 20 and NFPA 24 and underground notes on the fire protection drawings before connection is made to aboveground sprinkler or fire pump piping.

1.12 GUARANTEE

A. The Contractor, in addition to other warranties or guarantees required by the contract documents, shall guarantee workmanship on all piping, devices, and related materials for a

period of one year from the date of the Engineer's final written acceptance of the work. All defects shall be promptly corrected at no cost to the Owner.

B. The Contractor is responsible for providing a system that has been coordinated with the contract documents and approved by all concerns referenced in this document including, but not limited to, the Owner, local authorities, and the Owner's representatives.

1.13 EXTRA MATERIALS

A. Provide spare sprinklers in accordance with the provisions of NFPA 13. The quantity of each type of extra sprinkler shall be as specified in NFPA 13.

B. Provide manufacturer's sprinkler wrenches for each type/model of installed sprinklers.

C. Provide metal cabinets specifically designed for storage of spare sprinklers and sprinkler wrenches. Cabinets shall be of sufficient size to permit spare sprinklers to fit upright and reasonably secured within the sockets of the cabinets; spare sprinklers shall not be laid on their sides within the cabinets. Cabinets shall be located adjacent to each sprinkler riser manifold, unless otherwise indicated.

1.14 HYDRAULIC DESIGN INFORMATION SIGN

A. Provide a permanently marked, weatherproof metal or rigid plastic sign, with the following information inscribed thereon:

1. Location of the design area or areas
2. Discharge densities over the design area or areas, or number and discharge pressure of calculated sprinklers, as applicable
3. Required flow and residual pressure demand at the base of the riser
4. Occupancy classification or commodity classification and maximum permitted storage height and configuration
5. Hose stream demand included in addition to the sprinkler demand

B. The lettering on the sign shall be engraved or otherwise typeset. Handwritten signs shall not be accepted.

C. Signs shall be permanently secured to the system riser with corrosion resistant wire, chain, or other approved means.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment supplied under this specification shall be new and shall be UL-listed and/or FM-approved for fire protection service and installed and used as intended by the listing.

2.02 UNDERGROUND FIRE SERVICE MAINS

A. Underground pipe shall be UL-listed or FM-approved for fire protection service and shall be ductile iron pipe meeting AWWA C150 and AWWA C151, cement-mortar lined in accordance with AWWA C104, and laid in accordance with AWWA C600, or PVC piping meeting C900 and laid in accordance with AWWA C605.; or Polyvinyl Chloride (PVC) Pressure Pipe meeting AWWA C900 and laid per AWWA C60

B. The pressure class of the pipe, joints, fittings, valves and hydrants shall not be less than the maximum working pressure of the system under non-emergency (no-flow). In no case shall the pressure class be less than 175 psi.

C. Ductile iron pipe shall be joined by mechanical or push-on joints meeting AWWA C111, cast iron flanges meeting ANSI B16.1, ductile iron flanges meeting AWWA C115, or other approved means.

D. Fittings shall be cast iron meeting ANSI B16.1 or ductile iron meeting AWWA C110.

E. Fire hydrants shall be dry-barrel, high-pressure type, meeting the requirements of the local jurisdiction.

F. Underground sectional valves shall be AWWA NRS gate valves equipped with the mounting flange for indicator posts, unless indicated otherwise.

2.03 ABOVEGROUND PIPING SYSTEMS

A. Sprinkler pipe shall be per NFPA 13, and shall be steel conforming to ASTM A-53, A-135, or A-795. All piping shall be UL-Listed or FM-Approved. Piping joined by welding or rolled-groove methods shall have a minimum nominal wall thickness in accordance with Schedule

10 for sizes less than 6 in. (150 mm), 0.134 in. (3.40 mm) for 6 in. (150 mm), and 0.188 in. (4.78 mm) for 8 and 10 in. (200 and 250 mm). Piping joined by threaded methods shall be Schedule 40 for sizes less than 8 in. (200 mm) and Schedule 30 for sizes 8 in. (200 mm) and larger.

B. Pipe shall be joined by threaded, rolled-groove, welded or flanged methods. Welding methods shall comply with all requirements of AWS D10.9, threads shall be cut to ANSI/ASME B 1.20.1, and groove dimensions shall be compatible with the listings of the couplings and fittings used. Flange gaskets shall be red rubber sheet, 1/16 in. thick, conforming to ASTM D-2000. Gaskets for grooved couplings shall be EPDM, grade E type A, conforming to ASTM D-2000.

C. All grooved couplings and fittings shall be of the same manufacturer.

D. Fittings shall be cast iron conforming to ANSI B16.1 or ANSI B16.4, malleable iron conforming to ANSI B16.3, or steel conforming to ANSI B16.5, ANSI B16.9, ANSI B16.11, ANSI B16.25, or ASTM A234.

E. Where changes in pipe diameters occur or are required, only tapered fittings (e.g., reducing tees, concentric reducers) shall be used. Reducing couplings shall not be utilized.

2.04 SPRINKLERS

A. Sprinkler selection for each hazard area shall be in accordance with the Sprinkler Design Schedule indicated on the fire protection drawings.

B. Upright and pendent sprinklers in unfinished areas shall have natural brass finish.

C. Pendent sprinklers (and associated escutcheon plates, in all finished areas shall be recessed or semi-recessed type with a white finish, unless otherwise noted on the drawings.

2.05 PIPING SPECIALTIES

A. Wet-pipe Sprinkler Riser Valve: Provide Viking Easy Riser Swing Check Valve or equivalent, equipped with 2-in. main drain valve piped to exterior, and inlet and outlet pressure gauges for each individual sprinkler system. Each check valve shall have a removable faceplate to allow for internal inspection of the assembly without removing the check valve from the riser.

B. Pressure Relief Valve: Each wet-pipe sprinkler system shall be provided with a listed pressure relief valve not less than ½ in. in size and set to 10 psi above working pressure of the system (i.e., 185 psi). Relief valve shall be the Globe Model ARV Adjustable Relief Valve (GFV-575), or equivalent.

C. Vent Valves: A single automatic air vent valve shall be provided for each sprinkler system, with the vent valve located at the high point of the system. Each air vent shall be provided with a listed/approved indicating ball valve upstream of the vent to allow for servicing of the assembly. Each vent valve shall be a Potter Model PAV, without exception.

D. Waterflow Indicators: Provide vane-type waterflow switches at each individual wet-pipe sprinkler system supply. Switch shall have sensitivity setting to signal any flow of water that equals or exceeds the discharge from the smallest sprinkler installed on the system. Waterflow switch mechanisms shall incorporate an instantly recycling, adjustable retard element, adjustable up to 90 seconds, which shall be set between 30 and 60 seconds. Switches shall be rated at 175 psi cold water pressure. Switches shall be compatible with the fire alarm system and NFPA 72. All vane-type waterflow switches shall be Potter Model VSR, without exception.

E. Valve Supervisory Switches: Provide fire sprinkler control valves with approved built-in supervisory (tamper) switches shall be provided to the extent possible. The switch shall be designed to transmit a supervisory signal to the building fire alarm system. The supervisory signal shall be obtained during the first two revolutions of the hand wheel or operating crank. The switch shall not interfere with the operation of the valve, nor obstruct the view of its indicator. The trouble signal shall be obtained during abnormal interconnecting circuit conditions. Devices shall be compatible with the fire alarm system and the requirements of NFPA 72. All switches shall be suitable for installation of end-of-line devices. Switch shall incorporate tamper-resistant features. All tamper switches provided for OS&Y valves shall be Potter Model OSYSU-2, without exception. All tamper switches provided on post indicator valves shall be Potter Model PCVS-2, without exception.

F. Pressure Gauges: Pressure gauges shall be the Bourdon-tube type with a metal corrosion-resistant case, flat glass window, 3½-in. diameter white background dial with black markings,

and a 0-300 psig range. Gauge accuracy shall be 3-2-3% of full range. A shutoff valve shall be provided with each gauge connection.

2.06 VALVES

A. Provide valves as required by NFPA 13 and of types approved for fire protection system service. Valves 2 in. and smaller shall be bronze. Unless otherwise specified, valves 2½ in. and larger shall be bronze mounted with iron bodies.

B. Gate Valves
   1. Up to and including 2 in.: Bronze body, bronze trim, rising stem, handwheel, inside screw, single wedge, or disc.
   2. Over 2 in.: Iron body, bronze trim, rising stem, handwheel, OS&Y (unless provided with an indicator post), single wedge, resilient-seated.

C. Globe Valves
   1. Up to 2 in.: Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable composition disc, with back-seating capacity repackable under pressure.
   2. Over 2 in.: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, renewable seat and disc.

D. Ball Valves
   1. Up to and including 2 in.: Bronze one-piece body, stainless steel ball, Teflon seats and stuffing box ring, lever handle and balancing stops.
   2. Over 2 in.: Cast steel body, chrome plated steel ball, Teflon seat and stuffing box seals, lever handle, flanged.

E. Butterfly Valves
   1. Bronze body, stainless steel disc, resilient replaceable seat, threaded ends, extended neck, handwheel and gear drive and integral indicating device, and built-in tamper proof switch compatible with the fire alarm system.
   2. Cast or ductile iron body, chrome plated ductile iron disc, resilient replaceable EPDM seat, extended neck, handwheel and gear drive and integral indicating device and built-in tamper proof switch compatible with the fire alarm system.

F. Fire Department Hose Valves
   1. Brass body, UL-listed/ FM-approved
   2. Field adjustable pressure restricting mechanism, rated inlet pressure to 200 psi.

2.07 PIPE HANGERS

A. Pipe hangers, braces and supports shall be provided in accordance with NFPA 13.

B. Hangers for support of piping and equipment shall be UL-listed and/or FM-approved for fire protection service. Supports, including all-thread rods, shall not interfere with access to operating areas or contact building services equipment.

2.08 PIPE SLEEVES

A. For sleeves in masonry concrete walls, floors, roofs provide ASTM A53, Schedule 40 or standard weight, hot-dip galvanized steel pipe sleeves.

B. For sleeves in partitions, and other than masonry and concrete walls, floors and roofs provide hot-dip galvanized steel sheet having a nominal weight of not less than 0.90 pounds per sq.ft.

2.09 PIPE ESCUTCHEON PLATES

A. Provide approved one piece or split hinge type metal plates for piping passing through floors, walls, and ceilings in exposed areas. Provide chromium-painted finish or white-painted finish on plates in finished areas as appropriate. Securely anchor plates in place with set screws or other approved means.

2.10 FIRE DEPARTMENT CONNECTION

A. Provide an approved Storz-type fire department connection (FDC) at the location shown on the fire protection drawings.

B. The FDC shall be provided with a permanent metal FDC identification sign conforming to the requirements of NFPA 13 and the local Fire Authority.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate the work of this Section with other affected work.
B. The Contractor shall take any necessary measures to prevent damage to the facilities and equipment, and shall take any necessary measures to keep the premises dry at all times. Damage resulting from the work and testing under this section, whether intentional or not, shall be repaired by the Contractor at no cost to the Owner.
C. Prior to the operation (opening or closing) of any valve controlling water to the domestic or fire system, notification shall be given to, and approval obtained from, the General Contractor.
D. The A/E, Developer and Owner shall NOT be responsible for providing a safe working place for the Contractor, subcontractors, or their employees, or any individual responsible to them for the work. The responsibility rests with the Contractor.
E. Ream pipe and tube ends. Remove burrs and fins.
F. Prepare piping connections to equipment with flanges or unions.
G. All excess oil, dirt, pipe joint compound, rust, mill scale, and factory coatings shall be removed from piping and equipment. All dirt, debris and excess cutting oil shall be removed from the interior of all piping and equipment before it is erected.

3.02 INSTALLATION

A. All equipment shall be installed in an aesthetic and skilled manner in accordance with NFPA standards and other applicable standards referenced by this document. Final appearance of all systems and equipment shall be neat and clean. All piping in areas with finished ceilings shall be concealed.
B. Inspect, test, and approve piping before covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in pipe sizes through tapered reducing pipe fittings; the use of bushings will not be permitted. Welding shall be performed in the shop; field welding will not be permitted. Conceal piping, fittings, fixtures, hangers and supports in areas with suspended ceilings and finished areas.
C. Install equipment in accordance with manufacturer’s instructions.
D. Use proper lubricant on ends of piping or gaskets where required by pipe fitting or coupling manufacturer. The manufacturer’s recommended lubricant shall be used.
E. Where required by manufacturer, properly torque bolts to manufacturer’s specifications using a torque wrench.
F. All sprinklers shall be installed after the piping has been installed at ceiling level, and not while the piping is on ground level. There shall be no exceptions.
G. Place pipe runs to minimize obstruction to other work.
H. Insulate connection between pipe and fittings, hangers or dissimilar metal against direct contact. Use dielectric insulating flanges and units.
I. Support all sprinkler piping, risers, etc., as specified in applicable NFPA standards.
J. Provide a grooved end cap fitting at ends of all cross mains and riser manifolds to serve as flushing connections.
K. The Contractor shall install equipment, piping and hangers so that it will not interfere with piping, lighting, electrical conduit and wiring, structural members, air-conditioning equipment, and ceiling construction. If any such interference exists or occurs, the Contractor shall make the necessary adjustment to permit satisfactory installation of the equipment with no additional cost.
L. Sprinkler installation shall be coordinated with the installed mechanical and electrical work and the ceiling grid/layout. Where sprinklers are to be installed on modular ceiling panels (lay-in acoustical tile), sprinklers shall be located in the center of the ceiling panel, or located in other symmetrical pattern acceptable to the Building Owner's Representative and in accordance with referenced standards and design drawings. The Contractor shall furnish additional sprinklers that may be required for coordinated ceiling pattern without additional cost to the Owner, even though number of sprinklers may exceed minimum code requirements.
M. The Contractor shall install the piping and equipment in accordance with approved shop drawings.
N. Main and Auxiliary Drains

1. Each system shall be furnished with a main drain that is capable of draining the majority of the system. Drains shall discharge to the exterior. Drainage to floor is not permitted.
2. Auxiliary drains shall be provided to drain any sections of piping that trap water, or are not capable of being drained by the main drain in accordance with NFPA 13. Auxiliary drains shall discharge to the exterior to the maximum extent possible and the location shall be approved by the Architect.
3. All drains terminating outside shall be piped to within 8 in. of finished grade. Concrete splash blocks shall be provided at grade level beneath all outside drains to preclude soil erosion where necessary.
4. All drain piping and fittings located on the exterior shall be galvanized.

O. Install piping to conserve building space, and not interfere with use of space and other work.

P. Group piping whenever practical at common elevations, as permitted by the structural design and the sprinkler layout, without creating obstruction conflicts with ESFR sprinklers.

Q. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

R. Coordinate location and method of hanging of sprinkler piping 4 in. and larger with the structural design; provide additional structural bracing where necessary. Do not penetrate structural members without the prior written approval of the structural engineer.

S. Tapping or drilling of load-bearing structural members is not permitted. Attachments may be made to steel or concrete structures with approved clamps and hangers designed in accordance with NFPA 13 and local standards.

T. Provide pipe sleeves where piping passes through walls, floors, roofs, and partitions. Grout sleeves in proper position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, roofs, and partitions. Provide sleeves in non-seismic areas that are nominally 2 in. larger in diameter compared to the nominal size of the primary pipe penetration the wall, floor, roof, or partition. Comply with NFPA 13 clearance requirements in seismic areas. Firmly pack space with noncombustible insulation and caulk at both ends of the sleeve with plastic waterproof cement that will dry to a firm but pliable mass, or provide a segmented elastomeric seal. In fire-resistive rated assemblies (walls, floors, ceiling and partitions), pack space with approved firestopping materials. Installation of materials shall result in fire resistance rating equal to or greater than the assembly rating, unless otherwise indicated. Extend sleeves in floor slabs 3 in. above the finished floor.

U. Die cut screw joints with full cut standard taper pipe threads with non-toxic joint compound applied to male threads only.

V. Install valves with stems upright or horizontal as required, not inverted. Remove protective coatings after installation.

W. The Contractor is responsible for coordination of system requirements with all conditions of the building and site including, but not limited to, blind spaces, shelving, lights, grilles and diffusers, piping, duct work, doors, windows, equipment platforms, walls (fire-rated and non-fire-rated), beams, joists, columns, HVAC equipment, electrical panels and equipment, ceilings, areas without ceilings, wall construction, floors and all construction, equipment and building appurtenances. Contractor shall coordinate the layout of equipment, piping and materials with the General Contractor to assure sufficient space and openings to accommodate the entire installation, and accessibility for maintenance and replacements, if necessary.

X. Equipment, devices, apparatus, and accessories requiring normal servicing, operation and maintenance shall be made easily accessible.

Y. Provisions shall be made by the Contractor to protect piping, sprinklers and other components of the sprinkler systems from exposure to the elements or extreme climatic conditions including freezing and high temperature.

Z. Pipe Hangers:
1. In areas subject to water pressures in excess of 100 psi, provide a hanger, designed to prevent upward pipe movement, within 12 in. of a pendent sprinkler located at the end of a branch-line or on armovers over 12 in. in length in areas with suspended ceilings. All-thread rods longer than 20 ft. supporting armovers or end sprinklers require additional reinforcement to prevent buckling.
2. Hangers shall be positioned such that they are connected to pipe segments only and not to fittings.

AA. Identification signs shall be provided. Attach properly lettered approved metal signs conforming to NFPA 13 to each valve and alarm device. Permanently affix hydraulic design data nameplates to the riser of each system. Provide signs on the sprinkler control valve of each system. The sign shall identify the area of coverage controlled by the valve.

BB. Provide an inspector's test connection (ITC) for each sprinkler system. All ITC locations shall be approved by the Architect. Each ITC terminating outside shall be piped to within 8 in. of finished grade. Concrete splash blocks shall be provided at grade level beneath each discharge to preclude soil erosion where necessary.

CC. Thrust Blocks
1. The trench in the area of each fitting shall be cut to provide a thrust block bearing surface on undisturbed soil.
2. Concrete shall be poured using forms to fit snugly against as much of the fitting as possible without interfering with access to fitting joints.
3. The concrete shall be allowed a minimum curing time of five days.

3.03 SPRINKLERS (UPRIGHT AND PENDENT TYPE)

A. The sprinkler contractor shall be responsible for proper consideration of all obstructions and other installed equipment which may have an impact on the operation of the sprinklers.

B. Prior to the start of construction, the sprinkler contractor shall closely coordinate with all other trade, including, but not limited to, structural steel, mechanical, electrical, plumbing, data processing, and material handling to ensure the water discharge from sprinklers will not be prohibited from reaching burning commodities.

C. The standard to be utilized in identifying sprinkler placement and obstruction issues shall be NFPA 13 (2019) and the latest version of FM Global Property Loss Prevention Data Sheet 2-0. Any obstruction issue identified during the course of construction or acceptance inspections shall be corrected to meet the requirements of this standard at no additional cost.

3.04 INSPECTIONS AND TESTING

A. The system shall be subject to inspection and acceptance by the Engineer and the Authorities Having Jurisdiction for the purpose of determining the system is in accordance with federal, state, local and specification requirements, applicable standards of the NFPA and FM Data Sheets, and other related codes or standards.

B. The Contractor shall be responsible for performing and certifying requisite inspection and tests in accordance with applicable codes and standards for all equipment furnished under this specification.

C. Inspection and test procedures shall be submitted to the Engineer for approval prior to use.

D. All underground piping shall be completely flushed in accordance with NFPA 20 and NFPA 24 in the presence of the Engineer. Flushing procedures are subject to the approval of the Engineer and the Authorities Having Jurisdiction.

E. All underground piping shall be hydrostatically tested at not less than 225 psi or 50 psi above working pressure for 2 hours in accordance with NFPA 24 and as indicated on the fire protection drawings. Before testing, the trench shall be backfilled between joints. All joints shall be left exposed during the test.

F. Each hydrant shall be fully opened and closed under full system pressure with the fire pump running and checked for proper drainage.

G. All interior system piping shall be hydrostatically tested at not less than 225 psi for 2 hours in accordance with NFPA 13.

H. All operating parts, including electrical equipment, shall be fully tested to ensure their proper operation. All control valves shall be fully closed and opened under full system pressure, with the fire pump running.

I. All field tests performed by the Contractor shall be conducted in the presence of the Engineer and other representatives at the Owner's option. All persons concerned shall be notified two weeks in advance of the tests in order to arrange attendance at the tests.

J. The Contractor shall perform supplemental tests and shall render additional services in connection with the sprinkler system, as directed. The cost, if any, will be negotiated prior to the test. The effect of additional tests, if any, on the delivery schedule shall be determined prior to undertaking the test.

END OF SECTION

SECTION 21 1316
DRY PIPE FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.01 SCOPE

A. Work covered by this Section:

1. Dry pipe sprinkler system
2. System design, installation, and certification

1.02 RELATED SECTIONS

A. Section 21 1313 Wet Pipe Fire Sprinkler Systems
B. Section 28 3111 Intelligent, Addressable Fire Alarm System
C. Unless specifically modified by this section, the requirements of Section 21 1313 shall apply to the design, material/ equipment, installation, and testing of the dry pipe sprinkler system.
D. The conditions of the Contract, including the General Conditions and Supplementary Conditions, and Division 1 - General Requirements, apply to work covered by this Section.
E. Comply with Mechanical, Electrical and Civil Division Sections, as applicable. Refer to other Divisions for coordination of work.

1.03 DEFINITIONS

A. Equipment and materials shall be approved for their designed use and performance. The term “approved” shall mean Underwriters Laboratories (UL) listed and/or FM Global (FM) approved and/or acceptable to the approval authorities.
B. Approval authorities shall include the Owner, authorized representative Harrington Group, Inc. (Engineer), insurance provider, the General Contractor, and the local fire/code official(s), where applicable, (Authorities Having Jurisdiction).
C. The term “Contractor” as used within this specification refers to the private underground fire service mains and/or fire sprinkler system subcontractor(s).

1.04 INTENT

A. It is the intent of this specification section to provide the Owner’s minimum design and construction requirements relative to the fire protection system described herein. The Contractor shall comply with the provisions of this section to the maximum extent possible while still complying with the provisions of the local codes and standards.
B. It is not the intent of this specification to provide complete design and construction requirements as may be stipulated by the applicable building and fire codes enforced in the local jurisdiction. The responsibility to identify and comply with all provisions of the local building and fire codes, including all applicable standards, rests with the design-build Contractor.

1.05 DESIGN-BUILD RESPONSIBILITY

A. The design-build Contractor is responsible for the design, installation, and testing of all fire protection systems specified herein so that the final work product is complete and usable to the Owner. The Contractor is responsible to prepare all plans, calculations, and permit applications; to affix all required certifications and seals, to pay all required fees, and to perform all other work necessary to secure a construction permit and to obtain final approval of the work.

1.06 REFERENCES

A. State of Georgia
   1. 2018 International Building Code w/ Georgia Amendments
   2. 2018 International Fire Code w/ Georgia Amendments
   3. 120-3-3 State Minimum Fire Safety Standards (Effective 01/01/20)
B. National Fire Protection Association (NFPA)
   1. NFPA 13 (2019) – Standard for the Installation of Sprinkler Systems
   2. NFPA 24 (2019) – Standard for the Installation of Private Fire Service Mains and Their Appurtenances

3. NFPA 70 (2017) – National Electrical Code®
4. NFPA 72 (2019) – National Fire Alarm and Signaling Code
5. NFPA 1963 (2019) – Standard for Fire Hose Connections

C. Underwriters Laboratories, Inc. (UL)
1. Fire Protection Equipment Directory (most current edition including supplements)
2. Building Materials Directory (most current edition including supplements)
3. Electrical Construction Materials Directory (most current edition including supplements)

D. FM Global (FM)
1. FM Global Research Approval Guide (most current edition including supplements)

1.07 SYSTEM DESCRIPTION

A. Dry Pipe Sprinkler Systems
1. Provide a dry pipe fire sprinkler system to protect the Outdoor Work Area.
2. The dry pipe sprinkler system shall be designed and installed in accordance with the requirements of NFPA 13, the fire protection drawings, and this section.
   a. The Contractor shall design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping, and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.
3. The dry pipe sprinkler system riser and all trim components shall be located as indicated on the drawings.

B. System Operational Features
1. The system shall include supervisory and alarm switches, and associated equipment. The sprinkler system piping shall be provided with supervisory air pressure not to exceed 40 psig.
2. Activation of any sprinkler waterflow pressure-type alarm switch shall cause an alarm condition at the building FACU.
3. Valve tamper and supervisory air pressure signals shall be monitored by the building FACU as supervisory conditions.

C. Location of Sprinklers
1. Location of sprinklers in relation to the ceiling and the spacing of sprinklers shall not exceed that permitted by NFPA 13 and the listing of each sprinkler. The spacing of sprinklers on the branch line(s) for open areas shall be essentially uniform.

D. Alarm and Supervisory Devices
1. Provide and install the following alarm and supervisory switches that shall be connected to the FACU by the contractor.
   a. Tamper Switches: All valves directly controlling water to fire sprinklers shall be provided with tamper supervisory devices. Refer to fire protection drawings.
   b. Waterflow Switch: The dry pipe sprinkler system shall be provided with a pressure-type waterflow device compatible with the fire alarm system and NFPA 72. Waterflow signals shall be priority signals that shall identify the flow device that is activated.
   c. Air Pressure Supervisory Switch: The dry pipe system shall be provided with a device to monitor the air pressure within the system piping. The device shall initiate a supervisory signal for high and low-pressure conditions

E. Drain pipe and valve shall be installed on the system to allow drainage. The system shall drain to the maximum extent possible through the main drain valve.

F. Dry Pipe System Operating Sequence
1. When a sprinkler is opened by heat from a fire, air flows out of the open sprinkler, lowering the air pressure in the system. The drop in air pressure causes the dry pipe valve to trip, with the sprinkler system piping then flooding and water discharging through the open sprinkler(s).
2. A waterflow signal shall be generated upon tripping of the dry pipe valve, with an alarm signal initiated at the FACU.
3. A supervisory signal shall be initiated at the FACU when the air pressure in the dry pipe system distribution piping exceeds or falls below the normal air pressure of 40 psi by a maximum of 10 psi.

G. Work Not Covered by this Section
   1. Electrical circuit (110 VAC/ 60 hz) for the air compressor

PART 2 - PRODUCTS

2.01 ABOVEGROUND PIPING SYSTEMS

A. Sprinkler pipe shall be internally and externally galvanized and per NFPA 13 and shall be steel conforming to ASTM A-53, A-135, or A-795. Piping joined by welding or rolled-groove methods shall have a minimum nominal wall thickness in accordance with Schedule 40 for sizes 8 in. (200 mm) and less. Piping joined by threaded methods shall be Schedule 40 for sizes less than 8 in. (200 mm) and Schedule 30 for sizes 8 in. (200 mm) and larger. All piping and components shall be UL Listed or FM Approved. All fittings are to be galvanized.

B. All mechanical couplings shall be provided with gaskets that are specifically designed for use in areas subject to freezing, with the gaskets specifically design to prevent water accumulation in the gasket.

2.02 SPRINKLERS

A. Sprinkler selection for the hazard area shall be 8.0 K-factor or larger, intermediate-temperature rated, standard response, upright-type stainless steel.

2.03 DRY PIPE SYSTEM RISER

A. The dry pipe valve shall be a factory-assembled unit
   1. Supervisory air shall be provided via a riser mounted air compressor.

B. Dry Pipe Valve: The dry pipe valve shall be rated for a working pressure of 175 psi. Valve shall be capable of being reset without opening the valve. Valve shall be of the type that does not require priming water to be properly set.
   1. The dry pipe valve shall be equipped with a means to prevent the valve from returning to the closed position until being manually reset.
   2. Assembly shall be factory-assembled with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances.

C. Air Pressure Switch: High/Low air pressure switch shall detect a 10 psi off normal system air pressure. The switch shall be capable of being mounted in any position in the alarm line trim piping of the dry pipe valve trim. The switch shall be a Potter PS40-2, without exception.

D. Valve Supervisory Switches: Provide sprinkler control valve with approved supervisory (tamper) switch. The switch shall be designed to transmit a supervisory signal to the building fire alarm system. The supervisory signal shall be obtained during the first two revolutions of the hand wheel or operating crank. The switch shall not interfere with the operation of the valve, nor obstruct the view of its indicator. The trouble signal shall be obtained during abnormal interconnecting circuit conditions. Devices shall be compatible with the fire alarm system and the requirements of NFPA 72. All switches shall be suitable for installation of end-of-line devices.

E. Pressure Gauges: Pressure gauges shall be the Bourdon-tube type with a metal corrosion-resistant case, flat glass window, 3½-in. diameter white background dial with black markings, and a 0-300 psig range. The upper gauge shall be specifically designed for use with dry pipe systems. Gauge accuracy shall be 3-2-3% of full range. A shutoff valve shall be provided with each gauge connection.

2.04 SUPERVISORY AIR SYSTEM

A. Air compressor: Provide an oil less piston-type compressor sized to fill the sprinkler system to the normal operating pressure within 30 minutes. The compressor shall be provided with a pressure sensing switch to allow for automatic starting and stopping of the compressor. The compressor system shall additionally be provided with an automatic air maintenance device (AMD) to regulate the pressure of the system if required by the compressor manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate the exact location for the dry pipe riser and associated manifold near to the exterior wall of the building.

B. All system piping shall be pitched to drain, with the minimum pitch/slope of the pipe being ½-in. in 10 ft.

3.02 INSPECTIONS AND TESTING

A. An air pressure leakage test at 40 psi shall be conducted for 24 hours. There shall be no drop in gauge pressure in excess of 1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test.

B. Dry Pipe Valve

1. The dry pipe valve shall be trip-tested in accordance with the manufacturer's published instructions. Water shall reach the inspector' test drain outlet within 60 seconds of the test valve being opened. A full-flow main drain test shall be made. The air pressure shall be reduced to verify proper operation of the air supply system and associated supervisory alarm devices.
2. Test results shall be witnessed and recorded. Test results shall include the number of seconds elapsed between the time the test valve is opened and tripping of the dry pipe valve, trip-point air pressure of the dry pipe valve, water pressure prior to valve tripping, and number of seconds elapsed between time the inspector's test valve is opened and water reaches the orifice.

C. Supervisory Air

1. Supervisory air pressure shall be reduced from the normal system pressure to the point at which a low-pressure signal is generated. Air pressure shall be restored to verify trouble signal restoration.
2. Supervisory air pressure shall be increased above the normal system pressure to the point at which a high-pressure signal is generated. Normal air pressure shall be restored to verify trouble signal restoration.
3. Automatic start/stop features of air compressor shall be tested.

D. All operating parts shall be fully tested to ensure their proper operation. All control valves shall be fully closed and opened under full system pressure.

E. All field tests performed by the Contractor shall be conducted in the presence of the Engineer and other representatives at the Owner's option. All persons concerned shall be notified two weeks in advance of the tests in order to arrange attendance at the tests.

F. The Contractor shall perform supplemental tests and shall render additional services in connection with the sprinkler system, as directed. The cost, if any, will be negotiated prior to the test. The effect of additional tests, if any, on the delivery schedule shall be determined prior to undertaking the test.

3.03 TRAINING SESSIONS

A. Prior to project completion, the Contractor shall provide initial operational training to the Owner's key employees.

B. The Contractor shall arrange finalized training sessions at the convenience of the Owner. The sessions shall be completed as soon as possible following system acceptance. Each training session shall include details of the system interface and control.

END OF SECTION

SECTION 22 05 03 - PIPES AND TUBES FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for following systems:
   1. Domestic water piping within 5 feet of building.
   2. Sanitary sewer piping within 5 feet of building.
   3. Storm water piping within 5 feet of building.

1.2 SUBMITTALS

A. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes.

B. Product Data: Pipe materials and fittings; manufacturer's catalog information.

1.3 QUALITY ASSURANCE

A. Perform Work according to ASME B31.9 code for installation of piping systems, and ASME Section IX for welding materials and procedures.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. As specified on the plumbing drawings.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE

A. As specified on the pluming drawings.

2.3 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. As specified on the plumbing drawings.
   1. Fittings: PVC, ASTM D2729.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.4 SANITARY SEWER PIPING, ABOVE GRADE

1. As specified on the plumbing drawings
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.5 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665.

1. Fittings: PVC, ASTM D2665.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.6 STORM WATER PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2665.
   1. Fittings: PVC, ASTM D2665.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection site piping. Size, location, and invert are as indicated on Drawings.

3.3 INSTALLATION - ABOVE GROUND PIPING

A. Group piping whenever practical at common elevations.

B. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.

C. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

E. Provide access where valves and fittings are not accessible.

F. Install non-conducting dielectric connections wherever jointing dissimilar metals.

G. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.

H. Slope piping and arrange systems to drain at low points.

I. Protect piping systems from entry of foreign materials by temporary covers, completing sections of Work, and isolating parts of completed system.

J. Install piping penetrating roofed areas to maintain integrity of roof assembly.

3.4 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

A. Install domestic water piping system according to ASME B31.9.

3.5 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

A. Install sanitary waste and vent piping systems according to ASME B31.9.

3.6 FIELD QUALITY CONTROL

A. Test domestic water piping system according to local authority having jurisdiction.

B. Test sanitary waste and vent piping system according to local authority having jurisdiction.

C. Test storm drainage piping system according to local authority having jurisdiction.

3.7 CLEANING

A. Clean and disinfect domestic water distribution system.

END OF SECTION

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SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gate valves.
   2. Ball valves.
   3. Check valves.

1.2 SUBMITTALS

A. Product Data: Manufacturer's catalog information with valve data and ratings for each service.

B. Manufacturer's Installation Instructions: Hanging and support methods, joining procedures.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

B. Manufacturer: Company specializing in manufacturing Products specified in this Section with three years' experience.

1.4 WARRANTY

A. Furnish five year manufacturer warranty for valves excluding packing.

PART 2 PRODUCTS

2.1 BALL VALVES

A. 2 inches and Smaller: MSS SP 110, 400 psi bronze body, chrome plated brass ball, full port, teflon seats, blow-out proof stem, solder ends with lever handle.

2.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

2.3 VALVE APPLICATIONS

A. Install shutoff valves at locations indicated on Drawings and according to this Section.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install ball valves for throttling, bypass, or manual flow control services.

D. Install ball valves in domestic water systems for shut-off service.

END OF SECTION

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping relating to plumbing work.
9. Firestopping accessories.
10. Equipment bases and supports.

1.2 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 SYSTEM DESCRIPTION

A. Firestopping Materials: either: [ASTM E119] [ASTM E814] [UL 263] [UL 1479] to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
1. Ratings may be three hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

****** [OR] ******

B. Firestop interruptions to fire rated assemblies, materials, and components.

C. Firestopping Materials: Comply with requirements of Section 078400.

****** [OR] ******

D. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.4 SUBMITTALS

A. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, pipe hanger and support locations, and detail of trapeze hangers.

B. Product Data:
1. Hangers and Supports: Manufacturers catalog data including load capacity.
2. Firestopping: Data on product characteristics, performance and limitation criteria.

C. Firestopping Schedule: Schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Design Data: Indicate load-carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Sizing methods sealed by a registered professional engineer. Calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Firestopping Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.5 QUALITY ASSURANCE

A. Through-Penetration Firestopping of Fire-Rated Assemblies: ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
   2. Floor [and Roof] Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
      a. Floor Penetrations Within Wall Cavities: T-Rating not required.

B. Through-Penetration Firestopping of Non-Fire-Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
   1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire-Resistant Joints in Fire-Rated Floor, Roof, and Wall Assemblies: UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

D. Fire-Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested according to ASTM E84.

F. Perform Work according to [applicable authority] [AWS D1.1] for welding hanger and support attachments to building structure.

G. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

B. Maintain this minimum temperature before, during, and for minimum three days after installation of firestopping materials.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Substitutions: Permitted

B. Plumbing Piping - DWV:
   1. Conform to either: [ASME B31.9] [ASTM F708] [MSS SP58] [MSS SP69] [MSS SP89].
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, or Carbon steel, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
   6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
   7. Vertical Support: Steel riser clamp.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:
   1. Conform to either: [ASME B31.9] [ASTM F708] [MSS SP58] [MSS SP69] [MSS SP89].
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, or Carbon steel, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
   4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
   5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
   6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
   8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
   9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
   10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
   11. Vertical Support: Steel riser clamp.
   12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   13. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

15. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
   1. Substitutions: Permitted

B. Inserts: Malleable iron case of [galvanized] steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: [26] gage thick galvanized steel.

B. Metal Counterflashing: [22] gage thick galvanized steel.

C. Lead Flashing:
   1. Waterproofing: 5 lb./sq. ft sheet lead.
   2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: [47] mil thick sheet compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-Fire-Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or [18] gage thick galvanized steel.

C. Sealant: [Acrylic]

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. Substitutions: Permitted

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:
   1. Substitutions: Permitted

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.8 FIRESTOPPING

A. Manufacturers:
   1. Substitutions: Permitted

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: [Single] component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: [Single] component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
   4. Fiber Stuffing and Sealant Firestopping: Composite of [mineral] or [ceramic] fiber stuffing insulation with silicone elastomer for smoke stopping.
   5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
   6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
   7. Firestop Pillows: Formed mineral fiber pillows.

2.9 FIRESTOPPING ACCESSORIES

A. Installation Accessories:

B. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
   1. Furnish UL-listed products.
   2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
   1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
   2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or waterstop type wall sleeve.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Do not drill or cut structural members.

3.2 INSTALLATION

A. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut [above] or [flush with top of] or [recessed into and grouted flush with] slab.

B. Pipe Hangers and Supports: According to either: [ASME B31.1] [ASME B31.5] [ASME 31.9] [ASTM F708] [MSS SP 58] [MSS SP 69] [MSS SP 89].

C. Support horizontal piping as scheduled.

D. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

E. Place hangers within 12 inches of each horizontal elbow.

F. Use hangers with 1-1/2 inch minimum vertical adjustment.

G. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

H. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

I. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

J. Support riser piping independently of connected horizontal piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.

N. Equipment Bases and Supports:
   1. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment .
   2. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
   3. Construct supports of either: [steel members] [formed steel channel] [steel pipe and fittings] . Brace and fasten with flanges bolted to structure.
   4. Provide rigid anchors for pipes after vibration isolation components are installed.

O. Flashing:
   1. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
   2. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
   3. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
   4. Seal all [floor] [shower] [mop sink] drains watertight to adjacent materials.
   5. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

P. Sleeves:
   1. Exterior watertight entries: Seal with mechanical sleeve seals.
   2. Set sleeves in position in forms. Provide reinforcing around sleeves.
   3. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
   4. Extend sleeves through floors 1 inch above finished floor level; caulk sleeves.

Q. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

R. Install either: [chrome-plated steel] or [stainless steel] escutcheons at finished surfaces.

S. Firestopping:
   1. Firestopping Materials:
   2. Install material at fire-rated construction perimeters and openings containing penetrating sleeves, piping and other items requiring firestopping.
   3. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
   4. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating ,to uniform density and texture.
   5. Compress fibered material to maximum 40 percent of its uncompressed size.

****** [OR] ******

   6. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

****** [OR] ******

   7. Place intumescent coating in sufficient coats to achieve rating required.
   8. Remove dam material after firestopping material has cured.
   9. Fire-Rated Surface:
      a. Seal opening at [floor,] [wall,] [partition,] [ceiling,] [and] [roof] as follows:
         1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
         2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
         3) Pack void with backing material.
         4) Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
      b. Where [cable tray,] [bus,] [cable bus,] [conduit,] [wireway,] [trough,] penetrates fire rated surface, install firestopping product according to manufacturer's instructions.

10. Non-Rated Surfaces:
    a. Seal opening through non-fire rated [wall,] [partition] [floor,] [ceiling,] [and] [roof opening] as follows:
        1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
        2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
        3) Install type of firestopping material recommended by manufacturer.
    b. Install [escutcheons] [floor plates] [or] [ceiling plates] where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
    c. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, according to manufacturer's instructions.
    d. Interior partitions: Seal pipe penetrations at [clean rooms,] [laboratories,] [hospital spaces,] [computer rooms,] [telecommunication rooms] [data rooms]. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.3 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
ABS (All sizes)	4	3/8
Aluminum (All sizes)	10	1/2
Brass		
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 foot length of pipe	10	5/8
CPVC, 1 inch and smaller	3	1/2
CPVC, 1-1/4 inches and larger	4	1/2
Copper Tube, 1-1/4 inches and smaller	6	1/2
Copper Tube, 1-1/2 inches and larger	10	1/2
Fiberglass	4	1/2
Glass	8	1/2
Polybutylene	2.67	3/8
Polypropylene	4	3/8
PVC (All Sizes)	4	3/8
Steel, 3 inches and smaller	12	1/2
Steel, 4 inches and larger	12	5/8

END OF SECTION

SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Inertia bases.
   2. Vibration isolators.

1.2 PERFORMANCE REQUIREMENTS

A. Consider upper floor locations critical unless otherwise indicated.

B. Maintain rooms at following maximum sound levels, in [Noise Criteria (NC)] [Room Criteria (RC)] as defined by [ASHRAE Handbook., HVAC Applications] [ANSI S1.8.]
   1. Offices
      a. Executive: [30]
      b. Conference rooms: [30]
      c. Private: [35]
      d. Open-plan areas: [40]
      e. Computer/business machine areas: [45]
      f. Public circulation: [45]

1.3 SUBMITTALS

A. Product Data: Schedule of vibration isolator type with location and load on each. Catalog information, indicating materials and dimensional data.

B. Manufacturer's Installation Instructions: Special procedures and setting dimensions.

C. Manufacturer's Certificate: Isolators meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work according to either [ARI 575] [ANSI S12.36].

B. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

C. Installer: Company specializing in performing Work of this Section with three years' experience.

PART 2 PRODUCTS

2.1 INERTIA BASES

A. Manufacturers:
   1. Substitutions: Permitted

B. Structural Bases:

1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
2. Construction: Welded structural steel with gusset brackets, supporting equipment and motor with motor slide rails.

C. Concrete Inertia Bases:
1. Mass: Minimum of 1.5 times weight of isolated equipment.
2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, concrete filled.
3. Connecting Point: Reinforced to connect isolators and snubbers to base.
4. Concrete: Reinforced 3,000 psi concrete.

2.2 VIBRATION ISOLATORS

A. Manufacturers:
1. Substitutions: [Permitted]

B. Open Spring Isolators:
1. Spring Isolators:
a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

C. Restrained Spring Isolators:
1. Spring Isolators:
a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
5. Restraint: Furnish mounting frame and limit stops.

D. Closed Spring Isolators:
1. Spring Isolators:
a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

E. Restrained Closed Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
   3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.

F. Spring Hanger:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Housings: Incorporate either [neoprene isolation pad meeting requirements for neoprene pad isolators] [rubber hanger with threaded insert].
   4. Misalignment: Capable of 20 degree hanger rod misalignment.

G. Neoprene Pad Isolators:
   1. Rubber or neoprene-waffle pads.
      a. 30 durometer.
      b. Minimum 1/2 inch thick.
      c. Maximum loading 40 psi.
      d. Height of ribs: not to exceed 0.7 times width.
   2. Configuration: either [Single layer] [1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.]

H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

I. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

J. Seismic Snubbers:
   1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
   2. Neoprene Elements: Replaceable, minimum of 0.75 inch thick.
   3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
   4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify equipment and piping is installed before Work of this Section is started.

3.2 INSTALLATION

A. Install isolation for motor-driven equipment.

B. Bases:
   1. Set steel bases for 1 inch clearance between housekeeping pad and base.
   2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

C. Adjust equipment level.

D. Install spring hangers without binding.

E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

G. Provide pairs of horizontal limit springs on fans with more than [6.0] inch static pressure, and on hanger supported, horizontally mounted axial fans.

H. Provide resiliently mounted equipment and piping with seismic snubbers. Provide each inertia base with minimum four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.

I. Support piping connections to isolated equipment resiliently either: [for scheduled distance.] [to nearest flexible pipe connector.] [as follows:]
   1. Up to 4 inch Diameter: First three points of support.
   2. 5 to 8 inch Diameter: First four points of support.
   3. 10 inch Diameter and Over: First six points of support.
   4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.4 SCHEDULES

A. Pipe Isolation Schedule:

Pipe Size Inch	Isolated Distance from Equipment
1	120 diameters
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters
10	54 diameters
12	50 diameters

16	45 diameters
24	38 diameters

END OF SECTION

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SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

1.2 SUBMITTALS

A. Product Data: Manufacturers catalog literature for each product required.

B. Shop Drawings: List of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Samples: Two tags, labels, and pipe markers, of size used on Project.

D. Manufacturer's Installation Instructions: Special procedures and installation.

E. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.5 QUALIFICATIONS

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

B. Installer: Company specializing in performing Work of this Section with three years' experience.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags:
1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.

B. Metal Tags:
1. Aluminum with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting according to Section 09 90 00.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion-resistant chain. Number tags consecutively by location.

F. Identify water heaters and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

G. Identify valves in main and branch piping with tags.

H. Identify piping, concealed or exposed, with plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plumbing piping insulation, jackets and accessories.

1.2 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding [50] in accordance with ASTM E84

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Maintain one copy of each document on site.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period of [24] hours.

1.6 WARRANTY

A. Furnish [five] year manufacturer warranty for man made fiber.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Glass Fiber and Mineral Fiber Insulation
   1. Manufacturers:
      a. Substitutions: Permitted

B. Closed Cell Elastomeric Insulation
   1. Manufacturers:
      a. Substitutions: Permitted

C. Polyisocyanurate Foam Insulation
   1. Manufacturers:
      a. Substitutions: Permitted

D. Extruded Polystyrene Insulation
   1. Manufacturers:
      a. Substitutions: Permitted

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. [Conform to ASTM C795 for application on Austenitic stainless steel.]
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Operating Temperature Range: 0 to 850 degrees F.
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. [Conform to ASTM C795 for application on Austenitic stainless steel.]
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Operating Temperature Range: 0 to 850 degrees F.

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. [Conform to ASTM C795 for application on Austenitic stainless steel.]
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: 0 to 650 degrees F.
   3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. [Conform to ASTM C795 for application on Austenitic stainless steel.]
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: 0 to 650 degrees F.

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.30 at 75 degrees F.
2. Maximum Service Temperature: 300 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 300 degrees F.

G. TYPE P-7: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Service Temperature: 250 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 250 degrees F.

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Canvas Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric treated with fire retardant lagging adhesive.

I. TYPE P-9: ASTM C591, Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.
1. Thermal Conductivity: 180 day aged value of [0.19] [0.19] [0.20] at 75 degrees F.
2. Operating Temperature Range: Range: Minus 297 to 300 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of either [4] [6] mils thickness and water vapor permeance of either [0.02] [0.01] perms.

J. TYPE P-10: ASTM C578, Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.
1. Thermal Conductivity: 180 day aged value of 0.259 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 297 to 165 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of either [4] [6] mils thickness and water vapor permeance of either [0.02] [0.01] perms.

K. TYPE P-11: ASTM C533; Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.
1. Thermal Conductivity: 0.45 at 200 degrees F.
2. Operating Temperature Range: 140 to 1200 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
1. [ASTM C921,] white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water vapor transmission: ASTM E96/E96M; 0.02 perm-inches.

B. PVC Plastic Pipe Jacket:
1. Product Description: [ASTM D1785,] One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: either [10] [15] [30] mil.
3. Connections: either [Brush on welding adhesive] [Tacks] [Pressure sensitive color matching vinyl tape].

C. ABS Plastic Pipe Jacket:
1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
2. Minimum service temperature: [-40] degrees F.
3. Maximum service temperature of [180] degrees F.
4. Water vapor transmission: ASTM E96/E96M; 0.012 perm-inches.
5. Thickness: [30] mil.

6. Connections: Brush on welding adhesive.

D. Field Applied Glass Fiber Fabric Jacket System:
1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:
a. Cloth: Untreated; 9 oz/sq yd weight.
b. Blanket: 1.0 lb/cu ft density.
c. Weave: [5 x 5]
3. Indoor Vapor Retarder Finish:
a. Cloth: Untreated; 9 oz/sq yd weight.
b. Vinyl emulsion type acrylic, compatible with insulation, [white] color.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with either [aluminum] [stainless steel jacket] single piece construction with self adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify [piping] [and/or] [equipment] has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing

insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, [pump bodies,] and expansion joints.
   2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
   3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
   1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
   2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
   3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. [Polyisocyanurate Foam Insulation] or [Extruded Polystyrene Insulation]:
   1. Wrap elbows and fitting with vapor retarder tape.
   2. Seal butt joints with vapor retarder tape.

F. Hot Piping Systems less than [140] degrees F:
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
   3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

G. Hot Piping Systems greater than [140] degrees F:
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
   3. Insulate flanges and unions at equipment.

H. Inserts and Shields:
   1. Piping [1-1/2] inches Diameter and Smaller: Install [galvanized] steel shield between pipe hanger and insulation.
   2. Piping [2] inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
      a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
      b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
   3. Piping Supported by Roller Type Pipe Hangers: Install [galvanized] steel shield between roller and inserts.

I. Insulation Terminating Points:
   1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
   2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
   3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

J. Closed Cell Elastomeric Insulation:
   1. Push insulation on to piping.
   2. Miter joints at elbows.
   3. Seal seams and butt joints with manufacturer's recommended adhesive.
   4. When application requires multiple layers, apply with joints staggered.
   5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

K. High Temperature Pipe Insulation:
   1. Install in multiple layers to meet thickness scheduled.
   2. Attach each layer with bands. Secure first layer with bands before installing next layer.
   3. Stagger joints between layers.
   4. Finish with canvas jacket [sized for finish painting].

L. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces [(less than 10 feet above finished floor)]: Finish with either [canvas jacket sized for finish painting] [PVC jacket and fitting covers] [ABS jacket and fitting covers].

M. Piping Exterior to Building: [Provide vapor retarder jacket.] Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with either [aluminum] [stainless steel] jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

N. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

O. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

P. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with [aluminum] [stainless steel] jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

Q. Prepare pipe insulation for finish painting.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Domestic Hot Water Supply and Recirculation	[P-1]	1-1/4 inches and smaller 1-1/2 inches and larger	0.5 1.0
Domestic Hot Water Supply and Recirculation systems with domestic water temperature maintenance cable	[P-1]	1 inch and smaller 1-1/4 inches to 2 inches 2-1/2 inches and larger	1.0 1.5 2.0
Domestic Cold Water	[P-1] [or] [P-5]	1-1/4 inches and smaller 1-1/2 inches and larger	0.5 1.0
Deionized Water	[P-1] [or] [P-5]	All sizes	1.0

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Storm Piping (horizontal above ground within building)	[P-1] [or] [P-5]	All sizes	[0.5]
Storm Piping (horizontal and vertical above ground within building when PVC pipe is used)	[P-1] [or] [P-5]	All sizes	[0.5]
Sanitary Sewer Piping (horizontal and vertical above ground within building when PVC piping is used)	[P-1] [or] [P-5]	All sizes	[0.5]

END OF SECTION

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SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water closets.
   2. Lavatories.
   3. Sinks.
   4. Showers.
   5. Service sinks.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer’s literature for plumbing fixtures.

1.3 SUSTAINABLE DESIGN SUBMITTALS

A. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
   1. Water Efficiency Certificates:
      a. Certify plumbing fixture flow rates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit literature and parts list.

1.5 QUALITY ASSURANCE

A. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

B. Maintain one copy of each document on site.

PART 2 PRODUCTS

2.1 FLUSH VALVE WATER CLOSETS

A. Provide wall hung water closets as specified on the plumbing drawings.

B. Substitutions: Permitted

2.2 LAVATORIES

A. Provide lavatories as specified on the plumbing drawings.

B. Substitutions: Permitted.

2.3 SINKS

A. Provide sinks as specified on the plumbing drawings.

B. Substitutions: Permitted.

2.4 SHOWERS

A. Provide sinks as specified on the plumbing drawings.

B. Substitutions: Permitted.

2.5 SERVICE SINKS

A. Provide sinks as specified on the plumbing drawings.

B. Substitutions: Permitted.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify adjacent construction is ready to receive rough-in work of this section.

B. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.2 INSTALLATION

A. Install each fixture with chrome plated rigid or flexible supplies with screwdriver stops, reducers, and escutcheons.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

END OF SECTION

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Safety stations (combination emergency fixture units).

B. Emergency-fixture water-tempering valves.

1.2 REFERENCE STANDARDS

A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment 2014.

B. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs 2011.

C. UL (DIR) - Online Certifications Directory Current Edition.

1.3 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's catalog sheets for fixtures, fittings, accessories, and supplies.

PART 2 PRODUCTS

2.1 SAFETY STATIONS (COMBINATION EMERGENCY FIXTURE UNITS)

A. Manufacturers:

1. Acorn Engineering Company: www.acorneng.com.
2. Encon Safety Products, Inc: www.enconsafety.com.
3. Guardian Equipment: www.gesafety.com.
4. Speakman Company: www.speakman.com.
5. Substitutions: See Section 016000 - Product Requirements.

B. ANSI Z358.1, free-standing shower with bowl-mounted dual eye wash spray head fixture assembly.

C. Product Certification: UL (DIR).

D. Tepid Supply Water Temperature: Set to 85 degrees F (29 degrees C).

E. Water Supply Connection Size: Minimum, 1-1/4 inch (3.2 cm).

F. Water Discharge Flow Rates:

1. Shower Head: Minimum, 20 gpm (75.7 lpm) at 30 psi (2 bar).
2. Eye wash Spray Heads: Minimum, 0.4 gpm (1.5 lpm) for 15 minutes.

G. Pipe and Fittings Material: Powder coated galvanized steel.

H. Shower Head: ABS Plastic

I. Bowl: ABS Plastic

1. Self-cleaning, non-clogging, 10 inches (25.4 cm) in diameter with escutcheon.

J. Freeze Protection: Thermostatically-actuated bleed valve.

K. Valves: Brass, Full flow, stay-open, with dedicated manual arm-rod operator with stainless steel actuating arm for shower and dedicated manual operator handle for eye wash.

L. Accessories:

1. Signage: ANSI Z535.2, emergency safety station equipment.

2.2 EMERGENCY-FIXTURE WATER-TEMPERING VALVES

A. Supply water tempering valves from same manufacturer as emergency fixture which it is servicing.

B. Tepid Water Temperature: Set to 85 degrees F (29 degrees C).

C. Capacity: Sized to match selected fixture(s) capacity.

D. Valve Assembly: Thermostatic mixing (blending) type made of lead-free cast brass body with integral built-in cold water bypass (fail safe), color marked dual-scale outlet temperature gauge, integral inlet check valve, integral inlet strainer, locking-type regulator, and mounting bracket.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that fixtures and accessories are of the correct type and size prior to installation.

B. Verify that deck, wall and floor finishes are prepared and ready for fixture installation.

3.2 INSTALLATION

A. Install fixtures and fittings in accordance with the manufacturer's instructions.

B. Adjust water flow rates to comply with manufacturer's rating of the fixture.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Operational Tests: Upon completion and sterilization of plumbing systems, conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

3.4 CLEANING

A. Thoroughly clean plumbing fixtures and equipment.

3.5 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Repair or replace products damaged before Date of Substantial Completion.

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Single- and three-phase motors for application on equipment provided under other Sections and for motors furnished loose to Project.

1.2 SUBMITTALS

A. Product Data: Catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

B. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.3 QUALIFICATIONS

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

B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this Section with three years' experience.

1.4 DELIVERY, STORAGE, AND HANDLING

A. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Motors 3/4 hp and Larger: Three-phase motor as specified below.

B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer’s standard.

C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
   1. Voltage: 208 and/or 230 and/or 230/460 and/or 460 volts, three phase, 60 Hz As indicated on Drawings.
   2. Service Factor: 1.25 and/or 1.15 and/or 1.0 As indicated on Drawings.
   3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
   4. Design for continuous operation in 40 degrees C environment, with temperature rise according to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   5. Insulation System: NEMA Class F and/or A and/or B and/or H.
   6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
9. Sound Power Levels: Conform to NEMA MG 1.

D. Single Phase Motors:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115 and/or 115/230 and/or 230 volts, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 THREE-PHASE MOTORS FURNISHED LOOSE

A. Manufacturers:
1. Substitutions: Permitted

B. Product Description: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds indicated.

C. Voltage: 208 and/or 230 and/or 230/460 and/or 460 volts, three phase, 60 Hz.

D. Service Factor: 1.25 and/or 1.15 and/or 1.0 As indicated on Drawings.

E. Enclosure: Meet conditions of installation unless specific enclosure is specified or indicated.

F. Design for continuous operation in 40 degrees C environment, with temperature rise according to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

G. Insulation System: NEMA Class F and/or A and/or B and/or H.

H. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

I. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.

J. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 and/or 50,000 and/or 100,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

K. Sound Power Levels: Conform to NEMA MG 1.

L. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.3 SOURCE QUALITY CONTROL

A. Test motors according to NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned motors

B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing motors to remain or are to be reinstalled.

3.2 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors according to motor manufacturer's requirements.

3.3 FIELD QUALITY CONTROL

A. Inspect and test according to NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

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SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Formed steel channel.
9. Firestopping relating to HVAC Work.
10. Firestopping accessories.
11. Equipment bases and supports.

1.2 SYSTEM DESCRIPTION

A. Firestopping Materials: Comply with requirements of Section 078400.

B. Firestopping Materials: ASTM E119 and/or ASTM E814 and/or UL 263 and/or UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
1. Ratings may be 3-hour for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

C. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction noted in Schedule at end of this Section and/or according to FM Design Numbers noted on Drawings and/or according to FM Design Numbers noted in Schedule at end of this Section and/or according to UL Design Numbers noted on Drawings and/or according to UL Design Numbers noted in Schedule at end of this Section and/or according to WH Design Numbers noted on Drawings and/or according to WH Design Numbers noted in Schedule at end of this Section

D. Firestop interruptions to fire rated assemblies, materials, and components.

1.3 PERFORMANCE REQUIREMENTS

A. Firestopping Materials: Comply with requirements of Section 07 84 00.

B. Firestopping: Conform to applicable code FM and/or UL and/or WH for fire resistance ratings and surface burning characteristics.

C. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.4 SUBMITTALS

A. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

B. Product Data:
   1. Hangers and Supports: Manufacturers catalog data including load capacity.
   2. Firestopping: Data on product characteristics, performance and limitation criteria.

C. Firestopping Schedule: Opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Design Data: Indicate load-carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods and/or calculations sealed by a professional engineer.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Special procedures and assembly of components.
   2. Firestopping: Preparation and installation instructions.

F. Manufacturer's Certificate: Products meet or exceed specified requirements.

G. Firestopping Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.5 QUALITY ASSURANCE

A. Through-Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
   2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
      a. Floor Penetrations Within Wall Cavities: T-Rating is not required.

B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
   1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire-Resistant Joints in Fire-Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

D. Fire-Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch wg minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested according to ASTM E84.

F. Perform Work according to applicable authority AWS D1.1 for welding hanger and support attachments to building structure.

G. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

H. Installer: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F

B. Maintain this minimum temperature before, during, and for minimum three days after installation of firestopping materials.

C. Provide ventilation in areas to receive solvent cured materials.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Furnish five one-year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Substitutions: Permitted

B. Refrigerant Piping:
   1. Conform to ASME B31.5 and/or ASTM F708 and/or MSS SP58 and/or MSS SP69 and/or MSS SP89.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron and/or Carbon steel, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
   6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
   7. Vertical Support: Steel riser clamp.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   9. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
   1. Substitutions: Permitted

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire-resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic; refer to Section 079000].

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Substitutions: Permitted

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:
1. Substitutions: Permitted

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.8 FIRESTOPPING

A. Firestopping Materials: Comply with requirements of Section 078400.

B. Manufacturers:
   1. Substitutions: Permitted

C. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single and/or Multiple component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single and/or Multiple component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
   4. Fiber Stuffing and Sealant Firestopping: Composite of mineral and/or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
   5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
   6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
   7. Firestop Pillows: Formed mineral fiber pillows.

D. Color: Dark gray and/or Black and/or As selected from manufacturer’s full range of colors.

2.9 FIRESTOPPING ACCESSORIES

A. Installation Accessories: Comply with requirements of Section 078400.

B. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

C. Dam Material: Permanent:
   1. Mineral fiberboard.
   2. Mineral fiber matting.
   3. Sheet metal.
   4. Plywood or particle board.
   5. Alumina silicate fire board.

D. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

E. General:
   1. Furnish UL listed products or products tested by independent testing laboratory.
   2. Select products with rating not less than rating of wall or floor being penetrated.

F. Non-Rated Surfaces:
   1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
   2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing and/or damming materials to arrest liquid material leakage.

D. Obtain permission from Architect/Engineer before using powder-actuated anchors.

E. Do not drill or cut structural members.

F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION

A. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above and/or flush with top of and/or recessed into and grouted flush with slab.

B. Pipe Hangers and Supports:
   1. Install according to ASME B31.1 and/or ASME B31.5 and/or ASME 31.9 and/or ASTM F708 and/or MSS SP 58 and/or MSS SP 69 and/or MSS SP 89.
   2. Support horizontal piping as scheduled.
   3. Install hangers with minimum 1/2 inch space between finished covering and adjacent Work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment.
   6. Support vertical piping at every other floor.
   7. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
   8. Support riser piping independently of connected horizontal piping.
   9. Provide copper plated hangers and supports for copper piping and/or sheet lead packing between hanger or support and piping.
   10. Design hangers for pipe movement without disengagement of supported pipe.
   11. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

12. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.

C. Equipment Bases and Supports:
   1. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 033000.
   2. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
   3. Construct supports of steel members and/or formed steel channel and/or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
   4. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 210548.

D. Flashing:
   1. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
   2. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
   3. Provide curbs for roof installations 14 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.
   4. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

E. Sleeves:
   1. Exterior watertight entries: Seal with mechanical sleeve seals.
   2. Set sleeves in position in forms. Provide reinforcing around sleeves.
   3. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
   4. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
   5. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent Work with stuffing and/or firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
   6. Install chrome plated steel and/or plastic and/or stainless steel escutcheons at finished surfaces.

F. Firestopping:
   1. Firestopping Materials: Comply with requirements of Section 078400.
   2. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
   3. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
   4. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
   5. Compress fibered material to maximum 40 percent of its uncompressed size.
   6. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
   7. Place intumescent coating in sufficient coats to achieve rating required.
   8. Remove dam material after firestopping material has cured. Dam material to remain.
   9. Fire-Rated Surface:
      a. Seal opening at floor, wall, partition, ceiling, and/or roof as follows:
         1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.

2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
3) Pack void with backing material.
4) Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

b. Where cable tray, bus, cable bus, conduit, wireway, and/or trough, penetrates fire rated surface, install firestopping product according to manufacturer's instructions.

10. Non-Rated Surfaces:
    a. Seal opening through non-fire rated wall, partition floor, ceiling, and/or roof opening as follows:
        1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
        2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
        3) Install type of firestopping material recommended by manufacturer.
    b. Install escutcheons, floor plates and/or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
    c. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, according to manufacturer's instructions.
    d. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

1.2 SUBMITTALS

A. Product Data: Manufacturers catalog literature for each product required.

B. Shop Drawings: List of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Samples: Two tags, labels, and/or pipe markers, size used on Project.

D. Manufacturer's Installation Instructions: Instructions, special procedures, and installation.

E. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

C. Installer: Company specializing in performing Work of this Section with three years' experience and approved by manufacturer.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two containers of spray-on adhesive.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Substitutions: Permitted

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags
   1. Manufacturers:
      a. Substitutions: Permitted
      b. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter and/or square.

B. Metal Tags:
   1. Manufacturers:
      a. Substitutions: Permitted
      b. Brass, Aluminum, and/or Stainless Steel with stamped letters; tag size minimum 1-1/2 inches diameter and/or square with finished edges.

C. Information Tags
   1. Manufacturers:
      a. Substitutions: Permitted
      b. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame and/or plastic laminated.

2.3 STENCILS

A. Stencils
   1. Manufacturers:
      a. Substitutions: Permitted

B. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
   2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
   3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
   4. Ductwork and Equipment: 1-3/4 inches high letters.

C. Stencil Paint:semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers
   1. Manufacturers:
      a. Substitutions: Permitted
      b. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers
   1. Manufacturers:
      a. Substitutions: Permitted
   2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.5 CEILING TACKS

A. Ceiling Tacks:
   1. Manufacturers:
      a. Substitutions: Permitted

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:
   1. HVAC equipment: Yellow.
   2. Fire dampers/smoke dampers: Red.
   3. Plumbing valves: Green.
   4. Heating/cooling valves: Blue.

2.6 LABELS

A. Labels
   1. Manufacturers:
      a. Substitutions: Permitted

B. Description: Aluminum, Polyester, and/or Laminated Mylar, size 1.9 x 0.75 inches adhesive backed with printed identification and bar code.

2.7 UNDERGROUND WARNING TAPE

A. Underground Warning Tape
   1. Manufacturers:
      a. Substitutions: Permitted

B. Description: Polyethylene tape with metallic core for detection and location of piping with metal detector resistant to acids, alkalis and other soil components.
   1. Size: 0.004 inch; 6 inches
   2. Color: As selected.
   3. Service Marking: Printed text as selected by Architect/Engineer in black and/or contrasting color and repeated at maximum 40 inches intervals.

2.8 LOCKOUT DEVICES

A. Lockout Hasps
   1. Manufacturers:
      a. Substitutions: Permitted

2. Anodized aluminum and/or Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches

B. Valve Lockout Devices
1. Manufacturers:
a. Substitutions: Permitted
2. Nylon, Steel, and/or Plastic device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates and/or stencil painting. Identify in-line pumps and other small devices with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers, and/or stenciled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. For exposed natural gas lines other than steel pipe, attach yellow pipe labels with "GAS" in black lettering, at maximum 5 foot spacing.

N. Identify ductwork with plastic nameplates and/or stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

O. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Testing adjusting, and balancing of air systems.

1.2 SUBMITTALS

A. Draft Reports: Submit for review prior to final acceptance of Project.

B. Test Reports: Submit prior to final acceptance of Project and for inclusion in operating and maintenance manuals. Assemble in soft cover, letter size, 3-ring binder, with table of contents page and tabs, and cover identification. Include reduced scale drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with State and/or Municipality of Highways and/or Public Work's standard.

B. Agencies:
   1. NEBB
   2. AABC

C. Report Forms: AABC MN-1 National Standards for Total System Balance forms and/or Forms prepared following ASHRAE 111 and/or NEBB forms in S.I. units.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Before starting work, verify systems are complete and operable.

B. Report defects, deficiencies, or abnormal conditions in mechanical systems preventing system balance.

C. Beginning of work means acceptance of existing conditions.

3.2 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust to within plus or minus 10 percent of design.

3.3 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to deliver design supply, return, and exhaust air quantities within previously stated tolerances.

B. Make air flow rate measurements in ducts by traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Use volume control devices to regulate air quantities only to extent those adjustments do not create objectionable air motion or sound levels. Change volume using dampers mounted in ducts.

E. Vary total system air quantities by adjustment of fan speeds. Provide drive changes to accomplish system air flow. Vary branch air quantities by damper regulation.

F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Allow for pressure drop equivalent to 50 percent loading of filters.

G. Adjust automatic outside air, return air, and exhaust air dampers for design conditions.

H. Measure temperature conditions across outside air, return air, and exhaust air dampers to check leakage.

I. At modulating damper locations, take measurements and balance at extreme conditions.

3.4 FIELD QUALITY CONTROL

A. Verify recorded data represents actually measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices. Set and lock memory stops.

END OF SECTION

SECTION 230700 - HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. HVAC piping insulation, jackets and accessories.
   2. HVAC equipment insulation, jackets and accessories.
   3. HVAC ductwork insulation, jackets, and accessories.

1.2 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

B. Samples: Submit two samples of representative size illustrating each insulation type.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 450 and/or 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Perform Work in accordance with State and/or Municipality of Highways and/or Public Work's standard.

E. Maintain one copy of each document on site.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.6 WARRANTY

A. Furnish five year manufacturer warranty for man made fiber.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Glass Fiber and Mineral Fiber Insulation
   1. Manufacturers:
      a. Substitutions: Section 016000 - Product Requirements

B. Closed Cell Elastomeric Insulation
   1. Manufacturers:
      a. Substitutions: Section 016000 - Product Requirements

C. Polyisocyanurate Foam Insulation
   1. Manufacturers:
      a. Substitutions: Section 016000 - Product Requirements

D. Extruded Polystyrene Insulation
   1. Manufacturers:
      a. Substitutions: Section 016000 - Product Requirements

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.23 at 75 degrees F
   2. Operating Temperature Range: 0 to 850 degrees F
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.23 at 75 degrees F
   2. Operating Temperature Range: 0 to 850 degrees F

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Operating Temperature Range: 0 to 650 degrees F
   3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Operating Temperature Range: 0 to 650 degrees F

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Operating Temperature Range: Range: Minus 70 to 180 degrees F

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.30 at 75 degrees F
   2. Maximum Service Temperature: 300 degrees F
   3. Operating Temperature Range: Range: Minus 58 to 300 degrees F

G. TYPE P-7: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Maximum Service Temperature: 250 degrees F
   3. Operating Temperature Range: Range: Minus 58 to 250 degrees F

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.
   1. Thermal Conductivity: 0.23 at 75 degrees F
   2. Maximum Service Temperature: 1200 degrees F
   3. Canvas Jacket: UL listed, 6 oz/sq yd plain weave cotton fabric treated with fire retardant lagging adhesive.

I. TYPE P-9: ASTM C591, Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.
   1. Density: 2.0, 4.0, and/or 6.0 pounds per cubic foot
   2. Thermal Conductivity: 180 day aged value of 0.19 and/or 0.20 at 75 degrees F
   3. Operating Temperature Range: Range: Minus 297 to 300 degrees F
   4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 and/or 6 mils thickness and water vapor permeance of 0.02 and/or 0.01 perms.

J. TYPE P-10: ASTM C578, Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.
   1. Thermal Conductivity: 180 day aged value of 0.259 at 75 degrees F
   2. Operating Temperature Range: Range: Minus 297 to 165 degrees F
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 and/or 6 mils thickness and water vapor permeance of 0.02 and/or 0.01 perms.

K. TYPE P-11: ASTM C533; Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.
   1. Thermal Conductivity: 0.45 at 200 degrees F
   2. Operating Temperature Range: 140 to 1200 degrees F

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water vapor transmission: ASTM E96/E96M; 0.02 perm-inches.

B. PVC Plastic Pipe Jacket:
   1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
   2. Thickness: 10, 15, and/or 30 mil
   3. Connections: Brush on welding adhesive, Tacks, and/or Pressure sensitive color matching vinyl tape.

C. ABS Plastic Pipe Jacket:
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
   2. Minimum service temperature: -40 degrees F
   3. Maximum service temperature of 180 degrees F
   4. Water vapor transmission: ASTM E96/E96M; 0.012 perm-inches.
   5. Thickness: 30 mil
   6. Connections: Brush on welding adhesive.

D. Aluminum Pipe Jacket:
   1. ASTM B209
   2. Thickness: 0.016, 0.020, 0.025, 0.032, and/or 0.040 inch thick sheet.
   3. Finish: Smooth and/or Embossed.
   4. Joining: Longitudinal slip joints and 2 inch laps.
   5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch and/or 1/2 inch wide; 0.015 inch thick aluminum. 0.010 and/or 0.020 inch thick stainless steel.

E. Stainless Steel Pipe Jacket:
   1. ASTM A240/A240M OR ASTM 666 Type 302, 304, and/or 316 stainless steel.
   2. Thickness: 0.010, 0.016, and/or 0.018 inch thick.
   3. Finish: Smooth and/or Corrugated.
   4. Metal Jacket Bands: 3/8 inch and/or 1/2 inch wide; 0.010 and/or 0.020 inch thick stainless steel.

F. Field Applied Glass Fiber Fabric Jacket System:
   1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
   2. Glass Fiber Fabric:
      a. Cloth: Untreated; 9 oz/sq yd weight.
      b. Blanket: 1.0 lb/cu ft density.
      c. Weave: 5 x 5, 10 x 10, and/or 10 x 20.
   3. Indoor Vapor Retarder Finish:
      a. Cloth: Untreated; 9 oz/sq yd weight.
      b. Vinyl emulsion type acrylic, compatible with insulation, black and/or white color.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum and/or stainless steel jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
   1. Thermal Conductivity: 0.24 and/or 0.023 at 75 degrees F
   2. Operating Temperature Range: 0 to 450 degrees F
   3. Density: 1.5, 1.65, and/or 2.3 pound per cubic foot

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft and/or reinforced aluminum foil jacket.
   1. Thermal Conductivity: 0.24 and/or 0.023 at 75 degrees F
   2. Operating Temperature Range: 0 to 450 degrees F
   3. Density: 3.0 and/or 4.2 pound per cubic foot
   4. Jacket Temperature Limit: minus 20 to 150 degrees F

C. TYPE E-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Operating Temperature Range: 0 to 650 degrees F
   3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F

D. TYPE E-4: ASTM C612; semi-rigid, fibrous glass board noncombustible.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Operating Temperature Range: 0 to 650 degrees F

E. TYPE E-5: ASTM C612; glass fiber, semi-rigid board, noncombustible.
   1. Thermal Conductivity: 0.23 at 75 degrees F
   2. Maximum Operating Temperature: 850 degrees F
   3. Density: 3.0 pound per cubic foot

F. TYPE E-6: ASTM C553; mineral fiber blanket, Type I.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Maximum Operating Temperature: 1000 degrees F
   3. Density: 1.0 pound per cubic foot

G. TYPE E-7: ASTM C533; Type II, hydrous calcium silicate block insulation, asbestos free.
   1. Thermal Conductivity: 0.45 at 200 degrees F
   2. Operating Temperature Range: 140 to 1200 degrees F

H. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F

I. TYPE E-9: ASTM C612, man made mineral fiber, noncombustible, Classes 1-4.
   1. Thermal Conductivity: 0.25 at 100 degrees F
   2. Maximum Service Temperature: 1200 degrees F
   3. Density: 4, 6, 8, 10, and/or 12 pound per cubic foot

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
   1. Product Description: ASTM D1785, sheet material, off-white color.
   2. Minimum Service Temperature: -40 degrees F
   3. Maximum Service Temperature: 150 degrees F
   4. Water Vapor Transmission: ASTM E96/E96M; 0.002 perm-inches.
   5. Thickness: 10, 15, 20, 30 mil
   6. Connections: Brush on welding adhesive, Tacks, and/or Pressure sensitive color matching vinyl tape.

B. Aluminum Equipment Jacket:
   1. ASTM B209
   2. Thickness: 0.016, 0.020, 0.025, 0.032, and/or 0.040 inch thick sheet.
   3. Finish: Smooth and/or Embossed.
   4. Joining: Longitudinal slip joints and 2 inch laps.
   5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.010 inch thick stainless steel.

C. Stainless Steel Equipment Jacket:
   1. ASTM A240/A240M OR ASTM 666 Type 302, 304, and/or 316 stainless steel.
   2. Thickness: 0.010, 0.016, and/or 0.018 inch thick.
   3. Finish: Smooth and/or Corrugated.
   4. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

D. Canvas Equipment Jacket: UL listed, 6 oz/sq yd plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

E. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water vapor transmission: ASTM E96/E96M; 0.02 perm-inches.

F. Field Applied Glass Fiber Fabric Jacket System:
   1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
   2. Glass Fiber Fabric:
      a. Cloth: Untreated; 9 oz/sq yd weight.
      b. Blanket: 1.0 lb/cu ft density.
      c. Weave: 5 x 5, 10 x 10, and/or 10 x 20.
   3. Indoor Vapor Retarder Finish:
      a. Cloth: Untreated; 9 oz/sq yd weight.
      b. Vinyl emulsion type acrylic, compatible with insulation, black and/or white] color.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

2.8 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.30, 0.27, and/or 0.25 at 75 degrees F
   2. Maximum Operating Temperature: 250 degrees F
   3. Density: 0.75, 1.0, and/or 1.5 pound per cubic foot

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied all service facing, reinforced aluminum foil facing, and/or metalized polypropylene scrim kraft facing meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.24, 0.23, and/or 0.22 at 75 degrees F
   2. Density: 1.6, 2.25, 3.0, 4.25, and/or 6.0 pound per cubic foot

C. TYPE D-3: ASTM C612, Type IA or IB, rigid glass fiber, no facing.
   1. Thermal Conductivity: 0.24, 0.23, and/or 0.22 at 75 degrees F
   2. Density: 1.6, 2.25, 3.0, 4.25, and/or 6.0 pound per cubic foot This type of insulation is available in thicknesses of 1/2, 1, 1-1/2, and 2 inches

D. TYPE D-4: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.
   1. Thermal Conductivity: 0.28, 0.26, 0.25, and/or 0.24 at 75 degrees F
   2. Density: 1.5, 2.0, 2.75, and/or 3.0 pound per cubic foot
   3. Maximum Operating Temperature: 250 degrees F
   4. Maximum Air Velocity: 6,000 feet per minute

E. TYPE D-5: ASTM C1071, Type II, rigid, glass fiber duct liner with coated air side.
   1. Thermal Conductivity: 0.23 at 75 degrees F
   2. Density: 3.0 pound per cubic foot
   3. Maximum Operating Temperature: 250 degrees F
   4. Maximum Air Velocity: 4,000 feet per minute

F. TYPE D-6: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Service Temperature Range: Range: Minus 58 to 180 degrees F

G. TYPE D-7: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet laminated with white thermoplastic rubber membrane.
   1. Thermal Conductivity: 0.27 at 75 degrees F
   2. Service Temperature Range: Range: Minus 58 to 180 degrees F

H. TYPE D-8: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.
   1. Thermal Conductivity: 0.42 at 500 degrees F
   2. Weight: 1.4 pound per square foot
   3. Surface Burning Characteristics: Maximum 0/0 flame spread/smoke developed index when tested in accordance with ASTM E84.

2.9 DUCTWORK INSULATION JACKETS

A. Aluminum Duct Jacket:
   1. ASTM B209.
   2. Thickness: 0.016, 0.020, 0.025, 0.032, 0.040 inch thick sheet.

3. Finish: Smooth and/or Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.010 inch thick stainless steel.

B. Vapor Retarder Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film and/or 0.0032 inch vinyl.
2. Water vapor transmission: ASTM E96/E96M; 0.02 and/or 1.3 perm.
3. Secure with pressure sensitive tape.

C. Canvas Duct Jacket: UL listed, 6 oz/sq yd plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Outdoor Duct Jacket: Asphalt impregnated and coated sheet, 50 and/or 36 lb/square

E. Membrane Duct Jacket: ASTM D4637; Type I, EPDM; non-reinforced, 0.045 and/or 0.060 inch thick, 48 inch wide roll; white and/or black color as selected.

2.10 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, self-adhesive pad, impact applied, and/or welded with integral and/or press-on head.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify piping, equipment and/or ductwork has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
   2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
   3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
   1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
   2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
   3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Polyisocyanurate Foam Insulation and/or Extruded Polystyrene Insulation:
   1. Wrap elbows and fitting with vapor retarder tape.
   2. Seal butt joints with vapor retarder tape.

F. Inserts and Shields:
   1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
   2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
      a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
      b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
   3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

G. Insulation Terminating Points:
   1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
   2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
   3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

H. Closed Cell Elastomeric Insulation:
   1. Push insulation on to piping.
   2. Miter joints at elbows.
   3. Seal seams and butt joints with manufacturer’s recommended adhesive.

4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting, PVC jacket and fitting covers, ABS jacket and fitting covers, aluminum jacket, and/or stainless steel jacket.

J. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum and/or stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

K. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

L. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

M. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum and/or stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

N. Prepare pipe insulation for finish painting.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.

3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum and/or stainless steel jacket with seams located on bottom side of horizontal equipment.

G. Cover glass fiber, cellular glass, hydrous calcium silicate, and/or cellular foam insulation with metal mesh and finish with heavy coat of insulating cement, aluminum jacket, and/or stainless steel jacket.

H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

J. Prepare equipment insulation for finish painting.

3.4 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.

B. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting and/or aluminum jacket.

E. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

F. External Elastomeric Duct Insulation:
1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer’s recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.
4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

G. Duct and Plenum Liner:
1. Adhere insulation with adhesive for 90 and/or 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

H. Ducts Exterior to Building:
1. Install insulation according to external duct insulation and/or duct liner paragraph above.
2. Provide external insulation with vapor retarder jacket. Cover with outdoor jacket finished as specified with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
3. Finish with mineral fiber outdoor duct jacket, aluminum duct jacket, and/or membrane duct jacket.
4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.

I. Prepare duct insulation for finish painting.

3.5 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Chilled Water Supply and Return 40 to 60 degrees F	P-1	1-1/4 inches and smaller 1-1/2 inches inch and larger	0.5 1.0
Chilled Water Supply and Return less than 40 degrees F	P-1	3/4 inch and smaller 1 inch to 6 inches 8 inches and larger	0.5 1.0 1.5
Glycol Supply and Return	P-1	1-1/4 inches and smaller 1-1/2 inches inch and larger	0.5 1.0
Condenser Water			
Condensate Piping from Cooling Coils	P-5	All sizes	0.5
Refrigerant Suction	P-5	All sizes	0.5
Refrigerant Hot Gas	P-5	All sizes	0.5

B. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Combustion Air	D-2	1.5 2
Outside Air Intake	D-2	1.5 2
Equipment Casings	D-2	1.0 1.5
Supply Ducts (internally insulated)	D-4 D-5	1.0 1.5
Return Ducts (internally insulated)	D-4 D-5	0.5 1.0
Supply Ducts (externally insulated) Thickness indicated is installed thickness.	D-1 D-2 D-6	1.0 1.5
Return Ducts (externally insulated) Thickness indicated is installed thickness.	D-1 D-2 D-6	1.0 1.5
Duct Coils	D-1	1.0 1.5
Kitchen Exhaust Duct (2 layers of 1-1/2 inch (40 mm) each)	D-8	3.0
Supply Air, Return Air, and/or Exhaust Air (exterior to building on roof)	D-2 D-7	2.0
Supply Air, Return Air, and/or Exhaust Air (exterior to building on roof)	D-2 D-7	2.0
Evaporative Condenser Intake and Exhaust Thickness indicated is installed thickness.	D-1 D-2	1.0 1.5
Exhaust Ducts Within 10 feet (3 m) of Exterior Openings Thickness indicated is installed thickness.	D-1 D-2	1.0 1.5
Exhaust Ducts Exposed to Outdoor Air	D-2	2.0
Rectangular Supply Ducts Downstream of Variable Air Volume Boxes (internally insulated)	D-4 D-5	0.5 1.0
Rectangular Supply Ducts Downstream of Variable Air Volume Boxes (externally insulated)	D-1 D-2	1.0 1.5
Round Supply Ducts Downstream of Variable Air Volume Boxes (externally insulated)	D-1 D-2	1.0 1.5
Transfer Air Ducts (internally insulated)	D-4 D-5	0.5 1.0

END OF SECTION

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SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Duct materials.
2. Flexible ducts.
3. Insulated flexible ducts.
4. Single-wall, spiral, round ducts.
5. Casings.
6. Ductwork fabrication.
7. Duct cleaning.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product information for duct materials, duct liner, and/or duct connectors.

B. Shop Drawings:
1. Submit duct fabrication drawings on drawing sheets same size as Contract Documents, and indicating:
a. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other Work.
b. Duct Layout:
1) Indicate pressure classifications and sizes in plan view.
2) Exhaust Duct Systems: Indicate classification of materials handled as defined in this Section.
c. Fittings.
d. Reinforcement details and spacing.
e. Seam and joint construction details.
f. Penetrations through fire-rated and other walls.
g. Terminal unit, coil, and humidifier installations.
h. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Samples: Submit two samples of typical shop-fabricated duct fittings.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Welders' Certificates: Certify welders and welding procedures employed on the Work, verifying AWS qualification within previous 12 months.

F. Test and Evaluation Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

G. Manufacturer's Instructions: Submit special procedures for glass-fiber ducts.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Manufacturer Reports: Certify that installation of glass-fiber ductwork meets or exceeds specified requirements and/or recommended fabrication and installation requirements.

J. Qualifications Statements:
   1. Qualifications for manufacturer and installer.
   2. Manufacturer's approval of installer.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents:
   1. Record actual locations of ducts and duct fittings.
   2. Record changes in fitting location and type.
   3. Show additional fittings used.

1.4 QUALITY ASSURANCE

A. Perform Work according to SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Construct ductwork to NFPA 90A, NFPA 90B, and/or NFPA 96 standards.

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

D. Installer, Applicator, and/or Erector: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and protect materials according to manufacturer's instructions.

1.6 AMBIENT CONDITIONS

A. Minimum Conditions: Do not install duct sealant when temperatures are below those recommended by sealant manufacturers.

B. Subsequent Conditions: Maintain temperatures during and after installation of duct sealant.

1.7 EXISTING CONDITIONS

A. Field Measurements: Verify elevations, dimensions, and alignment of supporting construction prior to beginning Work.

1.8 WARRANTY

A. Furnish one-year manufacturer's warranty for ducts.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission.

B. Size round ducts installed in place of rectangular ducts according to ASHRAE Handbook - Fundamentals.

2.2 DUCT MATERIALS

A. Galvanized-Steel Ducts:
   1. Description: Galvanized-steel sheet, lock-forming quality.
   2. Comply with ASTM A653
   3. Zinc Coating: G60 and/or G90
   4. Comply with ASTM A90

B. Steel Ducts: Comply with ASTM A1008, A1011, and/or A568.

C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Hanger Rods:
   1. Material: Steel, galvanized.
   2. Comply with ASTM C443
   3. End Connections: Threaded both ends, threaded one end, and/or continuously threaded.

2.3 INSULATED FLEXIBLE DUCTS

A. Manufacturers:
   1. Substitutions: Permitted

B. Furnish each flexible duct section with integral clamping devices for connection to round or oval fittings.

C. Fittings:
   1. Join each flexible duct section to main trunk duct through sheet metal fittings.
   2. Construct fittings of galvanized steel and equip with factory-installed volume damper having positive locking regulator.
   3. Provide fittings installed in lined ductwork with insulation guard.

2.4 SINGLE-WALL, SPIRAL, ROUND DUCTS

A. Manufacturers:
   1. Substitutions: Permitted and/or Not permitted.

B. Description:
   1. Round, spiral, lockseam duct constructed of galvanized steel.
   2. UL 181, Class 1.

C. Duct Coating:
   1. PVC/PVS.
   2. Thickness: <___4_____> mils on outside and <____1____> mils on inside and/or on both sides.

2.5 TRANSVERSE DUCT CONNECTION SYSTEM

A. Manufacturers:
   1. Substitutions: Permitted

B. Description:
   1. SMACNA E-rated, SMACNA F-rated, and/or SMACNA J-rated rigidity class connection.
   2. Interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.6 CASINGS

A. Fabrication:
   1. Comply with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
   2. Construct for indicated operating pressures.

B. Doors:
   1. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles.
   2. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.

2.7 FABRICATION

A. Ductwork:
   1. Rectangular Ducts:
      a. Fabricate and support rectangular ducts according to SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated.
      b. Provide duct material, thicknesses, reinforcing, and sealing for indicated operating pressures.
   2. Round Ducts:
      a. Fabricate and support round ducts with longitudinal seams according to SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated.
      b. Provide duct material, thicknesses, reinforcing, and sealing for indicated operating pressures.
   3. Divergence:
      a. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible.
      b. Furnish maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
   4. Fittings:
   5. Take-Offs:
      a. Provide standard 45-degree lateral wye take-offs.
      b. If space does not allow 45-degree lateral wye take-off, use 90-degree conical tee connections.
   6. Sealing:
      a. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
      b. Sealants, Mastics, and Tapes: Comply with UL 181A, and provide products bearing appropriate UL 181A markings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

A. Install and seal ducts according to SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Install openings in ductwork as required to accommodate thermometers and controllers.

C. Pitot Tubes:
   1. Install pitot tube openings for testing of systems.
   2. Install pitot tubes complete with metal can and with spring device or screw to prevent air leakage.

D. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

E. Connect diffusers or light troffer boots to low-pressure ducts directly or with maximum 5 feet of flexible duct held in place with strap or clamp.

F. Connections to Supply Ducts:
   1. Connect air terminal units and/or air outlets and inlets to supply ducts directly or with maximum 5 feet of flexible duct.
   2. Do not use flexible duct to change direction.

G. Install duct hangers and supports as specified in Section 230529 - Hangers and Supports for HVAC Piping and Equipment.

H. Use double nuts and lock washers on threaded rod supports.

I. Painting and Coating:
   1. Paint buried metal ductwork without factory jacket with one coat of asphalt-based protective coating.
   2. Provide seams and joints with additional coat.

J. Connect flexible ducts to metal ducts with adhesive, liquid adhesive and tape, draw bands, and/or adhesive and sheet metal screws.

K. Plenum Doors:
   1. Set plenum doors 6 to 12 inches above floor.
   2. Arrange door swing such that fan static pressure holds door in closed position.

L. Fabric Ducts:
   1. Install ductwork and suspension system according to manufacturer's instructions.

M. Install residue traps in kitchen hood exhaust ducts at base of vertical risers, with provisions for cleanout.

N. Kitchen Hood Exhaust Ducts:
   1. Ductwork Exposed to View: Stainless steel.
   2. Concealed Ductwork: Stainless steel and/or carbon steel.

O. Exhaust Outlet Locations:
   1. Minimum Distance from Property Lines: 3 feet
   2. Minimum Distance from Building Openings: 3 feet
   3. Minimum Distance from Outside Air Intakes: 10 feet

3.3 FIELD QUALITY CONTROL

A. Inspection:
   1. Glass-Fiber Ducts: Obtain manufacturer's inspection and acceptance of fabrication and installation procedures at beginning of installation.

B. Testing:
   1. Ductwork Designed for 3 Inches wg above Ambient Pressure: Pressure-test minimum 25 percent of ductwork after duct cleaning but before duct insulation is applied or ductwork is concealed.
      a. Test according to SMACNA HVAC Air Duct Leakage Test Manual.
      b. Maximum Allowable Leakage: According to International Energy Conservation Code.

3.4 CLEANING

A. Duct Systems:
   1. Clean duct systems by forcing high-velocity air through duct to remove accumulated dust.
   2. To obtain sufficient air flow, clean one half of system completely before proceeding to other half.
   3. During cleaning operations, protect equipment from excessive dirt by using temporary filters or bypasses.

B. Duct Systems:
   1. Clean duct systems by using high-power vacuum machines.
   2. Install access openings in ductwork for cleaning purposes.
   3. During cleaning operations, protect equipment from excessive dirt by using temporary filters or bypasses.

3.5 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect ductwork, ductwork supports, linings, and coverings from weather.

C. Install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Back-draft dampers.
2. Combination fire-and-smoke dampers.
3. Duct access doors.
4. Dynamic fire dampers.
5. Static fire dampers.
6. Ceiling fire dampers.
7. Smoke dampers.
8. Volume control dampers.
9. Flexible duct connections.
10. Duct test holes.
11. Dial thermometers.
12. Static pressure gages.

1.2 SUBMITTALS

A. Shop Drawings: Indicate shop-fabricated assemblies including volume control dampers, duct access doors, and/or duct test holes.

B. Product Data:
1. Shop-fabricated assemblies and hardware used.
2. Electrical characteristics and connection requirements.
3. Fire dampers including locations and ratings.
4. Smoke dampers including locations and ratings.
5. Backdraft dampers.
6. Flexible duct connections.
7. Volume control dampers.
8. Duct access doors.
9. Duct test holes.
10. Product Data: For fire dampers, smoke dampers, and/or combination fire and smoke dampers:
    a. Include UL ratings, dynamic ratings, leakage, pressure drop, and maximum pressure data.
    b. Indicate materials, construction, dimensions, and installation details.
    c. Damper pressure drop ratings based on tests and procedures performed according to AMCA 500.

C. Manufacturer's Installation Instructions: Fire and combination smoke and fire dampers.

D. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of access doors and/or test holes.

1.4 QUALITY ASSURANCE

A. Test, rate, and label dampers according to latest UL requirements.

B. Damper pressure drop ratings based on tests and procedures performed according to AMCA 500.

C. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 COORDINATION

A. Coordinate Work with building control Work.

1.7 WARRANTY

A. Furnish five one-year manufacturer warranty for duct accessories.

1.8 EXTRA MATERIALS

A. Furnish two of each size and type of fusible link.

PART 2 PRODUCTS

2.1 DAMPERS

A. Back-Draft Dampers:
   1. Manufacturers: see plans
      a. Substitutions: Permitted
   2. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel and/or extruded aluminum. Blades, maximum 6 inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

B. Static Fire Dampers:
   1. Manufacturers: see plans
      a. Substitutions: Permitted
   2. Fire Rating: UL 555 classified and labeled as a 1-1/2 and/or 3 hour static fire damper.
   3. Air Flow Rating: UL approved for dual directional air flow.
   4. Integral Sleeve Frame: Minimum 20 gage by 12 inches roll formed, galvanized steel.
      a. Factory Sealant: Apply to dampers in HVAC systems with pressures to maximum 4 inches w.g.
   5. Blades:
      a. Style: Curtain type, in airstream.
      b. Action: Spring or gravity closure upon fusible link release.
      c. Orientation: Horizontal.
      d. Material: Minimum 24 gage roll formed, galvanized steel.

6. Closure Springs: Type 301 stainless steel, constant force type, if required.
7. Temperature Release Device:
   a. Fusible link, 165 degrees F, 212 degrees F, 285 degrees F, and/or Electro-thermal link, 24 VAC or VDC, 165 degrees F.
   b. Mounting: Vertical and/or Horizontal.
8. Duct Transition Connection, Damper Style:
   a. A style - rectangular connection, frame and blades in air stream.
   b. B style - rectangular connection, blades out of air stream, high free area.
   c. G style - A style connection, grille mounting tabs at end of sleeve for grille.
   d. R style - round connection, blades in air stream, non-sealed.
   e. RA style - round connection, frame and blades in air stream.
   f. LR style - round connection, blades out of air stream, non-sealed.
   g. LO style - oval connection, non-sealed.
9. Finish: Mill galvanized.
10. Picture Frame Mounting Angles:
    a. One-piece, roll formed retaining angles 1-1/2 x 1-1/2 inches (38 x 38 mm) and/or 1-1/2 x 2-1/2 inches (38 x 64 mm).
    b. Factory matched and shipped attached to damper.

C. Volume Control Dampers:
1. Manufacturers: see plans
   a. Substitutions: Permitted
2. Fabricate according to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
3. Splitter Dampers:
   a. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
   b. Blade: Fabricate of single and/or double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
   c. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
   d. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch and/or 12 x 48 inch.
4. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
5. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches w.g.
6. Quadrants:
   a. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
   b. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
   c. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.2 DUCT ACCESS DOORS

A. Manufacturers: see plans
1. Substitutions: Permitted

B. Fabricate according to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
   1. Less than 12 inches square, secure with sash locks.
   2. Up to 18 inches Square: Furnish two hinges and two sash locks.
   3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
   4. Larger Sizes: Furnish additional hinge.
   5. Access panels with sheet metal screw fasteners are not acceptable.

2.3 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
   1. Substitutions: Permitted

B. Fabricate according to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Connector: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
   2. Net Fabric Width: Approximately 2, 3, and/or 6 inches wide.
   3. Metal: 3 inch wide, 24 gage galvanized steel.

D. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lb per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.4 DUCT TEST HOLES

A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install according to NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Conform to Section 233100 for duct construction and pressure class.

B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Access Doors: Install access doors at following locations as indicated:
   1. Spaced every 50 feet of straight duct.
   2. Upstream of each elbow.
   3. Upstream of each reheat coil.
   4. Before and after each duct mounted filter.
   5. Before and after each duct mounted coil.
   6. Before and after each duct mounted fan.
   7. Before and after each automatic control damper.
   8. Before and after each fire damper, smoke damper, and/or combination fire and smoke damper.

9. Downstream of each VAV box.
10. Install at locations for cleaning kitchen exhaust ductwork according to NFPA 96.

D. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated and/or Install 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
   1. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.

E. Install temporary duct test holes where indicated and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

F. Install permanent duct test holes where indicated and required for testing and balancing purposes.

G. Install fire dampers, combination fire and smoke dampers, and/or smoke dampers at locations as indicated. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
   1. Install smoke dampers and combination smoke and fire dampers according to NFPA 92A.
   2. Install dampers square and free from racking with blades running horizontally.
   3. Do not compress or stretch damper frame into duct or opening.
   4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
   5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

END OF SECTION

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SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Diffusers.
2. Registers
3. Grilles.
4. Door grilles.
5. Louvers.
6. Louvered penthouses.
7. Roof hoods.
8. Goosenecks.

1.2 SUBMITTALS

A. Product Data: Sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

B. Samples: Two of each required air outlet and inlet type.

C. Test Reports: Rating of air outlet and inlet performance.

D. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance according to ASHRAE 70.

B. Test and rate louver performance according to AMCA 500.

C. Manufacturer: Company specializing in manufacturing products specified in this Section with three years' experience, and with service facilities within 100 miles of Project.

1.5 WARRANTY

A. Furnish one-year manufacturer's warranty for air outlets and inlets.

1.6 EXTRA MATERIALS

A. Furnish extra air outlets and inlets.

PART 2 PRODUCTS

2.1 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Square, adjustable pattern, stamped, multi-core, Square, stamped, multi-core, Square and rectangular, adjustable pattern, multi-louvered, and/or Square and rectangular, multi-louvered diffuser to discharge air in 360-degree, one-way, two-way, three-way, and/or four-way pattern with sector baffles where indicated.

C. Frame: Surface mount, Snap-in, Inverted T-bar, and/or Spline type. In plaster ceilings, furnish plaster frame and ceiling frame.

D. Fabrication: Steel and/or Aluminum with baked enamel off-white finish.

E. Accessories: Radial opposed-blade, Butterfly, and/or Combination splitter damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.2 CEILING SUPPLY REGISTERS/GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way and/or two-way deflection.

C. Frame: 1-1/4 and/or 1 inch margin with countersunk screw and/or concealed mounting and gasket.

D. Fabrication: Aluminum extrusions with factory off-white enamel, clear lacquer, and/or prime coat finish.

E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.3 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical and/or horizontal face.

C. Frame: 1-1/4 and/or 1 inch margin with countersunk screw and/or concealed mounting.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel, baked enamel, prime coated, and/or clear lacquer, color as selected].

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.4 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Fixed grilles of 1/2 x 1/2 x 1 inch and/or 1 x 1 x 1 inch louvers.

C. Fabrication: Polystyrene and/or Acrylic plastic with off-white and/or chrome finish.

D. Fabrication: Aluminum with factory clear lacquer, off-white enamel, and/or baked enamel finish.

E. Frame:
   1. 1-1/4 and/or 1 inch margin with countersunk screw mounting and/or concealed mounting.
   2. Channel lay-in frame for suspended grid ceilings.

F. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.5 CEILING LINEAR EXHAUST AND RETURN GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Streamlined blades with 90 degree one-way and/or two-way deflection, 1/8 x 3/4 inch on 1/4 and/or 1/2 inch o.c.

C. Frame: 1-1/4 and/or 1 inch margin, extra heavy for floor mounting, with countersunk screw and/or concealed mounting.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel, baked enamel, prime coated, and/or clear lacquer finish, color to be selected.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.6 WALL SUPPLY REGISTERS/GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical and/or horizontal face, single and/or double deflection.

C. Frame: 1-1/4 and/or 1 inch margin with countersunk screw and/or concealed mounting and gasket.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel, baked enamel, prime coat, and/or clear lacquer finish, color to be selected.

E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.7 WALL SUPPLY REGISTERS/GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with one-way and/or two-way deflection.

C. Frame: 1-1/4 and/or 1 inch margin with countersunk screw and/or concealed mounting and gasket.

D. Fabrication: Aluminum extrusions with factory off-white enamel, clear lacquer, and/or prime coat finish.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.8 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical and/or horizontal face.

C. Frame: 1-1/4 and/or 1 inch margin with countersunk screw and/or concealed mounting.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, Steel and aluminum with 20 gage minimum frame, and/or Aluminum extrusions, with factory off-white enamel, baked enamel, prime coated, and/or clear lacquer finish, color to be selected.

E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

F. Gymnasiums: Furnish front pivoted or welded in place blades, securely fastened to be immobile.

2.9 DOOR GRILLES

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Door grilles: As specified.

C. Type: V-shaped louvers of 20 gage thick steel, 1 inch deep on 1/2 inch o.c.

D. Frame: 20 gage steel with auxiliary frame to give finished appearance on both sides of door, with factory prime coat finish.

2.10 LOUVERS

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Louvers: As specified in Section 089100.

C. Product Description:
   1. Stationary, Adjustable, and/or Combination.
   2. Drainable, Non-Drainable, and/or Double drainable.
   3. "Thinline."

D. Type: 4 and/or 6 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame.

E. Fabrication: 16 gage thick galvanized steel and/or 12 gage thick extruded aluminum, welded assembly, with factory prime coat, baked enamel, anodized, and/or fluoropolymer spray finish color to be selected.

F. Mounting: Furnish with interior, exterior, flat flange, angle flange, screw holes in jambs, and/or masonry strap anchors for installation.

G. Bird Screen: Bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake.

2.11 ROOF HOODS

A. Manufacturers: see plans
   1. Substitutions: Permitted

B. Fabricate air inlet or exhaust hoods according to SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Fabricate of reinforced galvanized steel, minimum 16 gage base and 20 gage hood, or aluminum, minimum 16 gage base and 18 gage hood. Furnish removable hood; bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory prime coat and/or baked enamel finish.

D. Fabricate hood outlet area minimum of twice throat area.

E. Roof Curb: 8 inch, 12 inch, 16 inch, 20 inch, and/or 24 inch high self-flashing, galvanized steel, and/or aluminum construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, interior baffle with acoustic insulation, curb bottom, ventilated double wall, and/or hinged curb adapter, and factory installed nailer strip.

2.12 GOOSENECKS/VENT OUTLETS

A. Fabricate according to SMACNA HVAC Duct Construction Standards - Metal and Flexible, of minimum 18 gage galvanized steel.

2.1 ROOF CURBS

A. Height: 14 inches, 16 inches, 20 inches, and/or 24 inches.

B. Self-flashing, Galvanized steel, and/or Aluminum construction with continuously welded seams built-in cant strips.

C. Factory-installed nail strip, 1 inch insulation and curb bottom, interior baffle with acoustic insulation, curb bottom, ventilated double wall, and/or hinged curb adapter.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify inlet and outlet locations.

B. Verify ceiling and/or wall systems are ready for installation.

3.2 INSTALLATION

A. Install diffusers to ductwork with airtight connection.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.

C. Paint visible portion of ductwork behind air outlets and inlets matte black.

D. Do not locate air registers, diffusers or grilles in floors of toilet or bathing rooms.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 266010 ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Contractor shall install all electrical work covered by the below specifications and approved drawings. Provide all material, labor transportation, tools, supervision, etc., necessary to complete the total electrical job. All items not specifically mentioned herein which are obviously necessary to make a complete working installation shall be provided by the contractor, including any necessary field engineering and/or detail drawings required. Drawings shall be submitted for approval as provided for in "26 6010-1.04 Shop Drawings".

B. The work shall consist of, but shall not be limited to, the installation of the following systems:

1. Exterior and interior electrical systems for power, lighting, controls, miscellaneous systems and new electrical normal and emergency power services as indicated on the Drawings.
2. Connections to equipment specified in Specifications and Approved Drawings.
3. Temporary Power as required for the project.
4. Fire seal all floor, wall or ceiling penetrations in any rated assembly back to their original ratings.
5. New emergency generator with sub-base fuel tank and sound attenuated enclosure and Service Entrance ATS as indicated on the Documents.
6. Temporary Power for the RWPS to maintain partial operation of the RWPS during the upgrade of the electrical systems. Contractor to provide and install a 250 Amp, 600 Volt, three phase, 3 wire NEMA 3R panelboard, with 250 Amp Main Lugs Only at the existing service overhead pole to power one (1) – 100 Hp, 575 Volt and one (1) – 75 Hp, 575 Volt three phase pump motors. Panelboard to have one (1) – 150 Amp, 3 pole circuit breaker and one (1) – 125 Amp, 3 pole circuit breaker (both rated service entrance) to temporary feed the two pump motors in the RWPS. Provide and install a 100 Amp, 120/240 Volt, single phase, 3 wire panelboard at the existing service overhead pole to power the miscellaneous and low voltage items in the RWPS as required to keep the station functional during the electrical construction. Additional details will be made available to the Contractor at a later date.
7. The Contractor shall furnish to the Owner at the final review a complete Short Circuit Study; Coordination Study and Arc Flash Hazard Study including Arc Flash Hazard Labels for the project. The Study shall be performed by a Licensed Professional Engineer, licensed and in good standing in the State of Georgia. The Professional Engineer shall have a minimum of five (5) years of continuous power system study experience. The study shall be done using SKM Systems Analysis, Inc. software or an equivalent software. The Contractor shall provide to the Owner the complete system analysis software project files of all work performed. The Study will include the entire power system (normal and emergency power) as indicated in the Documents. The Arc Flash PPE to be determined by incident energy analysis method (reference - NFPA 70E-2018, Article 130.5(F)(1) and 130.5(G)) Arc Flash Hazard calculations (incident energy, working distance, and arc flash boundary) to be based on IEEE 1584-2018. Arc Flash Hazard Label to contain date issued, equipment name, incident energy, arc flash boundary, working distance, a complete description of arc flash PPE clothing and equipment (reference - NFPA 70E-2018, Table 130.5(G)).

1.02 CODES AND FEES:

A. All work shall be done in accordance with the requirements of the National Electrical Code, NFPA #70, 2020 Edition, all local and state codes and the regulation of the local utility companies providing services.

B. The contractor shall obtain and pay for all permits and inspections required by the building and safety codes and ordinances and the rules and regulations of any legal body having jurisdiction.

C. All electrical items covered by this specification shall be U.L. labeled and listed for the purpose.

1.03 DRAWINGS:

A. The drawings indicate the general arrangement of electrical equipment.

B. Dimensions for layout of equipment shall be obtained from the Equipment Drawings, the Architectural Drawings, the M/P Drawings or the Electrical Drawings or Equipment Shop Drawings as required.

C. Discrepancies shown on different drawings, between Drawings and Specifications or between documents and field conditions shall be promptly brought to the attention of the Engineer and Owner.

1.04 SHOP DRAWINGS:

A. The contractor shall submit for review by the Engineer and Owner, eight sets of complete schedules and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive materials, such as catalog sheets, product data sheets, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements, model numbers alone will not be acceptable. Data submitted for review shall contain all information required to indicate compliance with equipment specified. Complete electrical characteristics shall be provided for all equipment. Submittals for lighting fixtures shall include photometric data. The Engineer or Owner reserves the right to require sample of any equipment to be submitted for approval.

B. Each individual submittal item for materials and equipment shall be marked to show specification section and paragraph number which pertains to the item.

C. Prior to submitting shop drawings, the contractor shall review the submittal for compliance with the contract documents and place a stamp or other confirmation thereon which states that the submittal complies with contract requirements. Submittals without such verification will be returned without review.

D. Eight complete sets of Submittals shall be made for each of the following items:

Switchboards / Panelboards / Circuit Breakers	Conduits
Disconnect Switches / Fuses	Conductors
Wiring Devices	Dry Type Transformers
Control Components	Lighting Fixtures / Poles
Lighting Controls	Emergency Generator
Motor Control Center	Mini-Power Zone Units

VFD’s / Soft Start Motor Controllers / Across the Line Motor Starters

1.05 RECORD DRAWINGS:

A. At the time of final inspection, provide three (3) sets of complete data on electrical equipment used in the project and Reproducible As-Built Drawings reflecting all field changes. This data shall be in bound form and shall include the following items:

1. Test results required by these specifications.
2. Panelboard shop drawings and copies of the final circuit directories reflecting all field changes.
3. Data sheets indicating electrical characteristics and construction details of all devices, panelboards, light fixtures and associated equipment.

4. All conduits that are buried less than 36” below grade shall be identified on the As-Built Drawings. Indicate the entire length of the conduit run that is less than 36” below grade on the “As-Built Drawings”.

5. All "As-Built" Drawings shall have the Contractor's name, address, telephone number, date and indication that the drawings are "As-Built".

1.06 UTILITY SERVICES:

A. Electrical Power and Telephone services shall be as indicated on the drawings. The Contractor is responsible to coordinate with the local utility companies as to the date services are required to the site.

1.07 SITE INVESTIGATION:

A. Prior to submitting bids of the project, the contractor shall visit the site of the work to become aware of ALL EXISTING conditions which may affect the cost of the project. This project is located at an existing operating water treatment plant and raw water pump station, which will remain in full operation during construction.

1.08 COOPERATION:

A. The contractor shall coordinate his electrical activities with other trades so to avoid delays, interference’s and any unnecessary work.

1.09 GUARANTEE:

A. For guarantee of work under Division 26, refer to the general and special conditions.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Materials or equipment specified by manufacturer's name shall be used, unless alternate manufacturers are approved by the Owner/Engineer.

B. All material shall be new and shall conform to the applicable standard or standards where such have been established for the particular material in question. Publications and standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM).
2. Underwriters' Lab (UL).

3. National Electrical Manufacturer Association (NEMA).
4. Insulated Cable Engineers Association (ICEA).
5. Institute of Electrical and Electronic Engineers (IEEE).
6. Edison Electric Institute (EEI).
7. National Fire Protection Association (NFPA).
8. American Wood Preservers Association (AWPA).
9. American National Standards Institute (ANSI).

C. Material of the same type shall be the product of a single manufacturer.

PART 3 - EXECUTION

3.01 WORKMANSHIP:

A. All work shall be neatly, orderly, and securely installed with conduits, panels, boxes, switches, etc., perpendicular and/or parallel with the principle structural members. Exposed raceways shall be offset where they enter surface mounted equipment. Wiring installed in panels and other enclosures shall be looped and laced and not wadded or bundled.

3.02 SITE OBSERVATION REVIEWS:

A. At any intermediate or the final site observation review, reviews shall be made on the electrical system to indicate that the electrical system is in proper working order as per these specifications and the approved drawings.

B. Contractor shall provide all instruments, labor and materials for any intermediate and final electrical site reviews.

C. Equipment covers (i.e., panelboard trims, motor controls, device plates, and junction box covers) shall be removed, as directed, for site review of internal wiring. All circuits throughout project shall be energized and shall be tested for operation and equipment connections in compliance with contract requirements.

D. Perform the following test after the installation but prior to energizing equipment:

1. Megger test all feeders and branch circuits 50 Amps or greater. Allowances for leakages shall be within the manufacturers recommend tolerances. Testing methods shall be per the cable manufacturer’s recommendations. Certified test results and the manufacturers data/recommendations shall be provided to the Owners Representative as indicated below.
2. The Contractor shall perform any other test which may be required by any legal authority having jurisdiction to verify this installation meets that requirement or requirements.
3. Primary injection test shall be performed on all ground fault relays to assure the proper operation and settings and as per NEC Article 230.95 (C). A written record of this test will be made available to the Chief Electrical Inspector, the Electrical Engineer or the Electrical Plan Reviewer prior to the Final Electrical Inspection.

3.03 IDENTIFICATION:

A. Contractor shall identify each device such as circuit breakers, panelboards, contactor, timeclock, controllers, etc. with Black on White Phenolic Tags using machine cut letters, 1/4" minimum height, unless otherwise noted. Permanently attach to each device as required. For all panelboards, switchboards, transformers, MCC, VFD's, enclosed motor starters, enclosed circuit breakers, disconnect switches and Service Entrance ATS to include name, voltage, phase, number of wires, ampacity rating, short circuit rating and name/location of feed to the device.

B. Contractor shall provide and install a Black on White Phenolic Tag using machine cut letters, 3/8" minimum height, unless otherwise noted. Permanently attach to the Main Circuit Breaker/ATS or Main Circuit Breaker for the service as required. This tag will indicate the maximum available fault current at the Main Device and the date calculated as required by NEC Paragraphs 110.16 and 110.24.

3.04 CLEANING AND PAINTING:

A. Oil, dirt, grease, and other foreign materials shall be removed from all raceways, fittings, boxes, panelboard trims, and cabinets to provide a clean surface for painting. Scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, switchboard, or other equipment enclosures shall be touched up with paint furnished by the equipment manufacturers specifically for that purpose. Painting in general is specified under other sections of the specifications.

B. Trim covers for flush-mounted panelboards, telephone cabinets, pull boxes, junction boxes and control cabinets shall not be painted unless specifically required by the architect. Where such painting is required, trim covers shall be removed for painting. Under no conditions shall locks, latches or exposed trim clamps be painted.

3.05 EXCAVATION, TRENCHING AND BACKFILLING:

A. All conduits shall be buried a minimum of 36" below finished grade. Provide and install magnetic warning tape 12" below finished grade over the entire length of all buried conduits.

B. The contractor shall perform all excavation to install the electrical work herein specified. During excavation, material for backfilling shall be piled back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. All excavated materials not to be used for backfill shall be removed and disposed of by the contractor. Grading shall be done to prevent surface water from flowing into trenches and other excavation and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut. No tunneling shall be done. Any area disturbed during excavation shall be repaired back to its original condition, i.e.: paving, concrete, grassing, sod, gravel, sidewalks, etc.

C. The bottom of the trenches shall be graded to provide uniform bearing and support for conduits, cables, or duct bank on undisturbed soil at every point along its entire length. Overdepths shall be backfilled with loose, granular, moist earth, tamped. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.

D. The trenches shall be backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has a cover of not less than the adjacent ground but not greater than 2" above existing ground. The backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. The compaction of the filled trench shall be at least equal to 95% of the maximum density as determined by the Standard Proctor Test. Settling the backfill with water will not be permitted. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore the surface to the grade and compaction indicated, mounded over and smoothed off.

E. Contractor shall repair all surfaces disturbed by the installation of all underground conduit systems back to their original condition with the same type of material and construction and/or up-grade as approved by the Owners Representative and Engineer. Any paved area or hard surface disturbed (asphalt or concrete paving) shall be saw cut to have clean and straight edges for the required trenching and repaired back to its original condition as indicated above.

F. The Contractor shall provide ALL REQUIRED erosion control for this project as required by the County / City / State Officials.

3.06 DIRECT BORING:

A. The contractor shall direct bore conduit runs in this project where indicated on the Drawings or as an alternate to trenching, at the Contractor’s option. Minimum depth of all conduits shall be 36” below finished grade. All excavated materials shall be removed and disposed of by the contractor. Any area disturbed during boring shall be repaired back to its original condition, i.e.: paving, grassing, sod, gravel, etc.

B. Contractor shall repair all surfaces disturbed by the installation of all underground conduit systems back to their original condition with the same type of material and construction and/or up-grade as approved by the Architect and Owner. No holes or trenches shall be left open after the end of each workday.

C. All direct bore conduits shall be accurately located on the Contractor’s “As-Built” Documents that are to be provided to the Owner at the completion of the project.

D. The Contractor shall provide ALL REQUIRED erosion control for this project as required by the County / City / State Officials.

END OF SECTION

SECTION 266100 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 GENERAL:

A. Provide complete conduit system including boxes, fittings and supports. All empty conduits shall be left with fiber polyline pull cord.

1.02 RACEWAYS:

A. Contractor shall install all conduits as per the below requirements.

1. Intermediate Metal Conduit (IMC) shall be ferrous galvanized conduit and shall comply with Article 342 of the National Electrical Code. Use in all areas, EXCEPT in the Plant Area, no metallic conduit allowed in the Plant Area.
2. Rigid steel conduit shall be ferrous galvanized conduit and shall comply with Article 344 of the National Electrical Code. Use in all areas, EXCEPT in the Plant Area, no metallic conduit allowed in the Plant Area.
3. Electrical Metallic Tubing (EMT) shall be ferrous galvanized conduit and shall comply with Article 358 of the National Electrical Code. EMT conduit shall be used only in areas with concealed conduits. Use in all areas, EXCEPT in the Plant Area, no metallic conduit allowed in the Plant Area.
4. Liquid tight flexible non-metal conduit shall comply with Article 356 of the National Electrical Code.
5. Flexible metal conduit shall comply with Article 348 of the National Electrical Code. Use in all areas, EXCEPT in the Plant Area, no metallic conduit allowed in the Plant Area.
6. Rigid nonmetallic conduit shall be polyvinyl chloride Schedule 80 (PVC) and comply with Article 352 of the National Electrical Code. Schedule 80 (PVC) conduits shall be used only as indicated on the Drawings and in the Plant Area.

B. Coordinate all raceways with the process piping, process equipment, mechanical ductwork and plumbing work installed in the job.

C. Seal all penetrations through any rated floor; wall or ceiling shall be sealed back to their original rating. Refer to the Architectural Specifications for means and methods.

1.03 OUTLETS:

A. Location of Outlets: Unless specifically indicated, all outlets are located diagrammatically on the drawings. Outlets shall be located so that they will be symmetrical with Architectural details and power outlets shall be so located as to serve the equipment.

PART 2 - PRODUCTS

2.01 CONDUCTORS:

A. All conductors shall be copper and have 600 Volt type THHN-2/THWN-2 insulation except where noted on drawings. Conductors installed where fixtures are used as raceway shall be 90^{o}C Type THHN-2 or XHHN.

B. All branch circuits shall be a minimum of #12 AWG solid or stranded copper except for motor leads, which shall be a minimum #12 AWG, stranded copper, unless otherwise noted on drawings.

C. All branch circuit and feeder conductors, No. 6 AWG and smaller shall be color coded as follows: 208Y/120 Volt, three phase system; Phase A--Black, Phase B--Red, Phase C--Blue, Neutral--White, Ground--Green. 480Y/277 Volt, three phase system; Phase A--Brown, Phase B--Orange, Phase C--Yellow, Neutral--Gray, Ground--Green with stripe. 120/240 Volt, single phase system, Phase A--Black, Phase B--Red, Neutral--White, Ground--Green.

D. VFD Cable shall be 3 conductor with ground, 2000 Volt, Type XLPE RHH-RHW-2 PVC Cable. Type TC-ER VFD Power Cable 2000 Volt, three conductor, Copper, with Cross Linked Polyethylene (XLPE) insulation, (RHH-RHE-2) with Polyvinyl Chloride (PVC) Jacket with three (3) Symmetrical Bare Copper Grounds and Copper 5 mil Tape Shield with minimum of 50% overlap. Southwire Spec 45451 or approved equal.

2.02 PULLBOXES:

A. All pull boxes in the Plant Area shall be NEMA 4X PVC (as indicated on the Documents) and shall comply with Article 314 of the National Electrical Code, for the number, size and position of conduits entering the box, size of box and maximum number of conductors in a box.

B. Pull boxes for the non-Plant Area shall be metal boxes and shall comply with Article 314 of the National Electrical Code, for the number, size and position of conduits entering the box, size of box and maximum number of conductors in a box.

2.03 OUTLET BOXES:

A. Outlet boxes shall be provided for each device. Boxes shall not be smaller than specifically indicated herein and shall be larger if required by Article 314 of the National Electrical Code for the number and size of conductors installed. All boxes shall be non-metallic Type FD boxes in the Plant Area and metallic boxes in the non-Plant areas.

2.04 RECEPTACLES:

A. Receptacles shall be of the type and ratings as indicated below:

1. Duplex outlets shall be 20 Amp 125 Volt A.C. 3 wire Specification grade straight blade with gray face, unless otherwise noted on the Drawings.
2. GFCI duplex outlets shall be 20 Amp 125 Volt A.C. 3 wire Specification grade straight blade with gray face, unless otherwise noted on the Drawings.
3. All switches shall be 20 Amp 120/277 Volt Specification grade with gray handles, unless otherwise noted on the Drawings.

B. Device plates shall be one piece single or multi-gang type selected to match the specific device or combination of devices. Device plates for flush mounted devices in the non-Plant areas shall be Stainless Steel type and as required for the devices, unless specifically indicated otherwise. Devices flush mounted in exposed masonry construction shall be jumbo type. Device plates for surface mounted devices shall be used with the type of outlet of outlet box in which the device is mounted. All devices installed in areas exposed to the weather or the Plant Area and where specifically indicated shall be provided with a non-metallic weatherproof device plate in-use, extra-duty type or approved equal.

PART 3 – EXECUTION

3.01 RACEWAYS:

A. Exposed metallic conduits shall be installed parallel or at right angles to existing walls, ceilings, and structural members. Support exposed metallic conduits at not more than ten foot intervals and within three feet of outlets, junction boxes, cabinets and fittings. Individual runs of conduits shall be supported by one hole conduit straps; groups of conduits shall be supported on 1 1/2" X 1 1/2" fourteen gauge galvanized steel channel for galvanized steel conduit and 1 1/2" X 1 1/2" twelve gauge aluminum channel for aluminum conduit; Kindorf, Unistrut or Powers, suspended from structure with 1/2" threaded steel rods with spring steel conduit supporters for galvanized conduits or with 1/2" threaded aluminum rods with aluminum conduit supporters for aluminum conduits. Attach rods to structure with swivel type clamps. Individual runs of exposed conduits attached to structural steel shall be supported by beam clamps. Where conduits must pass through structural members obtain approval of Engineer with respect to location and size of hole prior to drilling.

B. Exposed non-metallic conduits shall be installed parallel or at right angles to existing walls, ceilings, and structural members. Support exposed non-metallic conduits as per NEC Table 352.30 – Support of Rigid Polyvinyl Chloride Conduit (PVC). Individual runs of conduits shall be supported by non-metallic or stainless steel one hole conduit straps; groups of conduits shall be supported on 1 1/2" X 1 1/2" fourteen gauge stainless steel channel or aluminum channel. Channel shall be Kindorf, Unistrut or Powers, suspended from structure with 1/2" threaded stainless steel rods with spring stainless steel conduit supporters or with 1/2" threaded aluminum rods with aluminum conduit supporters. Attach rods to structure with swivel type stainless steel clamps. Where conduits must pass through structural members obtain approval of Structural Engineer with respect to location and size of hole prior to drilling.

C. Concealed branch circuit conduits shall be supported at intervals not exceeding ten feet and within three feet of each outlet, junction box, cabinet or fitting. Individual branch circuit conduits shall be attached to structural steel members with spring steel type conduit clips and to non-metallic structural members with one hole conduit straps. Where branch circuit conduits must be suspended below structure, conduits shall be supported by trapeze type support, typical to the type for exposed conduits indicated above. Conduits shall not be attached to channels of ceiling suspension system or suspension wires. Concealed feeder conduits larger than one inch trade diameter, above ceiling, shall be attached to structure on intervals not exceeding twelve feet with conduit beam clamps, one hole conduit straps or trapeze type support in accordance with conditions encountered.

D. Conduit support devices shall be attached to structure as required by the Structural Engineer. Nails are not acceptable.

E. Rigid conduit shall be attached to sheet metal enclosures with two bonding type lock nuts and insulated bushing. EMT connectors and couplings shall be watertight compression type and manufactured by Thomas and Betts or Appleton. All connectors shall be of the insulated throat type. Rigid conduit stub ups not attached to enclosure shall be terminated with steel insulated throat, grounding type bushing. All connectors and couplings shall be approved for the purpose.

F. Expansion fittings shall be provided in all feeder conduits where conduits pass through building expansion joints. All conduits penetrating rated fire walls or rated fire floors shall be installed with devices to maintain the fire rating of the wall or floor penetrated. Use O.Z. Gedney "Fire-Seal" or approved alternate. Contractor shall caulk holes on both sides of smoke walls where conduits penetrate.

G. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry work is complete.

H. All conduits entering buildings from below grade shall be sealed with fiber and insulating electrical putty to prevent entrance of moisture.

I. Flexible conduit shall comply with the above and below specifications.

1. Flexible conduit shall be used for connection to vibrating equipment, electric duct heaters, unit heaters and rotating machinery and for connection from junction box to corresponding recessed lighting fixture.
2. Flexible liquidtight conduit connecting motors, duct heaters, unit heaters and other electrical equipment subject to vibration not less than eighteen inches in length or as permitted by the NEC.
3. Flexible metal conduit from outlet box to recessed lighting fixture shall not exceed six feet in length.
4. Flexible conduit used for other than connections to lighting fixtures shall not be less than one-half inch trade size and in no case, shall flexible conduit size be less than permitted by the National Electrical Code for the number and size of conductors to be installed therein. Three-eighths inch flexible conduit may be used for connection to light fixtures providing conduit fill requirements of National Electrical Code are not exceeded.
5. Ground continuity through flexible conduit shall be maintained with green equipment grounding conductor, do not use flexible conduit for ground continuity.
6. When exposed to weather, when specifically indicated, or when installed in areas subject to moisture, flexible conduit shall be non-metallic liquidtight type.
7. All connectors for flexible conduit shall be standard set screw type, cast connectors, bushed as required for flexible conduit. When used with liquid type flexible conduit, connectors shall be standard compression type.

3.02 PULL OR JUNCTION BOXES:

A. Pull boxes shall be provided where specifically indicated and where required to facilitate the installation of conductors. Pull boxes shall be installed exposed only in unfinished spaces, unless otherwise specifically indicated, and shall be installed to be fully accessible.

B. Where pull boxes are installed in finished spaces, boxes shall be as indicated on the Documents.

C. Pull boxes required for horizontal feeders containing more than one feeder shall be provided with reinforced flange and removable 12 gauge 1 1/2" X 1 1/2" stainless steel channel for support of conductors. Wood supports within pull boxes are not acceptable.

D. Splices shall not be permitted in pull boxes except when specifically approved in writing by the Engineer or where specifically shown on the drawings. Where splices are permitted, splices shall be made with insulated splicing sleeves attached to conductors with hydraulic crimping tool. Split bolt connectors are not acceptable for splices within pull boxes.

E. Feeders within pull boxes shall be individually laced with nylon tie straps of the type with enlarged tab to permit identification of each feeder within pull box.

F. Minimum pull or junction box size shall be as per the NEC.

3.03 CONDUCTORS:

A. All feeder and branch circuit conductors No. 4 AWG and larger shall be phase identified in each accessible enclosure by 1" wide plastic tape attached to conductors in a readily visible location. Tape colors shall match color requirements specified herein.

B. All branch circuit conductors shall be connected as indicated on the drawings. All conduits shall have a ground wire pulled and shall comply with Article 250 of the National Electrical Code.

C. Conductors within enclosures, i.e., panels, terminal cabinets, control cabinets shall be grouped and laced with nylon tie straps. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.

D. Splices in conductors shall be made only within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code, 2020 Edition. Do not splice conductors in panelboards, safety switches, or motor control enclosures. Splices in conductors No. 10 AWG or smaller shall be made with Skotchlok insulated spring connectors, Ideal wing nuts, or Ideal steel crimp connectors with wrap-cap insulating caps. Splices in conductors No. 8 AWG and larger shall be made with split bolt connectors taped with No. 88 plastic electrical tape or Ideal Type GP or GT tap connectors and insulating cover unless splices are specifically indicated to be made with insulating crimping sleeves applied to the conductors with hydraulic operated crimping tool. Splices in all inground junction boxes shall be made as per the Details in the Documents (UL Labeled/Listed for direct burial and submersible applications as per UL 486D)

E. Conductors used only for 120 Volt control wiring systems shall be minimum No. 14 AWG stranded type MTW 600 Volt insulation. Control conductors to be J.I.C. color coded. Where control conductors terminate on terminal strip, make termination with lug applied to conductor with crimping tool.

F. Phase rotation established at service equipment shall be maintained throughout entire project.

G. Pull wires shall be 500# minimum test continuous fiber polyline.

3.04 OUTLET BOXES:

A. Outlet boxes shall be sized as per the NEC and as required for the installation and installed where required for the installation and as per the NEC.

B. Unless otherwise indicated or specified, all receptacles shall be mounted with top of device, the distances indicated herein, above the finished floor except where finished walls are exposed concrete block, in which case height shall be adjusted to allow outlet box for device to be mounted at block joint

1. Wall switches: 48"
2. Wall receptacles: 18"
3. Countertop mounted: 6" above the backsplash with the major axis horizontal, unless otherwise noted. Contractor to verify backsplash height prior to rough-in of the outlet boxes. Outlet boxes are to be above the backsplash.
4. Telephone and Data Outlets: 18"

C. All devices shall be mounted within outlet boxes to allow device plates to be in contact with wall on all sides. Devices shall be accurately aligned with major axis of device parallel to adjacent predominate building feature.

D. Wall switches shall be installed on the strike side of doors, unless otherwise indicated on the Contract Drawings.

END OF SECTION

SECTION 266231 - EMERGENCY GENERATOR

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. The Vendor shall provide to the Owner an engine driven generator set that has been prototype tested, factory built, production tested, together with all accessories necessary for a complete installation as shown on the Documents and drawings and specified herein. The Contractor shall receive, unload and install the emergency generator. All equipment shall be new and of current production by an international firm which manufactures the generator and controls. The Contractor shall provide a full tank of diesel fuel after acceptance of the generator and all site testing is complete.

1.02 GENERAL REQUIREMENTS:

A. The generator set will be of the latest commercial design and will be complete with all the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied shall meet the requirements of the National Electrical Code, along with all applicable local codes and regulations. All equipment shall be new and of current production of a national firm which manufactures the generators and assembles the generator sets as a complete and coordinated system. There will be one source responsibility for warranty, parts, and service through a local representative with factory-trained servicemen.

1.03 SUBMITTAL:

A. The submittal shall include specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number, each required interconnection between the generator set, the transfer switch, and the remote annunciator panel as required by the Documents.

1.04 TESTING:

A. To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and/or local representative shall be responsible for these separate tests: final production tests and site tests.

B. Production Tests

1. Final Production Tests: Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
2. Verify the single-step load pickup maximum in KW that can be placed on the unit
3. Transient and steady—state governing.
4. Safety shutdown device testing.
5. Voltage regulation.
6. Rated Power @ 0.8 PF
7. Maximum Power.
8. Certified test record will be sent prior to shipment for review by the Owner and Engineer.

B. SITE TESTS

1. Site Tests will be the responsibility of the installing contractor, in accordance with the generator manufacturer. The site testing shall include the installation check, start-up, and four (4) hour full load test shall be performed by the manufacturer's local

representative. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test.

2. Lubricating oil and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected. The Generator Vendor shall provide and install all required lubricating oil and antifreeze for the initial set-up of the generator and shall verify levels are correct after all site testing is completed, if not, provide as needed.
3. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include block heaters, battery charger, generator strip heaters, remote annunciator, etc.
4. Start-up under test mode to check for exhaust leaks, path of exhaust gases outside the enclosure, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and frequency and phase rotation.
5. Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test.
6. The Contractor/Generator Vendor shall provide a four (4) hour full load (100% rating of the generators) bank test of the generator and provide the Owner with written certification that the generator meets all required requirements and is 100% ready for use on this project. This test shall be performed on site once the generator and associated equipment is fully installed. The Contractor is responsible for all diesel fuel for the load bank test and will completely re-fill the sub-base tank after all testing is complete. Tank will be left full for the Owner.

1.05 WARRANTY & MAINTENANCE:

A. A two year warranty for the generator set shall be included to guarantee against defective material and workmanship in accordance with the manufacturer’s published warranty from date of start-up. Optional warranties shall be available upon request.

B. The generator set manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall be regularly engaged in a maintenance contract program to perform preventive maintenance and service on equipment similar to that specified.

PART 2 – PRODUCTS

2.01 PRODUCTS:

A. The generator set shall be manufactured by Caterpillar Diesel Engine Generator Set with sound attenuated enclosure and sub-base fuel tank or approved equal by MTU Onsite Energy, Kohler or Generac. The generator shall be rated 1,250 KW / 1,563 KVA, C32 standby, 0.8 power factor, 480Y/277Volt, three phase, 4 wire and shall have an output circuit breaker, rated 2,500 Amp, 3 pole, 100% rated with GF Relay. The generator sets shall be capable of this full rating while operating in the conditions normal for Buford, Georgia.

B. The generator sets shall be capable of starting all rated loads in one block step as per NFPA 110 with a maximum voltage dip of 20% as allowed by the National Electrical Code and these Specifications. Provide a complete sizing report at the Shop Drawing Phase of the project for each generator indicating the maximum voltage dip is 20% or less for the single block load.

C. Vibration isolators shall be provided between the engine-generator and heavy-duty steel base and between the steel base and the sub-base fuel tank.

2.02 ENGINE:

A. The engine shall run at a governed speed of 1800 rpm. The engine shall be equipped with the following:

1. An electronic isochronous governor capable of +/- 0.25% steady-state frequency regulation.
2. 48 Volt positive engagement solenoid shift-starting motor.
3. 45 Ampere minimum automatic battery charging alternator with solid-state voltage regulation.
4. Positive displacement, full pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain.
5. Dry-type replaceable air cleaner elements for normal applications.

B. The engine shall be for operation on diesel fuel. The 1,250 KW unit shall be supplied with a minimum of 3,600 gallon double wall, UL-142 Labeled/Listed integral fuel tank base; high and low fuel solenoid level switches and low level alarm and rupture basin leak detection alarm. Sub-base tank will be provided with a fuel circulation system to maintain positive fuel movement in the tank at all times. Provide fuel filters as required.

C. The engine shall be liquid-cooled by a unit-mounted radiator, blower fan, water pump, and thermostats. This system shall properly cool the engine with up to 0.5 inches H20 static pressure on the fan in an ambient temperature up to 122ºF/50ºC and maintain this rating when installed in the sound enclosure. Provide with radiator duct flange.

D. Engine shall be certified for complaint with EPA Certified for Stationary Emergency Application, EPS Tier 2 emissions level. Emergency Standby Compliant Tier 2.

E. Engine shall be manufactured in the USA.

2.03 GENERATOR:

A. The alternator shall be salient-pole, brushless, 12-lead reconnectable, self-ventilated of drip-proof construction with amortisseur rotor windings and skewed 2/3 pitch stator for smooth voltage waveform. The insulation shall meet the NEMA standard (MG1-22) for Class H and be tropicalized. Temperature rise of the rotor and stator shall be limited, shall be Class F temperature rise. The excitation system shall be of brushless construction controlled by a solid- state voltage regulator capable of maintaining voltage within +/- 1% at any constant load from 0% to 100% of rating.

B. The generator set shall meet the transient response requirements of ISO 8528-5.

C. The alternator excitation shall be of a permanent magnet exciter design.

D. The generator, having a single maintenance-free bearing, shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.

2.04 CONTROLLER:

A. Standards

1. The generator must meet NFPA-110 Level 1 requirements (current version) and must have an integral alarm horn as required by NFPA. Controller shall be CAT EMCP 4.2 Genset Controller or approved equal.
2. Provide and install in the generator controller a Modbus Communications Card (CCM Card) such that the generator will communicate with the Owners control system.

B. Applicability

1. For standardization purposes, the control described herein must be available on generator sets 20 kW and larger.
2. The control must be usable on 48-volt starting systems.
3. Environment
   a. -40°C to +70°C operating temperature range
   b. 5-95% humidity, non-condensing

C. Hardware Requirements

1. The control shall have a run-off/reset-auto three-position selector switch.
2. Seven indicating lights:
   a. Switch Position
   b. Common alarm
   c. Common Shutdown
   d. System Ready
   e. Speed Signal
   f. Emergency Stop
3. Lighted display with two lines of 20 alphanumeric characters for messages. Panel lights must be supplied as standard.
4. Four position snap action sealed keypad for menu selection and data entry.
5. An audible alarm must be supplied in the control unit.

D. Control Functional Requirements

1. Field programmable time delay for engine start. Adjustment range, 0-15 in1 second increments.
2. Field programmable time delay engine cool down. Adjustment range, 0-99 minutes in 1-minute increments.
3. Output for overcurrent if the generator reaches a user programmable percentage of its KW rating. Load shed must also be enabled if the generator output frequency falls below 59 Hz (60 Hz system).
4. Programmable cyclic cranking that allows up to six crank cycles and up to 45 seconds of crank time per crank cycle.

E. Generator System Monitoring Requirements

1. All monitored functions must be viewable on the digital display.

2. The following generator functions must be monitored:
   a. all output voltages - line to line, and line to neutral, 1.0% accuracy
   b. all phase currents and average current, 1.0% accuracy
   c. output frequency, 1.0 accuracy
   d. KW for total and per phase
   e. KVA for total and per phase

f. KVAR for total and per phase
g. Power factor, overall and per phase
h. KWH and KVARH

3. Engine parameters listed below shall be monitored:
a. coolant temperature
b. oil pressure
c. battery voltage
d. RPM
e. Engine hours of use
f. Crank attempt counter
g. Start counter

4. The control must be capable of detecting the following conditions, indicate if the condition will shutdown the generator or provide a warning, and annunciate the situation, using words and phrases, on the digital display. The following will cause a system shutdown:
a. emergency stop
b. loss of speed signal
c. high engine temperature
d. low oil pressure
e. overcrank
f. under speed / over speed

5. The following will cause a warning but leave the generator running:
a. battery charger failure
b. customer programmed digital auxiliary input
c. customer programmed analog auxiliary input
d. power system supplying load
e. high battery voltage
f. high coolant temperature
g. loss of AC sensing
h. low battery voltage
i. low coolant temperature
j. low fuel level or pressure
k. low oil pressure
l. overcurrent
m. speed sensor fault
n. weak battery

6. The following must be programmable from the controller keypad:
a. Time delay settings:
b. generator run time (0 to 72 hours) - exercise
c. load shed
d. engine start
e. engine cool down
f. overvoltage and undervoltage delays
g. crank on and crank pause time
h. idle time
i. Trip point settings:
j. high battery voltage
k. low battery voltage
l. overspeed
m. underfrequency
n. overfrequency
o. overvoltage

p. undervoltage
q. load shed

2.05 ACCESSORIES:

A. Output Circuit Breakers:

1. The 1,250 KW unit shall have a 2,500 Amp, 3 pole, 100% rated output circuit breaker, molded case type, rated 65 KAIC, generator mounted with Ground Fault Relay. The generator output leads entering the line side of the circuit breaker shall be solder tinned as to prevent flyers, corrosion and improve conductivity between the alternator leads and the circuit breaker.

B. Generator Sound Attenuated Enclosure

1. The enclosure must be weatherproof / sound attenuated type (75 dBa at 23 feet minimum at full load). In addition, the enclosure must meet applicable National Electrical Code (NEC) and National Fire Protection Association (NFPA) codes relating to clearances of all items included with the Generator Set. Radiator temperature rating is to be maintained at 122 degree F / 50 degree C.
2. The performance of the enclosure must be in accordance with the Generator Set's specific requirements for cooling and combustion airflow. Clearances must be adequate for maintenance personnel and/or doors must be located such that service personnel have adequate access.
3. Lifting provisions must be provided in the base that enables the complete Gen-set with the enclosure to be lifted without damage.
4. Exhaust silencer shall be a Critical Grade Silencer mounted inside the enclosure for the sound attenuated units.

C. Engine block heater. Thermostatically controlled and sized to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements of NFPA-99 and NFPA-110, Level 1. Heater shall be rated for operation at 208 Volt, single phase or 208 Volt, three phase.

D. Battery rack, and battery cables, capable of holding the manufacturer's recommended batteries, shall be supplied.

E. The engine exhaust silencer shall be coated to be temperature and rust resistance, rated for critical application. The silencer will reduce total engine exhaust noise by 25-35 dB (A).

F. Each generator unit will be provided with an automatic float battery charger system, 10 Amp including alarms. Provide quantity as required for each generator. The battery charger shall be rated to operate at 120 volt, single phase.

G. The 1,250 KW generator shall be provided with a manufacturer provided and installed 100 Amp, 208Y/120 Volt, three phase, 4 wire auxiliary power panel with all required branch breakers and 100 Amp, 3 pole main breaker. Mount inside the generator enclosure to provide power for all accessories required by these specifications, including the engine block heater, battery chargers, lighting, etc. All accessories shall be prewired to this panel as required. All wiring shall be in accordance with the National Electrical Code, NFPA 70 - 2020 Edition.

2.05 SERVICE ENTRANCE AUTOMATIC TRANSFER SWITCH (ATS):

A. Provide Service Entrance Rated Automatic Transfer Switch as described herein and on the Contract Documents. ATS to be rated 3,000 Amp, 480Y/277 Volt, Three Phase, 3 Pole, 4 Wire, with 100% solid neutral and 3,000 Amp, 3 Pole with GF Relay normal main circuit breaker with LSIG electronic trip unit. Unit to be in NEMA 3R Lockable enclosure for outdoor installation. Unit to be UL 1008 Labeled/Listed and rated for Service Entrance. Unit to be fully rated 65 KAIC. Provide ATS with Energy Reduction Switch as required by the NEC Article 240.87. Basis of design is ASCO Power Technologies, Series 300 ATS, Delayed Transition, Service Entrance Rated in Secure NEMA 3R Enclosure.

B. Provide the following items:
   11BE – Programmable engine exerciser, event log, RS-485 communications
   18RX – Source Available Contacts
   44G – Internal Strip Heater for NEMA 3R enclosure
   119M – ERMS Switch.

END OF SECTION

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SECTION 266400 - ELECTRICAL SERVICE AND DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL:

A. Provide and install all electrical distribution equipment as specified, scheduled or indicated on the approved drawing and these specifications.

PART 2 - PRODUCTS

2.01 PANELBOARDS AND MAIN DISTRIBUTION SWITCHBOARD

A. Shall be bolt-in circuit breaker type with a rated main breaker or rated main lugs only as noted on drawings. All shall have UL 891 Listed and Labeled interrupting capacity of equal to or greater than the Fault Currents indicated on the Power Riser Diagram. All multiple breakers shall be common trip type only. Breakers with ground fault protection (LSIG) shall be provided where specifically indicated. All switchboards & panelboards shall be fully rated. Series rating are not permitted. All circuit breakers shall have 75 degree C rated lugs. All busing shall be silver/tin plated copper.

B. Panelboard’s end and side gutters shall have minimum clearance as required by the NEC. Depth shall be 5 3/4" minimum.

C. Approved manufacturers are: Square D, Eaton, GE/ABB, Siemens or approved equal.

D. Circuit breakers shall be numbered and connected to panel bus in the following sequence: Circuit 1, Phase A; Circuit 3, Phase B; Circuit 5, Phase C. Where bus diagrams are indicated on the drawings, breakers shall be positioned in panel to conform to diagrams; otherwise, single pole breakers shall occupy top positions in panel with blank spaces in lower positions and two and three pole breakers in between.

E. Main lugs of panels or main circuit breaker shall be UL listed for copper or aluminum conductors; refer to Documents for conductor types and sizes. Lugs shall be of the proper range for feeder conductors indicated on the Documents. Each circuit protective device shall be identified with numeral designation, cross referenced with typewritten circuit directory on interior of panel door. All panel directories shall include the load served by the individual circuit. A copy of each panel directory, reflecting all field changes shall be included in the bound data to be provided by the contractor at the time of final inspection.

F. Conductors within panels shall be grouped and laced with nylon tie straps. Splicing of conductors within panels is not acceptable. Only one conductor shall be installed under terminal of individual circuit breaker.

G. All panels throughout project shall be keyed alike.

H. Circuit breakers shall be provided with trip rating class and poles as indicated on the drawings. Class indicated is designation according to Federal Specification W-C-375C/GEN-2000 and indicates the frame size and interrupting rating required. Operation of multiple breakers shall be by single handle; tie handles are not acceptable.

I. Circuit breakers used for the control of discharge or fluorescent lighting shall be designated for the purpose and bear the marking “HID” or "SWD".

J. All panelboards and switchboards shall be marked with Arc Flash Warning Labels as required by Article 110.16 of the NEC.

K. Switchboard and power panelboard circuit breakers shall be equipped with line terminal jaws that shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted side by side without restriction.

2.02 DISCONNECT SWITCHES:

A. Fusible or Non-Fusible disconnect switches shall be Heavy Duty type, NEMA 12 and be provided for all motors located out of sight of motor controller and where specifically indicated on the drawings. Disconnect switches shall disconnect all underground conductors. When exposed to weather, enclosure shall be NEMA-4X Stainless Steel or NEMA 3R as noted on the Documents. Switches shall be installed to be fully accessible in accordance with Article 110.26 of the National Electrical Code.

B. Disconnect switches for single phase motors shall be horsepower rated, motor switches without overload protection, voltage rating as per motor nameplate voltage or greater.

C. Fusible disconnect switch shall disconnect all ungrounded conductors and shall be supplied with the proper sized fuse clips and fuses. Fuse size over frame size will be noted on drawings. Fuses shall be current limiting, time delay, dual element Type RK-5 fuses.

D. Disconnect switches shall be Square D, General Electric/ABB, Siemens, Eaton or approved equal. All disconnect switches shall be identified in accordance with the Paragraph 26 6010 - 3.03 Identification of these specifications and Article 110.22 of the National Electrical Code.

E. All disconnect switches shall be marked with Arc Flash Warning Labels as required by Article 110.16 of the NEC.

2.03 BACKBOARDS:

A. Provide and install backboards at all panels and power distribution equipment and as required by the local authorities. Backboards shall be 3/4" Fire rated (FRP) grade plywood.

2.04 DRY TYPE TRANSFORMERS:

A. Dry type transformers shall be provided where shown to provide service to specific panelboards as indicated on the drawings. Primary and secondary ratings are as indicated on the drawings. KVA ratings shall be as shown on the drawings. Transformers shall be constructed in accordance with NEMA Standard STI-20 and ANSI Standard C89.2 and Final Rule 10 CFR Part 429 and 430.

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B. Transformers shall be provided with six 2 1/2% full capacity taps, two above and four below normal voltage unless only four 2 1/2% taps, two above and two below are standard NEMA taps for the specific KVA rating. Vibration dampers shall be provided as a standard feature of all transformers.

C. Transformers shall be provided with Class H insulation rated for temperature rise of 150 degrees C. over 40 degrees C. maximum ambient. Temperature rating shall be a rated KVA. Maximum hot spot temperature shall be 220 degrees C.

D. Shop drawings for dry type transformers shall indicate sound and temperature rating, BIL, overload capacity and efficiency at 25%, 50% and 100% load, physical dimensions and net weight. Shop drawings shall also contain certification that transformers are constructed and tested in accordance with standards specified herein.

E. Primary and secondary connections to dry type transformers shall be made with liquidtight flexible metal conduit. Transformers shall be the product of Square D, General Electric/ABB, Hevi-Duty or approved equal.

F. Provide approved wall bracket where indicated or as required by space limitations. Provide vibration isolators under all transformers.

G. All transformers shall be marked with Arc Flash Warning Labels as required by Article 110.16 of the NEC.

2.05 MOTOR CONTROL CENTER:

A. Provide motor control center as indicated on the approved drawings. MCC shall be back to back design with the maximum length of 14 feet.

B. The motor control center shall be Square D Class 8998, Model 6, indoor type, NEMA Type 1 Gasketed enclosure conforming to NEMA Standard for Industrial Control IC-1, of the latest issue or approved equal. Motor control center wiring shall be NEMA Class I, Type B. Motor Control Center shall have 20 inch deep units with control units for front mounting only. Motor control center shall be fabricated by the company that manufactures the starters. Motor control center shall be fully rated 65 KAIC at 480 Volt, three phase, 3 wire. Units in the MCC shall communicate via Modbus TCP with the Owners SCADA System. MCC units shall be wired to a managed ethernet switch to communicate with the Owners SCADA system.

C. Structure: Each motor control center assembly shall consist of unit vertical structures, each 90 inches high, 20 inches wide and 20 inches deep, with 4" wide wire trough in each vertical structure accepting a maximum of 6 NEMA Size 1 or Size 2 non-reversing combination starter units, Size 6 starters accepted. The top section of the motor control center shall contain a continuous fully rated non-tapered copper bus, sized as shown on the drawings and a continuous wireway adequately protected from the bus section. A continuous wireway shall also be provided along bottom, 6" and at the top, 12" of each assembly. Each vertical section shall contain a 300 ampere copper bus, except where load shown required a larger bus which shall be adequately sized therefore. Bus shall be supported and braced to withstand the mechanical forces resulting from a short circuit of a minimum of 65,000 amperes RMS symmetrical at 480 volts. Incoming feeder to the motor control center to be as shown on drawings. Space for connection of incoming line feeders shall be provided. All bussing shall be Copper or Tin-Plated Copper.

D. Unit Construction: Combination MCP Motor Starter units through NEMA Size #4, non-reversing or reversing, shall be of drawout construction with facilities for a test position. Each MCP shall be rated to withstand a minimum of 65,000 Amp RMS Sym interrupting rating at 480 Volt. Each unit shall be equipped with guide rails for the removable starter and with a hinged door on which is mounted the MCP operating mechanism. All unit doors shall be gasketed. Operating mechanism shall be mechanically interlocked to prevent opening or closing door when the circuit is in the "on" position and shall be arranged for padlocking in the "off" position. Starter units shall be equipped with disconnecting type terminal blocks for all control wiring to type "B" terminals in the unit for NEMA size 1 and 2 starters. All terminal blocks shall be marked. When complete motor control centers must be split for shipping purposes, provisions shall be made for properly marked terminal blocks. Internal wiring shall be #14 gauge (AWG) minimum, stranded copper, with 600 volt thermoplastic insulation type MTW for 90 degrees C. maximum conductor temperature. Master terminals shall be 125% of the number to the total number of terminals in all the starters in the motor control center and shall be located in the wire space. Stab connectors shall be #6 AWG copper minimum.

E. Individual Circuit Breakers: Shall be sized as indicated on the drawings for the individual loads shown and shall be rated to withstand a minimum of 65,000 amps RMS symmetrical at 480 Volt.

F. Across the Line Motor Starters: Each FVNR motor starter shall have three overload relays and be provided with a seal-in and minimum of three control contacts for either N.O. or N.C. operation, rated minimum of 20 Amp. A minimum of three spare terminals of manufacturer's standard if exceeding three, shall be provided unless maximum terminal utilization is already accomplished within the compartment. All contactor coils for motor starters shall be rated 120 Volts, 60 Hz. Provide each unit with an individual control transformer of ample size for the continuous duty required for the starter plus 100 VA added capacity for auxiliary loads to be powered from the control transformer. The control transformer shall be rated 480 Volt primary, 120 Volt secondary, single phase except where shown otherwise on the drawings, with a fuse in one secondary line and the other line grounded. Primary connection of the control transformer shall be on the load side of the MCP. Each starter shall be provided with Phase Failure and Reverse Phase Relay factory wired to open the starter coil on loss of a phase or phase reversal. Overload protection relays shall be equal to TeSys T Motor Management system providing full motor monitoring, control, and protection with Modbus TCP/IP communications to the Owners SCADA system.

G. Variable Frequency Drives: The variable frequency drives shall be variable torque AC drives with circuit breaker protection (MCP) for the drive. The AC drive controller unit shall incorporate a self-contained, air-based cooling system. Air exhaust vents shall be louvered to help direct air flow away from personnel operating the AC drive controller unit. Fans, ductwork, or filters shall be easily accessible for maintenance. VFD drive controller units shall be provided with unit control terminal blocks for use in terminating field wiring. Terminal blocks shall be pull-apart type, 250 Volts, and rated for 10 amperes. Current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The stationary portion of the terminal block shall be used for factory connections and shall remain attached to the unit when the portion used for field connections is removed. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components. Unit shall be 6 Pulse with AC input line reactor. Unit to have graphic display on the face of the unit. VFD to be manufactured by the MCC manufacturer. VFD’s shall incorporate a digital comms card to communicate via Modbus TCP/IP to the Owners SCADA system.

H. Nameplates: Each starter unit shall be provided with a one-inch by three-inch nameplate that is attached to the motor control center compartment door by mechanical means (not adhesive). Nameplates shall be made of laminated plastic with white letters on a black background and shall bear nomenclature as per the Owner's requirements. Name tag shall indicate the same information as required for panels as indicated above in Section 266010-3.03.

I. Auxiliary Components: Indicating lights shall be transformer type 6 Volt, AC. Wiring devices and control devices in the panel doors shall be heavy duty, oil-tight or better. Provide and install an “H-O-A” (hand-off-auto) selector switch and "Motor On" indicating light in the door of each starter or VFD.

J. Terminals: Terminal boards shall be a minimum Size #6 screw type to accept ring type terminals.

K. Special Tools: Where special tools are required for maintenance of equipment, an adequate supply of such tools shall be furnished. Tools shall be segregated and clearly marked to indicate the equipment on which they are to be used.

L. Diagrams and Device Lists: Wiring diagrams shall be arranged for convenient field use for installation, testing, and trouble shooting. Each drawing shall be arranged so that it can be used and understood without reference to numerous other drawings. Device lists shall be provided to clearly identify devices and their functions. Drawings shall be coordinated so that the same identification is consistently used for each device and shall comply with J.I.C. standard format.

2.06 SOLID STATE SOFT START CONTROLLER:

A. Provide Solid State Soft Start Controller for the 75 Hp, 460 Volt, three phase motor at the Raw Water Pump Station. Controller to be Combination Altistart 22 Solid State Soft Start Controller by Square D or approved equal. Controller to have thermal magnetic circuit breaker disconnect switch, rated 65 KAIC. Isolation Contactor (AC3), Non-Reversing in NEMA 4X Stainless Steel Enclosure.

2.07 ACROSS THE LINE MOTOR STARTERS:

A. Across the Line Motor Starters shall be Full Voltage Non-Reversing motor starter, NEMA Sized with MCP (motor circuit protection) with three overload relays and be provided with a seal-in and minimum of three control contacts for either N.O. or N.C. operation, rated minimum of 20 Amp. All contactor coils for motor starters shall be rated 120 Volts, 60 Hz. Provide each unit with an individual control transformer of ample size for the continuous duty required for the starter plus 100 VA added capacity for auxiliary loads to be powered from the control transformer. The control transformer shall be rated 480 or 208 Volt primary (see Documents for voltage system where the starter is installed), 120 Volt secondary, single phase except where shown otherwise on the drawings, with a fuse in one secondary line and the other line grounded. Primary connection of the control transformer shall be on the load side of the MCP. Each starter shall be provided with Phase Failure and Reverse Phase Relay factory wired to open the starter coil on loss of a phase or phase reversal. Enclosure type is noted on the Documents. Provide and install an “H-O-A” (hand-off-auto) selector switch and "Motor On" indicating light in the door of each starter.

PART 3 - EXECUTION

3.01 MANUFACTURERS' RECOMMENDATIONS:

A. The contractor shall install all electrical distribution equipment in accordance with the manufacturer's recommendations and these specifications.

END OF SECTION

SECTION 266432 - VARIABLE FREQUENCY MOTOR CONTROLLERS

PART - GENERAL

1.01 Description

A. This specification describes a complete adjustable speed AC drive (VFD) used to control the speed of NEMA design B inverter duty induction motors.

1.02 Quality Assurance

A. The VFD manufacturing facility shall be ISO 9001 and ISO 14001 certified.

B. The VFD shall be manufactured by a company with at least ten (10) years' experience in the production of this type of equipment.

C. All printed circuit boards shall be completely tested before being assembled into the complete VFD. The VFD shall be subjected to a functional test and load test. The load test shall be at full rated load, or cycled load.

1.03 QUALIFICATIONS

A. The VFD shall meet the following specifications

1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL listed for 65 KAIC without the need for input fuses.

2. The VFD shall meet product standards UL 508A, 508C, or UL-61800-5 – Underwriter's Laboratory.

B. Acceptable manufacturers: Schneider/Square D or approved equal

1.04 SUBMITTALS

A. Submittals shall include in the Shop Drawing Phase of the Project and shall include the following information:
1. Outline dimensions and weight
2. Customer connection and power wiring diagrams
3. Complete technical product description, including a complete list of options provided
4. Compliance to IEEE 519 – Harmonic analysis for the project site including total current distortion. In case an alternative low harmonic solution is offered, the VFD manufacturer shall provide calculations, specific to the project site, showing that the total harmonic current distortion (TDD) at the Point of Common Coupling (PCC) is at or below THDi limits as recommended by IEEE 519- June 2014. Electrical Engineer shall provide specific electrical distribution system data necessary to perform harmonic calculations, if required.

PART 2 – PRODUCTS

2.01 DESIGN

A. The VFD shall be a 3-level Active Front End (AFE) AC drive that is designed to comply with standard IEEE 519-2014 when installed in a system that is already in compliance with the standard.

A 3-level design shall be used to provide a low harmonic current load to the power system and to avoid introducing additional common mode noise to the motor.

B. Passive harmonic filters shall be acceptable for motors less than 150 Hp in size provided the TDD is shown to be less than limits established by IEE 519-2014.

C. Line reactors or DC cokes shall be acceptable for motors less than 50 Hp as required to meet harmonic content requirements.

2.02 Ratings

A. The VFD shall be rated to operate on a 480 Volt, 3-phase power system.

B. The VFD shall be rated to operate at the following environmental operating conditions. Ambient temperature: 0 to 40 °C continuous. The VFD shall have the capability to operate up to 50 °C with derating. Altitude: 0 to 3300 feet above sea level without derating, less than 95% humidity, non-condensing.

C. The VFD shall be rated to operate from input power of 48 to 63 Hz.

D. The normal duty overload current capacity shall be 110% of rated current for one (1) minute out of ten (10) minutes.

E. The heavy-duty overload current capacity shall be 150% of rated current for one (1) minute out of ten (10) minutes.

2.03 Construction

A. The VFD manufacturer shall provide a complete package, ready-to-install solution. Third party entities that use VFD controllers from others in their package designs are not acceptable.

B. Enclosure types shall be UL NEMA Type 12 unless otherwise specified in the Documents.

2.04 Operator Interface

A. A detachable UL Type 12 / IP65 rated bi-color backlit graphical user interface terminal with keypad and capacitive wheel shall be provided for monitoring, annunciation, and configuration. The graphical display shall change to a red backlit color when an alarm occurs.

B. The user interface shall be capable of saving and downloading configurations of the VFDs, as well as transferring them to other VFDs.

C. The user interface shall offer a mini USB port for mass storage or PC device connection.

D. The VFD shall have self-diagnostic capabilities to display alarms, errors, and warnings as they occur and shall be able to store into memory the last 15 messages, at minimum. These shall be accessible by PC maintenance tools or by web server.

E. The displayed messages shall be in plain text.

F. The VFD shall display detected errors with QR codes to guide the user in the troubleshooting.

G. The HMI shall have embedded troubleshooting information to assist with fault codes.

H. The HMI shall be configurable to show up to 4 of the following parameters during operation:
Speed/torque in percent (%), RPM, or user-scaled units

Output frequency, voltage, current, and torque
Input voltage, power, and kilowatt hours
Heatsink temperature and DC bus voltage
Status of discrete inputs and outputs
Values of analog input and output signals
Values of PID controller reference, feedback, and error signals

2.05 Protective Features

A. Upon power-up, the VFD shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, AC-to-DC power supply, control power, and the pre-charge circuit.

B. The VFD shall be able to limit the motor surge limitation to twice the DC bus voltage. Suitable output filters must be provided to protect motors with the motor lengths provided in the drawings

C. The VFD shall provide VFD current protection.
Short circuit protection
Ground fault protection
Overcurrent protection

D. The VFD shall provide VFD voltage error protection.
Main overvoltage protection
Main undervoltage protection
DC Bus overvoltage protection
DC Bus pre-charge protection

E. The VFD shall provide VFD Thermal protection.
VFD overtemperature protection
Fan management
Switching frequency management

F. The VFD shall provide motor protection functions
Output phase loss detection
Motor overload detection
Motor stall protection

G. The VFD shall provide application protection functions
Catch on fly function
Motor overspeed input protection
Current limitation
Power limitation
Reverse inhibition
Underload protection
Overload protection
External error management with logging
Loss of follower signal
Thermal sensor management
PID feedback

2.06 Control Interface:

A. The speed command reference shall be selectable from the following sources:
I/O terminals
Communication network
Web server

Remote graphic display terminal

B. A minimum of the following standard inputs/outputs shall be provided to interface with control systems and instrumentation:
   Analog inputs: 3 programmable 0(4)-20 mA or 0-10 Vdc
   Two (2) analog inputs shall also be programmable for temperature sensors (PTC, PT100, PT1000, KTY84)
   Analog outputs: Two (2) programmable 0(4)-20 mA or 0-10 Vdc
   Discrete inputs: 6 programmable isolated logic inputs as either sink or source
   Discrete outputs: 3 programmable relay contacts and 1 open collector output

C. Programmable analog inputs shall be able to be assigned the following parameters at a minimum:
   Speed reference
   Summing reference
   Subtracting reference
   Multiplying reference
   Torque reference
   Torque limitation
   PID feedback
   Manual PID reference
   PID speed reference
   Forced local reference

D. Programmable analog outputs shall be able to be assigned the following parameters at a minimum:
   Motor current
   Motor frequency
   Motor torque (signed or unsigned)
   Motor power
   Motor voltage
   Output frequency (signed or unsigned)

E. Programmable discrete outputs shall be able to be assigned the following parameters at a minimum:
   Ready
   Drive running
   Frequency reference attained
   Drive error
   Frequency threshold attained
   Torque sign
   Output contactor command
   Input contactor command

2.07 Communications

A. The VFD shall provide at minimum one (1) Modbus and one (1) Ethernet Modbus TCP communication port. In addition, the following communications options shall be provided as necessary for communications. Refer to communication requirements specified elsewhere within the Contract Documents. Ethernet IP or Modbus TCP, RJ45 dual port for daisy chain

B. The VFD shall provide an embedded web server for enhanced diagnostic, configuration, parameter access, and energy management. It shall be possible to create a user-defined custom dashboard for viewing VFD and process status through tables, charts, and graphical views. It shall be possible to export data in standard table format using the web server, for information about energy consumption as well as error and warning history.

C. The VFD shall be compliant with the Cyber Security Management ISA Secure / Achilles.

D. VFD communications modules shall be capable of being remotely powered by a separate external 24Vdc to allow for continued communications when the VFD power supply is off.

2.08 Control Functions and Configurations

A. The VFD shall provide a speed set-point function capable of:
Maximum output frequency function
Low and high speed scaling and limitation function
Skip frequencies
Speed summing references
Preset speed references
Up-Down speed references

B. The VFD shall provide a Stop function capable of:
Deceleration ramp on power loss
Freewheel stop
Stop by DC injection at motor stop detection
Stop by DC injection by logic input
Stop on deceleration ramp adaptation

C. The VFD shall have an acceleration/deceleration, time-adjustable ramp function capable of:
Ramp type: linear ramp, S shape ramp, with U or customized profile
Ramp deceleration adaptation
Ramp switching

D. Application programming dedicated to pumps
1. The VFD shall provide pump control and monitoring functions
Pump cyclic start protection in order to protect the pump against in a dedicated time period
Multi-pump function to allow staging of multiple pumps with either contactors or multiple drives without the use of external controllers.

2. The VFD shall provide pump protection functions:
Anti-jam or De-ragging function
Pipe cleaning function start the pump regularly to avoid sedimentation in pump impeller
Cavitation protection
Low inlet pressure protection

3. The VFD shall provide application control functions.
Pulse input for connection to flow meter feedback
Process control (PID) function to maintain a process at a given pressure or flow reference
Friction loss compensation function to compensate pressure losses in pipe

Pipe Fill function for smooth pipe filling and to lessen the affects of water hammer
Sleep wake-up function

4. The VFD shall provide application protection functions.
   High flow protection
   Outlet pressure protection

5. The VFD shall provide pump curve input to help optimize pump performance.
   Input and storage of the pump characteristics including five (5) points of the pump curve.
   A best efficiency point (BEP) function with alarms to indicate deviation from BEP.
   The VFD Supplier shall have Windows-based PC software for configuring and diagnosing the VFD. It shall be possible to set and modify parameters, control the VFD, read actual values, and make trend analysis using the software.

E. The VFD shall provide a real time clock for time stamping detected errors.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install drives under this Division in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

B. Provide power wiring. Wire and terminate connections in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.02 FIELD QUALITY CONTROL

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

B. Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. The Contractor shall conduct performance verification tests in the presence of a customer representative, observing and documenting complete compliance of the system to the specifications.

3.03 TRAINING

A. Training of the Owner’s operation and maintenance personnel is required in cooperation with the Owner and the Contractor. Provide four (4) hours of instruction from competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting for each variant of the installed systems. Schedule instruction with the Owner after submission and approval of formal training agendas by the Contractor.

END OF SECTION

SECTION 266450 - GROUNDING

PART 1 - GENERAL

1.01 GROUNDING:

A. Shall comply with Article 250 of the National Electrical Code and all state and local codes and the requirements of the utility company serving the site.

B. Grounding shall be provided as per these specifications and the approved drawings.

C. The electrical system shall be a grounded wye supplemented with equipment grounding systems. All non-current carrying parts of the electrical system i.e., raceways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in close proximity with electrical circuits, shall be grounded to provide a low impedance path for potential ground faults.

D. The neutral conductor of the 480Y/277 Volt, Three Phase, 4 Wire or the 208Y/120 Volt, Three Phase, 4 Wire or the 120/240 Volt, Single Phase, 3 Wire systems shall be grounded to the ground system as indicated on the drawings. Grounding conductor shall be copper sized in accordance with Table 250.66 of the National Electrical Code and as indicated on the drawings. Conductor shall be installed in PVC Conduit to the ground point connection. Provide and install bonding jumper around all water valves and PRV valves as required.

PART 2 - PRODUCTS

2.01 PRODUCTS:

A. Ground rods shall be 3/4" copperweld sectional rods 10'-0" in length. Top of the ground rod shall be twelve (12) inches below finished grade. Connection to the ground rod shall be made by chemical weld process. Resistance to ground shall not exceed twenty-five (25) ohms.

PART 3 - EXECUTION

3.01 GROUND TEST:

A. Upon completion of the ground rod installation the contractor shall test the system by the "fall of potential" measuring method using a ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested. Placement of the auxiliary electrodes shall be in accordance with operating instructions of the test meter, but in no case, shall be placed within the effective resistance area of the system being tested. The effective resistance area shall be considered twice the ground rod length of the ground rod(s) driven. The test shall not be taken within forty-eight (48) hours of rainfall and shall include the data tested and the lowest reading recorded. Test results shall be forwarded, in writing, immediately to the engineer.

3.02 GROUNDING:

A. Each panelboard shall be provided with a copper or aluminum equipment grounding bar brazed or riveted to the associated enclosures or cabinet and an insulated neutral bar. The related feeder and branch circuit grounding conductors shall be brazed to the grounding bar or connected with pressure connector.

B. A grounding conductor shall be installed in all power and lighting conduit installations. All circuit grounding conductors shall be sized as per Table 250.122 of the National Electrical Code.

C. All motors shall be grounded by drilling and tapping the bottom of the motor junction box and attaching the conductor to the box with a round head bolt used for no other purpose. Conductor attachment shall be through the use of a lug attached to conductor with crimping tool.

END OF SECTION

SECTION 266500 - LIGHTING FIXTURES

PART 1 - GENERAL

1.01 GENERAL:

A. Lighting fixtures shall be selected from those fixtures included in the Lighting Fixture Schedule.

B. Request for fixture substitutions shall be as identified in the Instructions to Bidders and must be accompanied by construction specifications, photometric test data including foot lambert reading, and complete dimensions. Data for exterior lighting luminaries must also contain isocandle curves and average lumen distribution data.

C. Fixtures shall be selected from the Lighting Fixture Schedule not only by catalog number, but with consideration to mounting, number and types of LED's, and reference notes all as contained in the fixture schedule and/or drawings.

D. LED's shall be provided for all fixtures in accordance with Lighting Fixture Schedule and/or manufacturer's recommendations.

E. Verify fixture numbers, before placing order, to assure that fixtures will be furnished with proper frames, fitting and devices for installation in the ceiling system into which it is to be installed.

PART 2 - PRODUCTS

2.01 LED AND DRIVERS:

A. All LED and Drivers shall be as per the Lighting Fixture Schedule and provided for all fixtures as required.

PART 3 - EXECUTION

3.01 MANUFACTURER'S RECOMMENDATIONS:

A. Install all lighting fixtures in accordance with the manufacturer's recommendations, as herein specified, or as indicted on the drawings.

B. Fixtures suspended from ceiling joist shall be hung by means of fixture chain and approved light support supplied by light manufacturer. Two supports are required for each four foot (4') fixture.

C. Surface and wall mounted emergency lights are to be hung as per approved manufacturers methods for each light.

D. Ceiling grids shall not be used for the sole support of recessed, lay-in type fixtures. Each lay-in type, recessed fixture shall be independently supported from the structure by two #12 hanger wires installed on diagonal corners of the fixture.

E. Contractor to provide all additional framing members to mount the fixtures as required. All

miscellaneous metals shall be stainless steel with stainless steel clamps and mounting accessories in the plant area and galvanized steel with galvanized steel clamps and mounting accessories in the non-plant areas.

END OF SECTION

SECTION 26700 - AUXILIARY SYSTEMS

PART 1 - GENERAL

1.1 GENERAL:

A. Provide and install all electrical auxiliary systems as indicated on the drawings and/or specifications. The work shall consist of, but not be limited to, the installation of the following:

1. Empty Conduit Raceway systems for telephone, CATV and computer cabling systems as indicated on the drawings.

2. Complete Fire Alarm System as indicated on the documents, including design for device wiring as per the manufacturer.

1.2 FIRE ALARM SYSTEM:

A. Provide a Silent knight 6700 Fire Alarm System as indicated on the drawings and specified herein. The system shall meet all the requirements as indicated herein before and if any additional devices are required by the Authority Having Jurisdiction, these shall be included into the base bid. The Contractor shall verify that the dB sound requirements are met in all areas of the building with the system installed by the Contractor prior to the bid. System shall be a digital protocol analog addressable, non-coded, audio/visual system, supervised, Class B system and conforming to the requirements of NFPA 101, NFPA #72, ADA Federal Law, State of Georgia Handicap Accessibility Law 120-3-20, State of Georgia Rules and Regulations of the Safety Commissioner 120-3-20 and all State and Local Codes. The system is based on equipment by Silent Knight and is to be provided by the local authorized distributor for the geographical area. The system shall be complete, including the required wiring for the installation of all of the system components.

B. This system shall provide for, but not limited to, the activation of any system alarm initiating device shall cause the following:

1. Cause the activation to sound at all fire alarm audio/visual appliances until the system has been silenced or restored to normal.

2. Identify the type of alarm, specific device and location on a backlit LCD display at the FACP and the remote annunciator.

3. Cause the system alarm LED to flash at the FACP and remote annunciator.

4. Cause all visual signal appliances to flash until the system has been silenced or restored to normal.

5. All required programming of the new panel shall be included in the required system programming by the Contractor.

6. Activate relays to shut down air handlers (RTU’s) and the make-up air fan (MAU’s) as indicated on the drawings.

C. Activation of any system trouble signal shall automatically:

1. Identify the trouble condition, specific device, and location on the backlit LCD display at the system control panel and all remote annunciator.

2. Cause the system trouble LED to flash and an audible indicator to sound at the control panel and all remote annunciator.

D. Activation of any sprinkler system flow or tamper switch shall automatically:

1. Identify the type of supervisory alarm, specific device and location on a backlit LCD display at the FACP and all remote annunciator.

2. Cause the system supervisory alarm LED to flash at the FACP.

E. Operation of the alarm acknowledge switch at the Fire Alarm Control Panel or Remote Annunciator shall permit the silencing of the alarm signals during the alarm condition. The silencing of the alarm signals shall not prevent the resounding of the alarm devices should a subsequent alarm condition occur.

F. Provide a complete Fire Alarm One-Line Diagram with the Fire Alarm Submittals indicating all devices, wiring to each and all conduit sizes, if required, as required. The One-Line Diagram shall be approved by the Authority having Jurisdiction prior to submittal to the Engineer.

PART 2 - PRODUCTS

2.1 EMPTY RACEWAY SYSTEMS:

A. Conduits, boxes and cover plates shall be as specified and located as shown on the drawings.

2.2 FIRE ALARM SYSTEM:

A. The complete system shall be provided as per these specifications and Contract Drawings. The system is by Silent Knight or approved equal as indicated above and shall include, but not limited to, the following components:

1. Fire Alarm Control Analog Addressable Panel – Silent Knight 6700 analog addressable fire alarm control panel with alphanumeric display, analog addressable loop, notification appliance circuits, require battery utilizing sealed maintenance free batteries for twenty-four (24) hours standby followed by ten (10) minutes alarm. Provide all required power supplies or power modules as required. Provide with digital/IP communicator module in the FACP. The system shall be for operation on a 120 volt, single phase power system. Provide and install in separate enclosure a surge suppressor onto the power input to be Ditek #DTK-120-HW.

2. Remote Annunciator – Silent Knight 5860 Annunciator with Fire Drill Key Switch.

3. Addressable Manual Stations – Silent Knight Model PS-DATK Addressable Manual Stations. Pull stations shall be dual action. Provide spacer where manual pull stations are surfaced mounted.

4. Addressable Smoke Detectors – Silent Knight Model SK-PHOTO Addressable Photoelectric Smoke Detectors with Standard Twist-lock Base.

5. Duct Mount Smoke Detectors – Silent Knight Model DNR with SK-PHOTOR and SK-RELAY Addressable Photoelectric Smoke Detectors with Sampling Tubes. Contractor to verify and provide the correct lengths of sampling tubes as required for the project. Provide ceiling mounted remote indicator with test switch below the duct detector. Label the remote indicator with the identification number of the unit the detector serves and with the system address of the duct detector with permanent marker in block letters.

6. Heat Detectors – Silent Knight Model SK-HEAT Addressable Heat Detectors with Standard Twist-lock Base.

7. Addressable Monitor Modules – Silent Knight Addressable Monitor Modules as required to monitor sprinkler flow switches, sprinkler valve tamper supervisory switches, fire pump signals and other non-addressable equipment.

8. Wall Mounted Audio/Visual Alarm Signals – Shall be Silent Knight Audio / Strobe Alarm Signals (selectable 15, 30, 75 or 110 cd output). All Strobes to be set at 110 cd.

9. Ceiling Mounted Audio/Visual Alarm Signals – Shall be Silent Knight Audio / Strobe Alarm Signals (selectable 15, 30, 75 or 110 cd output). All Strobes to be set at 110 cd.

10. Wall Mounted Visual units shall be Silent Knight with Selectable candela signal, set at 110 candela initially.

11. Ceiling Mounted Visual units shall be Silent Knight with selectable candela signal, set at 110 candela initially.

12. Provide and install surge suppressors for all cables running into or out of the Fire Alarm Control Panel, Fire Alarm Circuit Extender Panel and on all circuits that are extended outside the building either underground or overhead between buildings and to PIV tamper switches. Surge suppressors shall be Ditek DTK-2MHLP-24B with Base installed at both ends of the cables as required. Each shall be installed in their own enclosure and not in the Fire Alarm Panels. If installed in the ceiling, the location shall be identified on the ceiling grid below the surge suppressor with a lime green adhesive dot with label indicating the device above. All surge suppressors shall be located on the record drawings as required by 16700 3.01 E below.

13. Provide all required Power Extender / Amplifier Extender Panels as needed for a complete installation. Provide and install in separate enclosure a surge suppressor onto the power input to be Ditek #DTK-120-HW

14. All interior surface mounted back boxes shall be non-metallic type, no metal handy boxes or boxes with knockouts will be allowed.

15. Heavy Duty Power Relays shall have 24 VCD coil, 20 Amp rated contacts and be compatible with the FACP.

PART 3 - EXECUTION

3.1 EMPTY RACEWAY SYSTEMS:

A. The contractor shall install all telephone equipment as per these specifications and the requirements of the local telephone company.

3.2 FIRE ALARM INSTALLATION:

A. The contractor shall color code and install all wiring in accordance with state and local codes and the requirements of the Manufacturer. All wiring shall be concealed plenum rated cables in the Office Area and in conduit in the Plant Areas, unless otherwise noted on the drawings, sized and routed by the Contractor/Vendor. Provide Shop Drawings as herein before indicated for wiring and conduit sizes.

1. All wiring and cable installed exposed in a space, concealed inside a wall, concealed above a non-accessible ceiling or underground outside the building shall be installed in conduit, sized for the number of cables. All line voltage wiring shall be installed in conduits. All low voltage wiring installed above accessible ceilings may be installed without conduit by using cable with a jacket which is U.L. listed for installation in a return air plenum.

B. The installation of the Fire Alarm System components, wiring, etc. shall be installed by a Fire Alarm Contractor whose installers have a minimum of a Level II NICET certification. No work is to be installed by the Electrical Contractor unless he meets the above requirement. A copy of the Fire Alarm System Installer's Level II Certification will be provided to the Owner prior to the commencement of the installation of the Fire Alarm System. The Fire Alarm System shall be installed in accordance with the Manufacturer's Specifications and the approved submittal documents.

1. Plenum cable shall pass through fire rated walls by drilling a hole in the wall and installing a conduit with bushings on each end through the wall. Install the cable through the conduit and then seal the opening around the conduit and the hole in the conduit with a U.L. listed fire rated sealant.

2. All plenum rated cable used for the Fire Alarm system shall have a red outer jacket. All cable ties shall be plenum rated.

3. All wiring leaving the envelope of the building shall be in conduit and be #12 AWG stranded copper conductors with 600 Volt rated Type THHN/THWN wiring as hereinbefore specified. The wire shall transition back to plenum once inside the envelope of the building.

C. After the completion of the installation, the Contractor shall test the entire system in accordance with NFPA 72 and the local Authority Having Jurisdiction to certify compliance as required. Provide the Owner with a Certificate indicating the system is in compliance with the Documents.

D. The Contractor shall label each device (initiating, signaling and circuit) with a permanent marker using a minimum of ¼" block lettering with the devices' associated address either the device base or frame or housing or on the connection junction box such that the label can be seen without removing any cover.

E. The manufacturer's authorized representative shall provide supervision of final system panel connections, perform a complete functional test of the system and submit a written report to the contractor attesting to the proper operation of the system.

F. Perform all tests necessary to meet the requirements of the local authorities having jurisdiction.

G. Upon completion of the installation, the contractor shall provide to the Owner a copy of the manufacturer's written report along with a signed written statement attesting that all system equipment was installed in accordance with these specifications and in accordance with wiring diagrams, instructions and directions provided to the contractor by the manufacturer.

H. All Fire Alarm Extender Panels must be installed no less than two (2) feet, but no more than five (5) feet from the floor.

I. The equipment manufacturer shall be registered as ISO 9001.

J. The Contractor shall have either a Low Voltage – Alarm or Low Voltage – Unrestricted license in the State of Georgia and be in good standing with the State. The person who has this license must be on site each day that the work is being performed. The Contractor shall have a current “System Supplier’s Training Certificate” issued by the equipment manufacturer of the system being provided. The Contractor shall have a minimum of ten (10) years in business and have a current business license in the County where the business is located and provide a copy to the Owner at the Shop Drawing Submittal portion of the project.

END OF SECTION

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SECTION 281000 - ACCESS CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Access control system requirements.

B. Access control point peripherals, including readers and keypads.

C. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 087100 - Door Hardware: Electrically operated door hardware, for interface with access control system.

B. Section 266450 - Grounding.

C. Section 266400 - Electrical Service and Distribution Equipment.

D. Section 266010 - Electrical General Requirements.

E. Section 266100 - Basic Materials and Methods

F. Section 266700 - Auxilary Systems.

G. Section 282000 - Video Surveillance: For interface with access control system.

H. Section 283111 - Building Intrusion Detection: For interface with access control system.

I. Section 284600 - Fire Detection and Alarm: For interface with access control system.

1.3 REFERENCE STANDARDS

A. NDAA - National Defense Authorization Act

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other installers to provide suitable door hardware as required for both access control functionality and code compliance.

2. Coordinate the placement of readers with millwork, furniture, equipment, etc. installed under other sections or by others.

3. Coordinate the work with other installers to provide power for equipment at required locations.

4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Access Control Cloud Services:

1. Subscription fees to be paid by Owner.

2. Obtain Owner approval of subscription fees and terms of service prior to submittal.

C. Preinstallation Meetings:

1. Conduct meeting with Owner and Engineer to review reader and equipment locations.

2. Conduct meeting with Owner and Engineer and other related equipment manufacturers to discuss access control system interface requirements.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements and mountings. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Certify that proposed system design and components meet or exceed specified requirements.

E. Evidence of qualifications for manufacturer.

F. Evidence of qualifications for installer.

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

H. Manufacturer’s detailed field testing procedures.

I. Field quality control test reports.

J. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

K. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

L. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.

2. NDAA

3. The requirements of the local authorities having jurisdiction.

4. Applicable TIA/EIA standards.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum three year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Access Control Units - Basis of Design: Honeywell, as indicated under product description below.

B. Access Control Units - Other Acceptable Manufacturers:

1. Honeywell International, Inc;www.honeywellaccess.com/#sle.
2. Bosch Security Systems; www.boschsecurity.us/#sle.
3. Stanley Security Solutions, Inc; https://www.stanleysecuritysolutions.com/.
4. Substitutions: See Section 016000 - Product Requirements.

C. Readers and Keypads - Basis of Design: Honeywell OmniClass 2.0 Contactless Smart Reader..

1. Card readers shall be "single-package" type, combining controller, electronics and antenna in one package.
2. Card readers shall read card serial number (CSN) of a MIFRAE card with configurable outputs as 26-bit, 32-bit, 34-bit, 40-bit, or 60-bit.
3. The reader shall be of potted, polycarbonate material, sealed to a NEMA rating of 4X (IP65).
4. The reader shall meet the following environmental specifications:
    a. Operating temperature: -30 to 150 degrees F.
    b. Operating humidity: 5% to 90% relative humidity non-condensing.
    c. Weatherized design suitable to withstand harsh environments.
5. The reader shall meet the following electrical specifications:
    a. Operating voltage: 10-16 VDC, reverse voltage protected
    b. Current requirements: (average/peak) 78/234mA @ 12 VDC

D. Contractor to furnish all required access control panels to ensure full connectivity within security system.

1. Basis of Design Product: Honeywell MPA2 Panel

E. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

F. Source Limitations:

1. Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.
2. Manufacturer must have a US based Vendor company.
3. The combined system must be built by a US based company. Premade systems are not acceptable.
4. Access Control hardware cannot be manufactured in China or Russia.

2.2 ACCESS CONTROL SYSTEM REQUIREMENTS

A. Provide new access control system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Access Control Points:

1. All Doors with Exterior Egress:

a. Function: Operational and emergency.
b. Access: Controlled entry, free exit.
c. Peripherals on Secure Side:
1) Reader: Contactless smart card reader.
2) Alarm sounder.
d. Locking Device: Magnetic lock.
1) Configuration: Fail-secure.
e. Interface Requirements:
1) Provide interface with fire alarm system to release door lock upon alarm.

2. Driveway Gates:
a. Access: Controlled entry, free exit.
b. Peripherals on Secure Side:
1) Reader: Contactless smart card reader with remote access..

C. Interface with Other Systems:
1. Provide products compatible with other systems requiring interface with access control system.
2. Interface with intrusion detection system as specified in Section 283111.
3. Interface with video surveillance system as specified in Section 282000.
4. Interface with fire alarm system as specified in Section 284600.

2.3 ACCESS CONTROL POINT PERIPHERALS

A. Provide devices compatible with control units and software.
B. Provide devices suitable for operation under the service conditions at the installed location.
C. Readers:
1. General Requirements:
a. Color: To be selected by Owner from manufacturer's available standard colors..
b. Contactless Smart Card Readers:
1) Utilize 64 bit authentication keys.
2) Support ISO compliant credentials.
3) Support data encryption.

D. Door Locking Devices (Electric Strikes and Magnetic Locks): Comply with Section 087100.
E. Alarm Sounders:
1. Minimum Sound Output: 85 db.

2.4 ACCESSORIES

A. Provide components as indicated or as required for connection of access control system to devices and other systems indicated.
B. Unless otherwise indicated, network switches required for network connections to system components to be provided by Contractor.
C. Provide cables as indicated or as required for connections between system components.
D. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install access control system in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Wiring Method: Unless otherwise indicated, use wiring in conduit.

1. Use suitable listed cables in wet locations, including underground raceways.
2. Use suitable listed cables for vertical riser applications.
3. Conduit: Comply with Section 260533.13.
4. Use power transfer hinges complying with Section 087100 for concealed connections to door hardware.
5. Do not exceed manufacturer's recommended maximum cable length between components.

D. Provide grounding and bonding in accordance with Section 260526.

E. Identify system wiring and components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Prepare and start system in accordance with manufacturer's instructions.

D. Program system parameters according to requirements of Owner.

E. Test for proper interface with other systems.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

3.6 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.7 MAINTENANCE

A. See Section 017000 - Execution, for additional requirements relating to maintenance service.

END OF SECTION

SECTION 282000 - VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Video surveillance system requirements.

B. Video recording and viewing equipment.

C. Cameras.

D. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 266010 - Electrical General Requirements.

B. Section 266100 - Basic Materials and Methods

C. Section 266400 - Electrical Service and Distribution Equipment.

D. Section 266450 - Grounding.

E. Section 266700 - Auxilary Systems.

F. Section 281000 - Access Control: For interface with video surveillance system.

G. Section 283111 - Building Intrusion Detection: For interface with video surveillance system.

1.3 REFERENCE STANDARDS

A. NDAA - National Defense Authorization Act.

B. 47 CFR 15 - Radio Frequency Devices current edition.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

D. NECA 303 - Standard for Installing Closed-Circuit Television (CCTV) Systems 2005.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.

2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.

3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:

1. Conduct meeting with Owner and Engineer to review camera and equipment locations and camera field of view objectives.

2. Conduct meeting with Owner and Engineer and other related equipment manufacturers to discuss video surveillance system interface requirements.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions,

finishes, service condition requirements, and installed features.

D. Design Data:

1. Video storage capacity calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Evidence of qualifications for installer.

G. Evidence of qualifications for maintenance contractor (if different entity from installer).

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

I. Manufacturer’s detailed field testing procedures.

J. Field quality control test reports.

K. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

M. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70.

2. NDAA

3. Applicable TIA/EIA standards.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum three year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Video Recording and Viewing Equipment - Basis of Design: Honeywell International, Inc. as listed below.

B. Video Recording and Viewing Equipment - Other Acceptable Manufacturers:

1. Honeywell International, Inc; www.honeywellvideo.com/#sle.
2. Bosch Security Systems www.boschsecurity.us/#sle.
3. Stanley Security Solutions, Inc; https://www.stanleysecuritysolutions.com.

C. Cameras:

1. Honeywell International, Inc: www.honeywellvideo.com/#sle.
2. Bosch Security Systems: www.boschsecurity.us/#sle.
3. Stanley Security Solutions, Inc: https://www.stanleysecuritysolutions.com.

D. Substitutions: See Section 016000 - Product Requirements.

E. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

F. Source Limitations:

1. Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.
2. Manufacturer must have US based vendor company.
3. The combined system must be built by a US based company. Premade systems are not acceptable.
4. All provided products must meet NDAA compliance.

2.2 VIDEO SURVEILLANCE SYSTEM

A. Provide new video surveillance system consisting of all required equipment, conduit, boxes, panels, wiring, connectors, hardware, supports, accessories, software, system programming, network video recorders, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description: IP system with connection to network (IP) cameras.

1. Video Storage Capacity: Suitable for storing video from all cameras for 3 days.

C. Cameras Required:

1. Bullet Cameras:
    a. Basis of Design Product: Honeywell HC30WB5R1
    b. Bullet cameras shall meet the following environmental conditions:
        1) Operating temperature: -40-140 degrees F
        2) Operating humidity: 90% relative humidity
    c. Bullet cameras shall meet the following electrical specifications:
        1) Power supply: 12 VDC / 24 VAC (50/60 Hz)
    d. Location: See Electrical Drawings.
    e. Lens Type: Furnished with camera.
    f. Angle of view: 100°~30°, Vertical: 72°~23°
    g. 5 Megapixels.

h. Accessories:
1) Mounting bracket.
2) Pole mount adapter.
3) Waterproof housing.

2. Dome Cameras:
a. Basis of Design Products: Honeywell HC30W45R3
1) Dome cameras shall meet the following environmental specifications:
(a) Operating temperature: 32-140 degrees F.
(b) Humidity: 90% relative humidity.
2) Dome cameras shall meet the following electrical specifications:
(a) Power supply: 12 VDC / 24 VAC (50/60 Hz)
b. Location: See Exhibit C: Camera Locations.
c. Lens Type: Furnished with camera.
d. Angle of View: Horizontal: 100°~30°, Vertical: 72°~23°
e. Accessories:
1) Mounting bracket.
2) Pole mount adapter.
3) Waterproof housing.

D. Video Recording and Viewing Equipment Required:
1. See article "VIDEO RECORDING AND VIEWING EQUIPMENT" below for product descriptions.
2. Fire Vault Room.
a. Network Video Recorder (NVR)

E. Interface with Other Systems:
1. Interface with access control system as specified in Section 281000.
a. Capable of affecting camera/video operation for selected access control system events.
2. Interface with intrusion detection system as specified in Section 283111.
a. Capable of affecting camera/video operation for selected intrusion detection system events.
b. Capable of affecting intrusion detection system status for selected video surveillance system events.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.

G. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.3 VIDEO RECORDING AND VIEWING EQUIPMENT

A. Provide video recording and viewing equipment compatible with cameras to be connected.

B. Network Video Recorders (NVRs):
1. Supports connection of network (IP) cameras.
2. Supports continuous and event-based recording.

C. Software:

1. Unless otherwise indicated, provide all software and licenses required for fully operational system.

D. Monitors:

1. Unless otherwise indicated, monitors to be provided by Contractor as part of work of this section.
2. Monitor: 36 inch TFT active-matrix LCD.
    a. Resolution: Up to 1280 x 1024 (SXGA).

2.4 CAMERAS

A. Provide cameras and associated accessories suitable for operation under the service conditions at the installed location. Provide additional components (e.g. enclosures, heaters, blowers, etc.) as required.

B. Where not factory-installed, provide additional components (e.g. lenses, mounting accessories, etc.) as necessary for complete installation.

C. Network (IP) Cameras:

1. Signal-to-Noise Ratio: Not less than 50 dB.
2. Provide the following standard features:
    a. Automatic electronic shutter.
    b. Automatic gain control.
    c. Automatic white balance.
    d. Web-based interface for remote viewing and setup.
    e. Password protected security access.

D. Camera Enclosures and Mounting Brackets:

1. Where not factory-installed, provide accessory camera enclosures suitable for operation under the service conditions at the installed location.
2. Where not factory-installed, provide accessory camera mounting brackets necessary for installation.

2.5 ACCESSORIES

A. Provide components as indicated or as required for connection of video surveillance system to devices and other systems indicated.

B. Provide components as indicated or as required for system power and network connections.

C. Provide cables as indicated or as required for connections between system components.

D. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system where applicable.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.

B. Install products in accordance with manufacturer's instructions.

C. Provide required support and attachment in accordance with Section 260529.

D. Identify system wiring and components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Prepare and start system in accordance with manufacturer's instructions.

C. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.

D. Program system parameters according to requirements of Owner.

E. Test for proper interface with other systems.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

3.6 PROTECTION

A. Protect installed system components from subsequent construction operations.

3.7 MAINTENANCE

A. Conduct site visit at least once every three months for a period of two years to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

END OF SECTION

SECTION 283111 - BUILDING INTRUSION DETECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Intrusion detection system requirements.

B. Alarm control unit.

C. Keypads.

D. Initiating devices.

E. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 087100 - Door Hardware: Electrically operated locks and door holder devices to be monitored and controlled by intrusion detection system.

B. Section 266450 - Grounding.

C. Section 266400 - Electrical Service and Distribution Equipment.

D. Section 266010 - Electrical General Requirements.

E. Section 266100 - Basic Materials and Methods.

F. Section 266700 - Auxilary Systems.

G. Section 281000 - Access Control: For interface with intrusion detection system.

H. Section 282000 - Video Surveillance: For interface with intrusion detection system.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compatibility of devices for the installed locations with work provided under other sections or by others.

2. Coordinate the placement of sensors and keypads with millwork, furniture, equipment, etc. installed under other sections or by others.

3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install building intrusion detection equipment until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

C. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

D. Certify that proposed system design and components meet or exceed specified requirements.

E. Evidence of qualifications for installer.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

G. Manufacturer’s detailed field testing procedures.

H. Field quality control test reports.

I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

J. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.

2. Extra Fuses: Two for each type and size installed.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience with intrusion detection systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized representative of control unit manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum three year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 GENERAL

A. Source Limitations:

1. Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.

2. Manufacturer must have a US based Vendor company.

3. The combined system must be built by a US based company. Premade systems are not acceptable.

4. Intrusion Detection products cannot be manufactured in China or Russia.

2.2 INTRUSION DETECTION SYSTEM REQUIREMENTS

A. Provide new intrusion detection system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Alarm Control Unit: New addressable alarm control panel located in coordination with Owner.

C. Keypads: Located as directed by Owner

D. Interface with Other Systems:

1. Provide products compatible with other systems requiring interface with intrusion detection system.

E. Provide products listed, classified, and labeled as suitable for the purpose intended.

F. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.3 ALARM CONTROL UNIT

A. Manufacturers:

1. Addressable Alarm Control Panel - Basis of Design: Honeywell International, Inc. as stated below.

2. Addressable Alarm Control Panel - Other Acceptable Manufacturers:

a. Honeywell International, Inc; www.security.honeywell.com/#sle.

b. Bosch Security Systems; www.boschsecurity.us/#sle.

c. Stanley Security Solutions, Inc; https://www.stanleysecuritysolutions.com.

B. Alarm Control Panel: Modular construction.

1. Enclosure: Lockable; provide tamper protection.

2. Power Supply:

a. Primary Power: 120 VAC; provide suitable transformer/power supply; supervised for loss of AC power.

C. Communications Interfaces: Supervised.

1. Supports system reporting to central station receivers via integral interface or accessory interface modules using:

a. Telephone lines.

D. Keypads: Supervised.

E. Peripheral Devices: Supervised; provide tamper protection.

F. Output Relays:

1. Relay Modules: Form C relays (normally open and normally closed); provide tamper protection.

2. Programmable to respond to system events, according to defined scheduling, or by manual activation from keypad.

G. User Codes:

1. Each user code to be individually assignable to any defined authority level for configurable access to system features and functions.

H. Scheduling:

1. Provide time/calendar-based scheduling capability for automated system control.

2. Supports open/close schedules for control of arming/disarming and reporting.

3. Supports timed events including, but not limited to:

a. Point bypass/unbypass.

b. Relay activate/deactivate.

I. Event Log:

1. Stores system events including time, date, partition, zone, and user code where applicable.
2. Supports viewing of event log on keypads.

2.4 KEYPADS

A. Manufacturer: Same as manufacturer of alarm control unit.

B. Provides interface to alarm control unit for system control and remote annunciation.

C. Provides visual notification of system status and zone information.

D. Provides audible notification to indicate system status, entry/exit delay, and alarm situations; provide separate distinguishable sounds for alarm and trouble conditions.

2.5 INITIATING DEVICES

A. Manufacturers: Same as manufacturer of alarm control units where possible.

B. General Requirements:

1. Provide devices suitable for intended application and location to be installed.
2. Outdoor Units: Weather resistant, suitable for outdoor use.
3. Addressable Systems:
   a. Addressable Devices: Individually identifiable by control unit.
   b. Provide suitable addressable modules for connection to conventional (non-addressable) devices and other components that provide a dry closure output.

2.6 ACCESSORIES

A. Provide components as indicated or as required for connection of alarm control unit to devices and other systems indicated.

B. Provide cables as indicated or as required for connections between system components.

C. Provide end-of-line resistors (EOLR) as required for supervision of hardwired zones.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Provide grounding and bonding in accordance with Section 260526.

D. Identify system wiring and components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Prepare and start system in accordance with manufacturer's instructions.

C. Inspection and testing to include, at a minimum:

1. Test each initiating device for proper response by alarm control unit.

2. Test for proper operation of output relays.
3. Test for proper interface with other systems.

D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.4 ADJUSTING

A. Program system parameters according to requirements of Owner.

3.5 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

3.7 PROTECTION

A. Protect installed system components from subsequent construction operations.

END OF SECTION

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SECTION 311000 - SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Clearing and protection of vegetation.

B. Removal of existing debris.

1.2 RELATED REQUIREMENTS

A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.

B. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

C. Section 015630 - Temporary Erosion and Sediment Control.

D. Section 017000 - Execution: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.

E. Section 017419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

F. Section 024100 - Demolition: Removal of built elements and utilities.

G. Section 312200 - Grading: Topsoil removal.

H. Section 312200 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

I. Section 312323 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.

J. Section 329300 - Plants: Pruning of existing trees to remain.

1.3 SUMMARY

A. Includes:

1. Protection of existing vegetation to remain.
2. Removal of existing vegetation.
3. Clearing and Grubbing.
4. Stripping and stockpiling soil and rock.
5. Removing of existing above and below grade site improvements.
6. Disconnecting, capping, sealing, grouting, and, removing, abandoning in-place site utilities.

1.4 DEFINITIONS

A. Clearing is defined as the removal of trees, brush, down timber, rotten wood, rubbish, any other vegetation, and other material at or above ground elevation not designated to be saved. Clearing also includes removal and replacement of fences, walls, guideposts, guide rail, signs, and other obstructions interfering with the proposed work.

B. Grubbing is defined as the removal from below the surface of natural ground of stumps, roots and stubs, brush, topsoils, organic materials and debris.

C. Plant Protection Zone is the area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and identified on the drawings.

D. Structures includes buildings or portions thereof, walls, silos, storm or root cellars, cisterns, wells, windmills, pit silos, water towers, etc. Structures shall be removed or filled to the ground surface.

E. Subsoil is defined as the soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typically with less than 1 percent organic matter and few soil organisms.

F. Surface Soil is the soil that is present at the top layer of an existing soil profile. In areas previously undisturbed this surface soil is typically referred to as "topsoil". In urban environments and areas where disturbance has occurred the surface soil can be subsoil.

G. Topsoil is the top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soils; the zone where plant roots grow.

H. Tree Protection Zone is the area surrounding individual or groups of trees to be protected during construction (and indicated on the drawings).

I. Trees, the line of demarcation between brush and trees, for the purpose of distinguishing clearing requirements, is that trees, as used, will be considered as that woody growth not falling within the limits of brush as defined below.

J. Brush is that growth which is less than 2 inches in diameter measured 6 inches from the ground on the uphill side and is less than 6 feet in height measured from the ground on the uphill side.

K. Vegetation is defined as trees, shrubs, groundcover, grass, and other plants.

1.5 PREINSTALLATION CONFERENCE

A. Conduct the Preinstallation conference at the Project Site after all staking and Temporary Measures have been installed.

1.6 MATERIALS OWNERSHIP

A. The material cleared from the areas shall become the Contractors' property and shall be completely removed by transporting from the Owner's Project Site, excluding materials indicated to be removed and relocated or be stockpiled.

1.7 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Site Plan: Showing:

1. Vegetation removal limits.

2. Areas for temporary construction and field offices.

C. Record Drawings:

1. Shall accurately reflect the location of capped utilities, below grade structural components, and existing utilities to remain, encountered during site clearing operations within the limits of disturbance.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fill Material: As specified in Section 312323 - Fill

PART 3 EXECUTION

3.1 SITE CLEARING

A. Comply with other requirements specified in Section 017000.

B. Protect survey control points and temporary bench marks from site clearing activities. Maintain these locations throughout site clearing activities.

C. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

D. Erosion and Sedimentation control measures are to be installed prior to commencing any site clearing.

E. Soil stripping activities will only be performed when the soil is dry or slightly moist.

3.2 EXISTING UTILITIES AND BUILT ELEMENTS

A. Comply with State law regarding Utility Locator Service: Notify GA 811 for area where Project is located prior to site clearing.

B. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

C. Protect existing utilities to remain from damage.

D. Do not disrupt public utilities without permit from authority having jurisdiction.

1. The Contractor will locate, identify, disconnect, isolate, cap, and seal utilities identified for removal and abandonment in-place.

2. Do not proceed with any activities that will interrupt existing utility services without written permission from the Owner.

E. Protect existing structures and other elements that are not to be removed.

1. Contractor will be responsible for restoring existing structures and other elements to their pre-construction condition and to the Owner's satisfaction.

3.3 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.

B. Protect those plants and trees identified to remain on site prior to commencing site clearing.

C. Do not begin clearing until vegetation to be relocated has been removed.

D. Do not remove or damage vegetation beyond the limits indicated on drawings.

1. 40 feet (12 m) outside the building perimeter.

2. 10 feet (3.1 m) each side of surface walkways, patios, surface parking, and utility lines less than 12 inches (305 mm) in diameter.

3. 15 feet (4.6 m) each side of roadway curbs and main utility trenches.

4. 25 feet (7.5 m) outside perimeter of pervious paving areas that must not be compacted by construction traffic.

5. Exception: Specific trees and vegetation indicated on drawings to be removed.

6. Exception: Selective thinning of undergrowth specified elsewhere.

E. Install substantial, highly visible fences at least 3 feet high (at least 1 m high) to prevent inadvertent damage to vegetation to remain:

1. At vegetation removal limits.

2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.

3. Around other vegetation to remain within vegetation removal limits.

4. See Section 015000 for fence construction requirements.

F. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

G. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated. Removed material shall become the Contactor's property and shall be disposed of in accordance with local and State laws.

1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.

2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).

3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).

4. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.

H. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

I. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner

3.4 DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 312200 - GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of topsoil.

B. Rough grading the site for site structures.

C. Finish grading.

D. Preparation of subgrades for slabs, walks, pavement, turf, grasses and plantings.

E. Grading and backfill for buildings and structures.

F. Subbase course for concrete walks, pavement.

1.2 RELATED REQUIREMENTS

A. Section 311000 - Site Clearing.

B. Section 312316 - Excavation.

C. Section 312316.13 - Trenching: Trenching and backfilling for utilities.

D. Section 312316.26 - Rock Removal.

E. Section 312323 - Fill: Filling and compaction.

F. Section 329219 - Seeding: Finish ground cover.

G. Section 329300 - Plants: Topsoil in beds and pits.

1.3 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil: See Section 312323.

B. Other Fill Materials: See Section 312323.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

B. Verify the absence of standing or ponding water.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect from damage above- and below-grade utilities to remain.

D. Notify utility company to remove and relocate utilities.

E. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.

F. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

G. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.

H. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.3 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil , unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. See Section 312323 for filling procedures.

G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.

H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

I. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

J. Grade to direct water away from buildings and to prevent ponding.

3.4 SOIL REMOVAL

A. Stockpile topsoil to be re-used on site; remove remainder from site.

B. Stockpile subsoil to be re-used on site; remove remainder from site.

C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet (2.5 m); protect from erosion.

3.5 FINISH GRADING

A. Grade surface to be free of unnecessary and irregular elevation changes. Compact as required. Grade to indicated features such as cross sections, elevations, and lines.

1. Cut peaks and fill low points unless shown otherwise.

2. Transition smoothly between existing and new finished grades.

B. Before Finish Grading:

1. Verify building and trench backfilling have been inspected.

2. Verify subgrade has been contoured and compacted.

C. Remove debris, roots, branches, stones, in excess of 1/2 inch (13 mm) in size. Remove soil contaminated with petroleum products.

D. Where topsoil is to be placed, scarify surface to depth of 3 inches (75 mm).

E. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches (75 mm).

F. Place topsoil in areas indicated.

G. Place topsoil where required to level finish grade.

H. Place topsoil to the following compacted thicknesses:

1. Areas to be Seeded with Grass: 6 inches (150 mm).

2. Areas to be Sodded: 4 inches (100 mm).

3. Shrub Beds: 18 inches (450 mm).

4. Flower Beds: 12 inches (300 mm).

5. Planter Boxes: To within 3 inches (75 mm) of box rim.

I. Place topsoil during dry weather.

J. Remove roots, weeds, rocks, and foreign material while spreading.

K. Near plants spread topsoil manually to prevent damage.

L. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

M. Lightly compact placed topsoil.

N. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) (30 mm) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch) (13 mm).

3.7 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Engineer as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.8 FIELD QUALITY CONTROL

A. See Section 312323 for compaction density testing.

B. Protection of graded areas:

1. Contractor to protect graded areas from foot traffic, roadway traffic, erosion, trash, and extreme temperatures.

2. Repair and recompact eroded and settled surfaces to match surface provided by Engineer .

3. If the surface settles, backfill with satisfactory soils, recompact, and regrade surface to match surface provided by Engineer .

3.9 CLEANING

A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

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SECTION 312316 - EXCAVATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, site structures, and utilities within the building.

B. Trenching for utilities outside the building to utility main connections.

C. Temporary excavation support and protection systems.

D. Dewatering within excavations and trenches.

1.2 RELATED REQUIREMENTS

A. Section 015630 - Temporary Erosion and Sediment Control: Slope protection and erosion control.

B. Section 017000 - Execution: Project conditions; protection of bench marks, survey control points, and existing construction to remain.

C. Section 024100 - Demolition: Shoring and underpinning existing structures.

D. Section 210553 - Identification for Fire Suppression Piping and Equipment: Underground warning tapes at underground fire suppression lines.

E. Section 220553 - Identification for Plumbing Piping and Equipment: Underground warning tapes at underground plumbing lines.

F. Section 230553 - Identification for HVAC Piping and Equipment: Underground warning tapes at underground HVAC lines.

G. Section 260553 - Identification for Electrical Systems: Underground warning tapes at underground electrical lines.

H. Section 311000 - Site Clearing: Vegetation and existing debris removal.

I. Section 312200 - Grading: Grading and soil removal from surface of site.

J. Section 312316.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

K. Section 312316.26 - Rock Removal: Removal of rock during excavating.

L. Section 312323 - Fill: Fill materials, backfilling, and compacting.

M. Section 313700 - Riprap.

N. Section 334100 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.

1.3 REFERENCE STANDARDS

A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards current edition.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Temporary Support and Excavation Protection Plan.

C. Project Record Documents: Record drawings at project closeout according to 017000 - Execution. Show locations of installed support materials left in place, including referenced locations and depths, on drawings.

D. Shoring Installer's Qualification Statement.

E. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

1.5 QUALITY ASSURANCE

A. Temporary Support and Excavation Protection Plan:

1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
2. Include drawings and calculations for bracing and shoring.
3. Bracing and shoring design to meet requirements of OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

B. Designer Qualifications: For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Geotechnical Testing Agency must be qualified according to ASTM E329 and ASTM D3740 for indicated testing.

D. Proof-rolling:

1. Proof-roll subgrade using a pneumatic-tired, 15-ton, dump truck to determine if soft spots are present. Proof-roll in a perpendicular pattern such that the truck moves in one direction first, and then perpendicular to that direction.
2. Backfill and compact problematic spots determined by proof-roll.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bedding and Fill to Correct Over-Excavation:

1. See Section 312323 for bedding and corrective fill materials at general excavations.
2. See Section 312316.13 for bedding and corrective fill materials at utility trenches.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.

C. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by Engineer. If the proposed excavation extends more than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 311000 for clearing, grubbing, and removal of existing debris.

C. See Section 312200 for topsoil removal.

D. Locate, identify, and protect utilities that remain and protect from damage.

E. Notify utility company to remove and relocate utilities.

F. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

G. Protect plants, lawns, rock outcroppings, and other features to remain.

H. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Engineer.

I. See Sections 017000 and 024100 for underpinning and shoring of adjacent structures that could be damaged by excavating work.

J. Maintain necessary erosion and sediment controls.

K. Maintain integrity of subgrade soils from extreme temperatures.

3.3 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

1. Excavations in stable rock or in less than 5 feet (1.5 m) in depth in ground judged as having no cave-in potential do not require excavation support and protection systems.

2. Depending upon excavation depth, time that excavation is open, soil classification, configuration and slope of excavation sidewalls, design and provide an excavation support and protection system that meets the requirements of 29 CFR 1926, Subpart P:

a. Sloping and benching systems.

b. Support systems, shield systems, and other protective systems.

B. Leave excavation support and protection systems, used as formwork or within 10 feet (3.03 m) of existing foundations, permanently in place, unless otherwise noted.

1. Cut off top 4 feet (1.22 m) below grade, abandon remainder.

C. Excavation support and protection systems not required to remain in place may be removed subject to approval of Owner or Owner's Representative.

1. Remove temporary shoring and bracing in a manner to avoid harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities and utilities.

3.4 EXCAVATING

A. Classified Excavation: Excavated materials are classified as earth and rock. Do not excavate rock until it has been classified and measured in accordance with Section 312316.26. The Contract Sum will be adjusted for rock excavation according to the adjustment unit price included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Excavation includes excavating pavements and surface obstructions, underground structures, utilities, and other items indicated to be removed and other materials not classified as rock or unauthorized excavations.

2. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.

3. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Unauthorized Excavation: Excavations that were not authorized by the Engineer or required by the Contract Documents. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Fill unauthorized excavation under other construction, pipe, or conduit with granular fill.

C. Excavate to accommodate new structures and construction operations.

1. Excavate to the specified elevations.

2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.

3. Cut utility trenches wide enough to allow inspection of installed utilities.

4. See Section 312316.26 for required excavation clearances for pipes in utility trenches.

5. Hand trim excavations. Remove loose matter.

D. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

E. Authorized additional excavation and replacement material will be paid according to Contract provisions for adjustment unit prices for stabilization stone, unless authorized

otherwise.

F. Repair or replace subgrades damaged by frost, rain, accumulated water, or construction activities without additional compensation.

G. Do not interfere with 45 degree bearing splay of foundations.

H. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard (0.25 cu m) measured by volume. See Section 312316.26 for removal of larger material.

3.5 DEWATERING

A. Contractor shall design, furnish, install, test, operate, monitor, and maintain dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities required to depress and maintain groundwater level below the base of each excavation during all stages of construction operations. Dewatering is to ensure work is completed on dry and stable subgrade.

B. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

C. Equipment:

1. Provide one (1) standby pump for every duty pump utilized for dewatering.

2. If pumps do not utilize self contained power generation, provide one standby generator to provide backup power to pump in the event of power failure.

D. Design Criteria:

1. Water table within areas of excavation is to be lowered a minimum of 2 feet beneath the bottom of the excavation.

2. Maintain stability of sides and bottom of excavation through the monitoring of conditions and collection and control of seepage into excavation.

3. Design and operate system to prevent damage to existing foundations, structures, or underground utilities.

E. Provide ditches, berms, and other common means and methods to divert surface water flow from accumulating in excavation area. Water shall be diverted to areas acceptable per requirements of authorities having jurisdiction.

F. Operation:

1. Operate dewatering system continuously throughout excavation activities. Continue operation until a point in which: Permanent construction provide sufficient dead load to withstand hydrostatic uplift of the normal groundwater, concrete has attained sufficient strength to withstand soil loads, and until waterproofing is complete.

2. Provide 24 hour supervision of dewatering system by personnel skilled in operation and maintenance of machinery.

3. Modify dewatering procedures if operation and discharge is to the detriment of existing site conditions or adjacent property conditions.

3.6 SUBGRADE PREPARATION

A. See Section 312323 for subgrade preparation at general excavations.

B. See Section 312316.13 for subgrade preparation at utility trenches.

3.7 FILLING AND BACKFILLING

A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.

B. Install underground warning tape at buried utilities according to Sections 210553, 220553, 230553, and 260553.

C. See Section 312323 for fill, backfill, and compaction requirements at general excavations.

D. See Section 312316.13 for fill, backfill, and compaction requirements at utility trenches.

E. See Section 312200 for rough and final grading and topsoil replacement requirements.

3.8 REPAIR

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.

3.9 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

B. Testing Agency: Engage a qualified geotechnical testing agency to perform tests and inspections below as Owner's responsibility to be paid under the testing and inspections allowance of Section 012100, Allowances.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent filling and grading only after test results for previously completed work comply with requirements.

D. Foundation Subgrade: At foundation subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval or other foundation subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Testing Agency.

3.10 CLEANING

A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 312200.

B. Remove excavated material that is unsuitable for re-use from site.

C. Remove excess excavated material from site.

3.11 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.

B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.

D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION

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SECTION 312316.13 - TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavating, backfilling, and compacting for utilities outside the building to utility main connections.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 312200 - Grading: Site grading.

C. Section 312316 - Excavation: Building and foundation excavating.

D. Section 312316.26 - Rock Removal: Removal of rock during excavating.

E. Section 312323 - Fill: Backfilling at building and foundations.

1.3 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: 4 inches (100 mm) below finish grade elevations indicated on drawings, unless otherwise indicated.

1.4 REFERENCE STANDARDS

A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses 2017.

B. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2018.

C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012, with Editorial Revision (2015).

E. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).

F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)) 2012, with Editorial Revision (2015).

G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.

H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision.

I. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).

J. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017a.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

D. Compaction Density Test Reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where indicated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Fill materials to comply with Section 312323.

2.2 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable facric.
   1. Subsurface Drainage Geotextile: non-woven, needle-punched, to standard with AASHTO M 288, for subsurface drainage purposes with over 50% stretch
      a. Survivability: AASHTO M 288, Class 2
   2. Separation Geotextile: woven, to standard with AASHTO M 288, for separation purposes with less than 50% stretch.
   3. Survivability: AASHTO M 288, Class 2

2.3 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 312200 for additional requirements.

C. Grade top perimeter of trenching area to prevent surface water from draining into trench. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by the Engineer.

3.3 TRENCHING

A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Excavate trench bottoms to have uniform support of installed conduit, joints, and fittings.
   1. For trenches to accommodate pipes with diameter of 6 inches or less and flat-bottom units, excavate trench bottom by hand without disturbing subgrade.
   2. For trenches to accommodate pipes with diameter greater than 6 inches, excavate trench bottom to support the bottom 90 degrees of pipe.
   3. Excavate trenches 6 inches deeper relative to surface to provide bedding course bearing material in hard or rocky areas.

C. For trenches in plant-protection areas, do not use mechanical equipment that could damage roots, only cut smaller roots that are in conflict with proposed utilities, and do not cut upstream roots.

D. Slope banks of excavations deeper than 4 feet (1.2 meters) to angle of repose or less until shored.

E. Do not interfere with 45 degree bearing splay of foundations.

F. Cut trenches wide enough to allow inspection of installed utilities.

G. Hand trim excavations. Remove loose matter.

H. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

I. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard (0.25 cu m) measured by volume. See Section 312316.26 for removal of larger material.

J. Remove excavated material that is unsuitable for re-use from site.

K. Stockpile excavated material to be re-used in area designated in Section 312200.

L. Remove excess excavated material from site.

M. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

N. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Engineer.

3.4 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with fill per Section 312323.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.5 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Fill up to subgrade elevations unless otherwise indicated.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.

G. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

H. Correct areas that are over-excavated.

1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

I. Compaction Density Unless Otherwise Specified or Indicated:

1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.

2. At other locations: 95 percent of maximum dry density.

J. Reshape and re-compact fills subjected to vehicular traffic.

3.6 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Utility Piping, Conduits, Duct Bank, and Pipe Culverts.:

1. Bedding: Use granular fill.
2. Cover with general fill.
3. Fill up to subgrade elevation.
4. Compact in maximum 8 inch (200 mm) lifts to 95 percent of maximum dry density.

B. Under roadways:

1. Provide 4 inch thick concrete slab support under the roadway surface. Encase conduit in 4 inches of concrete and backfill or place subbase course for roadway.

C. Under footings:

1. Backfill trench within 18 inches of bottom of footing. Fill to elevation with cast in place concrete.

D. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:

1. Drainage fill and geotextile fabric: Section 334100.
2. Cover drainage fill with general fill.
3. Fill up to subgrade elevation.
4. Compact to 95 percent of maximum dry density.

3.7 TOLERANCES

A. Top Surface of General Backfilling: Plus or minus 1 inch (25 mm) from required elevations.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch (25 mm) from required elevations.

3.8 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

B. Testing Agency: Engage a qualified geotechnical testing agency to perform tests and inspections below as Owner's responsibility to be paid under the testing and inspections allowance of Section 012100, Allowances.

C. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

D. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").

E. If tests indicate work does not meet specified requirements, remove work, replace and retest.

F. Frequency of Tests: One test every 150 linear feet or less, with a minimum of two tests per day when compaction is occurring.

3.9 CLEANING

A. Leave unused materials in a neat, compact stockpile.

B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

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SECTION 312316.26 - ROCK REMOVAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of identified rock during excavation.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 312323 - Fill: Fill materials.

1.3 DEFINITIONS

A. Site Rock: Solid mineral material with a volume in excess of 1/3 cubic yard (0.25 cubic meter) or solid material that cannot be removed with the capabilities of a Caterpiller D-8 dozer or Caterpillar 973 track loader (or equivalent) with 2 cu. yd. (No bucket on a D8) and hydraulically operated single tooth power ripper.

1.4 REFERENCE STANDARDS

A. NFPA 495 - Explosive Materials Code 2018.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate the proposed method of blasting , delay pattern, explosive types, type of blasting mat or cover, and intended rock removal method.

1.6 QUALITY ASSURANCE

A. Seismic Survey Firm: Company specializing in seismic surveys with five years documented experience.

B. Explosives Firm: Company specializing in explosives for disintegration of rock, with five years documented experience.

PART 2 PRODUCTS

2.1 MATERIALS

A. Explosives: Type recommended by explosive firm and required by authorities having jurisdiction.

B. Delay Device: Type recommended by explosives firm.

C. Blast Mat Materials: Type recommended by explosives firm.

D. Mechanical Disintegration Compound: Grout mix that expands upon curing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting work of this section.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

3.3 ROCK REMOVAL

A. Excavate and remove rock by either mechanical or explosive methods.

B. Mechanical Methods: Drill holes and utilize expansive tools, wedges, or mechanical disintegration compound to fracture rock.

C. If rock is uncovered requiring the explosives method for rock disintegration, notify the Engineer and Owner before use of explosives.

D. Use of Explosives: Obtain permits from authorities having jurisdiction before explosives are brought to site or drilling is started.

1. Comply with NFPA 495 and applicable state and local codes.
2. Prior to blasting, obtain a seismographic survey to determine maximum charges that can be used at each location in area of excavation without damaging adjacent properties or other work.
3. Prior to executing seismographic survey, advise owners of adjacent buildings and structures in writing; explain planned survey and blasting operations.
4. Prior to blasting, document conditions of buildings near locations of intended blasting and photograph existing conditions identifying existing irregularities.
5. Schedule work to avoid working hours of occupied buildings nearby.

E. Form level bearing at bottom of excavations.

F. Remove shaled layers to provide sound and unshattered base for footings.

G. In utility trenches, excavate to 6 inches (150 mm) below invert elevation of pipe and 24 inches (600 mm) wider than pipe diameter.

H. Remove excavated materials from site.

I. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 312323.

J. Remove excavated rock materials from site.

3.4 FIELD QUALITY CONTROL

A. Independent agency field inspection will be provided under provisions of Section 014000 - Quality Requirements.

B. Provide for visual inspection of foundation bearing surfaces and cavities formed by removed rock.

END OF SECTION

SECTION 312323 - FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Filling, backfilling, and compacting for the structures shown in the Contract Documents.

B. Backfilling and compacting for utilities outside the building to utility main connections.

C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

D. Rigid plastic foam block fill.

E. Lightweight concrete fill.

1.2 RELATED REQUIREMENTS

A. Section 013330 - Structural Submittals.

B. Section 014525 - Structural Testing/Inspection Agency Services.

C. Section 015630 - Temporary Erosion and Sediment Control

D. Section 033000 - Cast-in-Place Concrete.

E. Section 312200 - Grading.

F. Section 312316 - Excavation.

G. Section 312316.13 - Trenching.

H. Section 312316.26 - Rock Removal.

I. Section 313700 - Riprap.

J. Section 321216 - Asphalt Paving.

K. Section 334100 - Subdrainage.

1.3 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: 4 inches (100 mm) below finish grade elevations indicated on drawings, unless otherwise indicated.

C. Backfill: Soil material or engineered material used to fill an excavated area.

1. Initial Backfill: Backfill placed adjacent to the pipe barrel and over the pipe and pipe haunches to provide support at the pipe sides.

2. Final Backfill: Backfill paced atop initial backfill in a trench or excavated area.

D. Base Course: One or more layers of specified material of designed thickness placed on a subgrade or a subbase to support a surface course.

E. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

F. Borrow Soil: Borrow soils is satisfactory materials brought from off-site locations used for fill and backfill.

G. Drainage Course: Course supporting the slab on grade that also minimizes upward capillary flow of pore water.

H. Fill: Soil and engineered materials used to raise existing grade elevations.

I. Satisfactory Soils: As defined within the Geotechnical Report and herein. Soil Classification Groups CL, ML, SC, GW, GP, GM, SW, SP, and SM according to ASTM D 2487 Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: <40

2. Plasticity Index: <15

J. Unsatisfactory Soils: Soil Classification Groups GC, OL, CH, MH, OH, and PT according to ASTM D 2487 Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

2. Unsatisfactory soils also include soils whose N-values are less than 7 blows per foot (bpf) observed during Standard Penetration Resistance testing

K. Rock Excavation: Natural geological formations or other material which cannot be removed by adequate equipment (in good condition) as defined below, shall be considered a change in the scope of work and paid for by the Owner if encountered.

1. Open Excavation and Grading: Rock in excess of the capabilities of a Caterpillar D-8 dozer or Caterpillar 973 track loader (or equivalent) with 2 cu. yd. bucket (NO bucket on a D8) and hydraulically operated single tooth power ripper.

2. Trenches, Pits and Footings: Rock in excess of the capabilities of a Caterpillar 320 hydraulic excavator (or equivalent) using a 2 ft. Bucket width (3/4 cu. yd.).

3. Minimum Effort: If rock is not removed during the process of normal digging and ripping, then extend the excavation to expose the rock surface within the limit of original excavation. Contact the Engineer who may direct the sides of rock to be exposed to a depth of 3 feet. This will be to determine the extent of additional work.

L. Trench borrow shall consist of approved material imported from off-site for use as fill or backfill required to be placed in trenches either as initial select earth backfill or final common earth backfill. Trench borrow shall not be used until all suitable trench excavation material has been placed in the trench, unless authorized by the Engineer. The Contractor shall make his own arrangements for obtaining borrow and pay all costs involved, unless otherwise designated on the plans and in the contract documents. Borrow material must be approved by the Engineer prior to use.

1.4 REFERENCE STANDARDS

A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses 2017.

B. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2018.

C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates 2019.

D. ASTM C150/C150M - Standard Specification for Portland Cement 2020.

E. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete 2012.

F. ASTM C796/C796M - Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam 2019.

G. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) 2012, with Editorial Revision (2015).

H. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).

I. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)) 2012, with Editorial Revision (2015).

J. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.

K. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision.

L. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2017, with Editorial Revision (2018).

M. ASTM D6817/D6817M - Standard Specification for Rigid Cellular Polystyrene Geofoam 2017.

N. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017a.

O. ASTM D7557/D7557M - Standard Practice for Sampling of Expanded Geofoam Specimens 2009, with Editorial Revision (2013).

P. ICC-ES AC239 - Acceptance Criteria for Termite-Resistant Foam Plastic 2008, with Editorial Revision (2014).

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings for Manufactured Fill.

1. Submit plan, section, and profile drawings. Indicate size, type, location, and orientation of each geofoam block.

2. Submit location and type of connectors.

3. Indicate proposed weighting or guying.

C. Soil Samples: 10 pounds (4.5 kg) sample of each type of fill; submit in air-tight containers to testing laboratory.

D. Materials Sources: Submit name of imported materials source.

E. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.

F. Compaction Density Test Reports.

G. Lightweight Concrete Test Reports.

H. Manufacturer's Instructions.

I. Designer's Qualification Statement.

J. Manufacturer's Qualification Statement.

K. Lightweight Concrete Fill Installer's Qualification Statement.

L. Testing Agency Qualification Statement.

M. Specimen Warranty.

1.6 QUALITY ASSURANCE

A. Designer Qualifications: Perform design of structural fill under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

C. Lightweight Concrete Fill Applicator Qualifications: Company specializing in performing work of the type specified and with at least 13,000 cubic yards (10,000 cu m) in five years of documented experience and approved by manufacturer.

D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section and as stated below.

1. Structural Testing/Inspection Agency shall perform the following quality related items:

a. Verify structural fill complies with specifications.

b. Determine particle size, liquid limit, plastic limit, plasticity index and maximum density of each type of soil.

c. Observe proof rolling.

d. Perform a sufficient number of field density tests to verify compaction of structural fill. As a minimum, perform one test per lift for every 2500 square feet of fill placed.

e. Verify foundation bearing capacity.

f. Verify quantities of material removed and quantities of material placed where Unit Prices are involved.

E. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where indicated.

1. Separate differing materials with dividers or stockpile separately to prevent intermixing.

2. Prevent contamination.

3. Protect stockpiles from erosion and deterioration of materials.

a. Store in a manner that drains surface water and cover to prevent erosion from rain and wind.

b. Store soil at an appropriate distance from excavation boundaries.

1.8 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

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

C. Provide ten year manufacturer warranty for manufactured fill material.

1.9 SURVEY

A. Prior to construction, have structure location staked and certified by a licensed surveyor. If discrepancies between actual lines and elevations exist, notify design professional before proceeding with layout of structure.

1.10 SUBSURFACE CONDITIONS

A. Copies of a subsurface investigation of the site will be made available upon request. The data is not intended as a representation or warranty of the continuity of such conditions. Owner will not be responsible for interpretation or conclusions drawn therefrom by the contractor. The data is made available for the convenience of the contractor and is not guaranteed to represent all conditions that may be encountered.

B. Contractor may examine the site and make his own subsurface explorations at no additional cost to the owner. Notify owner prior to making any subsurface explorations.

1.11 EXISTING UTILITIES

A. Locate existing underground utilities by careful hand excavation. If utilities are to remain in place, provide protection from damage during construction operations.

B. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Do not interrupt existing utility service facilities occupied and used by owner or others, unless written permission is given by the design professional and then only after temporary utility services have been provided.

C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the design professional immediately for directions.

D. Repair damaged utilities to satisfaction of utility owner.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Provide borrow soil if satisfactory soils are not available from excavation.

B. General Fill: Subsoil excavated on-site.

1. Graded.
2. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.
3. Complying with ASTM D2487 Group Symbol CL.

C. Structural Fill: Subsoil excavated on-site, or authorized imported borrow.

1. Liquid Limit: Less than 40, Plasticity Index: Less than 15
2. Graded, % passing #200 sieve: Less than 65%
3. Free of lumps larger than 3 inches (75 mm), rocks larger than 2 inches (50 mm), and debris.
4. Complying with ASTM D2487 Group Symbol CL.

D. Concrete for Fill: As specified in Section 033000; compressive strength of 2500 psi (17.235 MPa).

E. Granular Fill: Class 1A Materials: Materials for use as foundation, embedment, and backfill as classified in ASTM D2321 - Table 1 for use during the installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Application.

F. Granular Fill: Fill Type Graded Aggregate Base: Coarse aggregate, complying with State of Georgia Department of Transportation Section 815 standard.

G. Coarse Granular Fill: Narrowly graded mixture of crushed stone or gravel, free of clay, shale, and organic matter in accordance with ASTM D448 coarse aggregate grading Size 57 with 100 percent passing a 1-1/2 inch sieve and zero to 5 percent passing a No. 8 sieve.

H. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.

1. Grade in accordance with ASTM D2487 Group Symbol SW.

I. Topsoil: See Section 312200.

J. Engineered Fill - Lightweight Concrete:

1. Finished Properties, Class II Engineered Fill:
   a. Cast Density, Maximum: 30 pounds per cubic foot (480 kg/cu m).
   b. Compressive Strength, Minimum: 41 pounds per square inch (280 kPa).
2. Materials:
   a. Cement: ASTM C150/C150M.
   b. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.
   c. Admixtures: As recommended by lightweight concrete fill manufacturer.
   d. Expansion Material: Manufacturer's recommended expansion material.
   e. Mix Design: By manufacturer.

2.2 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, non-woven, needle-punched, for sub-surface drainage applications.

B. Geotextile Fabric: Non-biodegradable, woven, for separation applications.

C. Vapor Retarder: 10 mil (0.25 mm) thick, polyethylene.

2.3 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. See Section 312200 for additional requirements.

D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

E. Verify structural ability of unsupported walls to support imposed loads by the fill.

F. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

G. Verify areas to be filled are not compromised with surface or ground water.

3.2 STRIPPING

A. Perform stripping per requirements set forth in Section 311000, and specified herein.

B. Strip vegetation, topsoil, roots, and other unsuitable material to a depth determined by the Structural Testing/Inspection Agency but not less than one foot, nor less than 10 feet outside the perimeter of the structure.

C. Stockpile sufficient amounts of topsoil as required to cover areas to be landscaped with a minimum of six inches of material.

3.3 EXCAVATION

A. Perform excavation per requirements set forth in Section 312316, and specified herein.

B. Excavation shall be considered unclassified.

C. Perform excavation to the depths and limits on the Drawings and as specified herein.

D. Do not excavate to full depth when there is probability of frost forming or ground freezing in excavation before concrete is placed.

E. Ground water may be encountered during the foundation excavation. Provide a system for controlling the ground water to a level at least three feet below the lowest point of the excavation.

F. Keep excavations dry by sloping ground away from holes and trenches.

3.4 PREPARATION

A. Scarify and proof roll subgrade surface to a depth of 6 inches (150 mm) to identify soft spots.

B. After stripping or excavation and before any fill placement, fill areas shall be proofrolled with a minimum of five passes of a vibratory drum or small roller in each of two perpendicular directions.

C. Areas found to be soft or pumping shall have the soft soil removed and replaced with structural fill and compacted as outlined herein.

D. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

E. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

F. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

G. Before backfilling, complete all:

1. Trash removal.
2. Concrete formwork removal.
3. Underground utility testing, inspection, and surveying.
4. Installation of supported wall bracing.
5. Removal of temporary construction structures such as bracing.
6. Subdrainage, waterproofing, and insulating.

3.5 FILLING

A. Fill to contours and elevations indicated using unfrozen materials.

B. Fill up to finish grade elevations unless otherwise indicated.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches (150 mm) compacted depth.

G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.

H. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

I. Correct areas that are over-excavated.

1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

J. Compaction Density Unless Otherwise Specified or Indicated:

1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.

K. Reshape and re-compact fills subjected to vehicular traffic.

L. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.6 PLACEMENT OF BACKFILL

A. Backfill behind wall shall be placed in layers of six inches.

B. Compact backfill behind walls to 95 percent of the maximum dry density as measured by Standard Proctor, ASTM D698, with water content within +/-2 percent of the optimum moisture content.

3.7 ENGINEERED FILL - LIGHTWEIGHT CONCRETE

A. Install lightweight concrete fill according to manufacturer's written instructions.

B. Use batching, mixing, and placing equipment approved by the manufacturer.

C. Prevent segregation of material.

D. Tolerance: Finished surface within 2 inches (50 mm) of elevation indicated on drawings.

3.8 FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated in specifications or construction drawings.

3.9 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch (25 mm) from required elevations.

B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch (25 mm) from required elevations.

3.10 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

B. Testing Agency: Engage a qualified geotechnical testing agency to perform tests and inspections below as Owner's responsibility to be paid under the testing and inspections allowance of section 012100, Allowances.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent filling and grading only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Testing Agency.

E. Soil Fill Materials:

1. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

2. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.

3. If tests indicate work does not meet specified requirements, remove work, replace and retest.

4. Perform Tests at the following locations and frequencies:

a. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests for paved areas and one test for each building slab area.

b. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.

c. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.11 CLEANING

A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 320190 - OPERATION AND MAINTENANCE OF PLANTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Maintain plants in manner that promotes health, growth, color and appearance, to quality levels specified; replace dead, dying, and damaged plants at no extra cost to Owner.

1. It is Contractor's responsibility to determine type and quantity of soil amendments and fertilizer required.

B. Maintain newly planted landscape plants, including turf (lawns), turf (playfields), trees, shrubs, hedges, vines, ground cover, perennials, flowering bulbs, and annuals.

C. Clean up landscaped areas.

D. Maintenance Period: The time frame covered by these requirements is 90 days:

1. Start Date: The date upon which planting and seeding activities are begun on site.

1.2 RELATED REQUIREMENTS

A. Section 015713 - Temporary Erosion and Sediment Control.

B. Section 312200 - Grading.

C. Section 329219 - Seeding.

D. Section 329300 - Plants.

1.3 REFERENCE STANDARDS

A. ANSI A300 Part 1 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices 2017.

B. ANSI Z133.1 - American National Standard For Arboricultural Operations - Pruning, Repairing, Maintaining, And Removing Trees, And Cutting Brush - Safety Requirements 2012.

C. ASTM D4972 - Standard Test Methods for pH of Soils 2019.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Soil Tests and Analysis: Submit report showing number of samples, test results, and recommendations for soil amendments and fertilizer.

C. Product Data: Manufacturer's data sheets on each fertilizer, herbicide, pesticide, and other chemical material to be used, showing trade name, chemical composition, mixing instructions, recommended application rate, storage and handling instructions, and application instructions.

D. Shop Drawings:

1. Maintenance plan.

2. Recommendations of the local Cooperative Extension Service office for maintenance and care of turf.

E. Certificates: Certification of composition of the following as delivered:

1. Fertilizer.

2. Mulch.

3. Pesticides.

4. Herbicides.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Maintenance Contractor: The contractual entity that performed the planting installation.
2. Pruners: Certified member, or supervised by certified member, of International Society of Arboriculture.
3. Pesticide Applicators: Certified by authorities having jurisdiction.
4. Herbicide Applicators: Certified by authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver U.S. EPA-controlled materials to site in original containers with legible labels indicating registration number and registered uses.

B. Deliver fertilizer and manufactured soil amendments to site in original containers bearing manufacturer's chemical analysis, name, trade name or trademark, and indication of compliance with applicable state and federal laws and regulations ; alternatively, bulk delivery with equivalent certificate is acceptable.

C. Store fertilizer, soil amendments, and mulch in dry locations away from contaminants.

D. Do not store pesticides, herbicides, or other chemical treatment materials in locations where they could damage seeds or plants.

PART 2 PRODUCTS

2.1 FERTILIZERS AND SOIL AMENDMENTS

A. Fertilizers: Free flowing granular organic type containing nitrogen, phosphorus, and potassium, plus trace minerals and micro-nutrients; controlled release type is preferred.

1. Determine type and quantity based on soil analysis.
2. Turf Fertilizer: As specified in Section 329219.
3. Non-Turf Plant Fertilizer: As specified in Section 329300.

B. Soil Amendments: Type and quantity as required to achieve specified results, based on soil analysis.

PART 3 EXECUTION

3.1 EXAMINATION

A. If soil analysis has not already been performed, take sufficient samples to obtain a comprehensive analysis; perform analysis in accordance with ASTM D4972.

3.2 LANDSCAPE MAINTENANCE - GENERAL

A. Protect existing vegetation, pavements, and facilities from damage due to maintenance activities; restore damaged items to original condition or replace, at no extra cost to Owner.

B. General Cleanup: Remove debris from all landscape areas at least once a week and from turf areas before each mowing.

1. Debris consists of trash, rubbish, dropped leaves, downed branches and limbs of all sizes, dead vegetation, rocks, and other material not belonging in landscaped areas.
2. Remove debris from site and dispose of properly.

C. Watering, Soil Erosion, and Sedimentation Control: Comply with federal, state, local, and other regulations in force; prevent over-watering, run-off, erosion, puddling, and ponding.

1. Repair temporary erosion control mechanisms provided by others.
2. Repair eroded areas and replant, when caused by inadequate maintenance.
3. Prevent sediment from entering storm drains.

D. Trees: Exercise care to avoid girdling trees; provide protective collars if necessary; remove protective collars at end of maintenance period.

E. Fertilizing: Apply fertilizer only when necessary.

F. Drainage Channels: Remove obstructions in gutters, catch basins, storm drain inlets, yard drains, swales, ditches, and overflows.

1. Remove grates from catch basins to clean.

2. Prevent encroachment of other vegetation on turfed surface drainage channels.

G. Health Maintenance: Inspect all plants regularly for health:

1. Eradicate diseases and damaging pests, regardless of severity or speed of effect.

2. Treat accidental injuries and abrasions.

3. If a plant is unhealthy but not yet dead, according to specified definitions, determine reason(s) and take remedial action immediately.

4. Remove dead plants immediately upon determining that they are dead.

H. Pesticide and Herbicide Application: Comply with manufacturer's instructions and recommendations and applicable regulations.

1. Obtain Owner's approval prior to each application.

2. Apply in manner to prevent injury to personnel and damage to property due to either direct spray or drifting, both on and off Owner's property.

3. Use backflow preventers on hose bibbs used for mixing water; prevent spills.

4. Inspect equipment daily before application; repair leaks, clogs, wear, and damage.

5. Do not dispose of excess mixed material, unmixed material, containers, residue, rinse water, or contaminated articles on site; dispose of off site in legal manner.

6. Rinse water may be used as mix water for next batch of same formulation.

7. Contractor is responsible for all recordkeeping, submissions, and reports required by laws and regulations.

I. Replanting: Perform replacement and replanting immediately upon removal of dead plant.

3.3 IRRIGATION

A. Irrigation: Do not allow plants to wilt; apply water as required to supplement rainfall; do not waste water; do not water plants or areas not needing water; do not water during rainfall; shut off water flow when finished; repair leaks.

1. Provide backflow preventers on hose bibbs used for irrigation hoses.

3.4 TURF MAINTENANCE

A. Maintain turf in manner required to produce turf that is healthy, uniform in color and leaf texture, and free from weeds and other undesirable growth.

1. Grass Density - Lawns: 20 plants per square foot (200 plants per square meter), minimum.

2. Bare Spots - Lawns: 2 percent of total area, maximum; 6 inches (150 mm) square, maximum.

3. Keep turf relatively free of thatch, woody plant roots, diseases, nematodes, soil-borne insects, stones larger than 1 inch (25 mm) in diameter, and other materials detrimental to grass growth.

4. Limit broadleaf weeds and patches of foreign grass to a maximum of 2 percent of the total area.

B. Mowing: During growing season(s) mow turf to uniform height, in manner that prevents scalping, rutting, bruising, and uneven or rough cutting.

1. Prior to mowing clean all debris and leaves from turf surface.

2. Schedule frequency of mowing so that no more than one-quarter to one-third of grass leaf length is removed during a cutting.

3. Make each successive mowing at approximately 45 degrees to the previous mowing, if practical.
4. Cool Season Grasses:
    a. Reduce mowing height in fall and spring.
    b. Use rotary type mowers; mulcher type mowers may be used.
5. Warm Season Grasses:
    a. Increase mowing height slightly as fall approaches.
    b. Use reel type mowers; do not use mulcher mowers.

C. Trimming: Immediately after each mowing, neatly trim perimeter of each turf area and around obstructions within turf area; match height and appearance of adjacent turf.
1. Adjacent to Pavements: Cut edges of turf to form a distinct, uniform turf edge.
2. Adjacent to Planting Beds and Permanently Mulched Areas: Cut edges of turf to form a distinct, uniform turf edge.
3. Around Other Trees and Poles: Where no planting bed or mulched area exists, trimming with string trimmer is acceptable.
4. At Fences: Trim on both sides of fence.
5. Irrigation Heads and Valve Boxes: Trim neatly so grass doesn't interfere with operation.

D. Fertilizer: Apply as recommended by manufacturer and at rate indicated by soil analysis.
1. Cool Season Grasses: Apply at least once, in Fall before first frost; do not apply high nitrogen fertilizer during Summer; Spring application is optional but must be reduced in quantity.

3.5 PLANTING BED MAINTENANCE

A. Planting beds include all planted areas except turf.

B. Begin maintenance immediately after plants have been installed; inspect at least once a week and perform needed maintenance promptly.

C. Keep planting beds free of pests; remove weeds and grass by hand before reaching 1 inch (25 mm) height.

D. Do not allow climbing, twining, or creeping plants to encroach into other species.

E. Replace mulch as required and remove debris.

3.6 TREE AND SHRUB MAINTENANCE

A. Trees will be considered dead when main leader has died back or when 25 percent or more of crown has died ; except as otherwise indicated for palm trees.

B. Shrubs will be considered dead when 25 percent or more of plant has died.

C. Inspect woody plants for health by scraping up to 1/16 inch (2 mm) square area of bark; no green cambium layer below bark shall be evidence of death.

D. Adjust stakes, guys and turnbuckles, ties, and trunk wrap as required to promote growth and avoid girdling.

E. Fertilizing: Fertilize all trees at least once during maintenance period, preferably in the Fall; use accepted standards for determining type and method of fertilization.

F. Pruning: Unless otherwise indicated, prune only to maintain balanced natural shape; follow recommendations of ANSI A300 and ANSI Z133.1 and best local practices for species involved.

G. Shrubs: Prune at least once during maintenance period at best time to influence ultimate shape and size for the particular species.
1. Prune to balance the plant's form and according to its natural growth characteristics.

2. Remove water shoots, suckers, and branches not complying with desired shape and size.

H. Hedges: Trim to encourage growth into voids and gaps.

3.7 CLEANING

A. Remove fallen deciduous leaves in Fall; removal may wait until all leaves have fallen.

B. Clean adjacent pavements of plant debris and other debris generated by maintenance activities.

C. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner; Owner's trash collection facilities may be used.

D. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner.

3.8 CLOSEOUT ACTIVITIES

A. 10 days prior to end of maintenance period, submit request for final inspection.

B. Final inspection will be conducted by Engineer.

END OF SECTION

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SECTION 321216 - ASPHALT PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate base course.

B. Single course bituminous concrete paving.

C. Double course bituminous concrete paving.

1.2 RELATED REQUIREMENTS

A. Section 312200 - Grading: Preparation of site for paving and base.

B. Section 312323 - Fill: Compacted subgrade for paving.

C. Section 321313 - Concrete Paving: Concrete substrate and curbs.

D. Section 321723.13 - Painted Pavement Markings.

1.3 REFERENCE STANDARDS

A. AI MS-2 - Asphalt Mix Design Methods 2015.

B. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction 2009a.

1.4 PERFORMANCE REQUIREMENTS

A. Design paving and subbase at 95% compaction to AASHTO T-99 for movement of trucks up to 60,000 lbs (27 200 kg).

B. Design paving and subbase at 95% compaction to AASHTO T-99 for parking.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Georgia DOT standard.

B. Mixing Plant: Complying with State of Georgia DOT standard.

C. Obtain materials from same source throughout.

1.6 FIELD CONDITIONS

A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.

B. Place bitumen mixture when temperature is not more than 15 F degrees (8 C degrees) below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.1 MATERIALS

A. Asphalt Cement: ASTM D946.

B. Aggregate for Binder Course: In accordance with State of Georgia DOT standards.

C. Aggregate for Wearing Course: In accordance with State of Georgia DOT Standards.

D. Tack Coat: Homogeneous, medium curing, liquid asphalt.

2.2 ASPHALT PAVING MIXES AND MIX DESIGN

A. Binder Course: 4.5 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

B. Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

2.3 SOURCE QUALITY CONTROL

A. Test mix design and samples in accordance with AI MS-2.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 PREPARATION - TACK COAT

A. Apply tack coat in accordance with manufacturer's instructions.

B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).

3.3 PLACING ASPHALT PAVEMENT - SINGLE COURSE

A. Install Work in accordance with State of Georgia DOT standards.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

3.4 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.

B. Compacted Thickness: Within 1/4 inch (6 mm) of specified or indicated thickness.

C. Variation from True Elevation: Within 1/2 inch (12 mm).

3.5 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for quality control.

B. Provide field inspection and testing. Take samples and perform tests in accordance with ASTM D3666.

3.6 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury until surface temperature is less than 140 degrees F (60 degrees C).

END OF SECTION

SECTION 321313 - CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 321216 - Asphalt Paving: Asphalt wearing course.

1.3 REFERENCE STANDARDS

A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete 1991 (Reapproved 2009).

B. ACI 301 - Specifications for Structural Concrete 2016.

C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).

D. ACI 305R - Guide to Hot Weather Concreting 2010.

E. ACI 306R - Guide to Cold Weather Concreting 2016.

F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.

G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.

H. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.

I. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.

J. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2020.

K. ASTM C150/C150M - Standard Specification for Portland Cement 2020.

L. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.

M. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).

N. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.

O. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019.

P. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete 2019.

Q. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.

R. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction 2018.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on joint filler, admixtures, and curing compound.

C. Design Data: Indicate pavement thickness, design mixture, designed concrete strength, reinforcement, and typical details.

PART 2 PRODUCTS

2.1 PAVING ASSEMBLIES

A. Concrete Sidewalks and Median Barrier: 3,000 psi (20.7 MPa) 28 day concrete, 4 inches (100 mm) thick.

B. Driveway and Parking Area Pavement: 4,000 psi (27.6 MPa) 28 day concrete, thickness shown on the drawings.

2.2 FORM MATERIALS

A. Plywood or metal form material, profiled to suit conditions.

1. Must provide visibly smooth exposed surfaces.

B. Form-Release Agent should not impair concrete surface.

C. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).

1. Thickness: 1/2 inch (12 mm).

2.3 REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M, Grade 80 (80,000 psi) (550 MPa) yield strength; deformed billet steel bars; unfinished.

B. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; galvanized.

C. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi (280 MPa) yield strength; deformed billet steel bars; unfinished finish.

D. Reinforcing Bars and Tie Bars: ASTM A615/A615M, deformed, Grade 60.

E. Epoxy Coating: epoxy repair coating should be a two-part liquid surface coating.

F. Hook Bolt: ASTM A307, Grade A.

2.4 CONCRETE MATERIALS

A. Obtain cementitious materials from same source throughout.

B. Cement: ASTM C150/C150M, Normal - Type I Portland cement, gray color.

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

D. Water: Potable.

E. Air-Entraining Admixtures: ASTM C260/C260M.

F. Chemical Admixtures: ASTM C494/C494M, Type A - Water Reducing, Type C - Accelerating, and Type G - Water Reducing, High Range and Retarding.

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

2.5 ACCESSORIES

A. Curing Compound: ASTM C309, Type 1, Class A.

B. Surface Retarder:

1. Color: As selected by Engineer from manufacturer's standard range.

2. Water soluble liquid for surface of concrete.

C. Slab Isolation Joint Filler: 1/2 inch (13 mm) thick, height equal to slab thickness, with removable top section that will form 1/2 inch (13 mm) deep sealant pocket after removal.

1. Material: ASTM D1751, cellulose fiber.

D. Tactile Warning Surfaces: See Section 321726.

2.6 CONCRETE MIX DESIGN

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

1. For trial mixtures method, employ independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.

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

C. Concrete Properties:

1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 4000 psi (27.6 MPa), unless noted otherwise.

2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.

3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.

4. Silica Fume Content: Maximum 15 percent of cementitious materials by weight.

5. Water-Cement Ratio: Maximum 45 percent by weight.

6. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.

7. Maximum Slump: 4 inches (100 mm).

2.7 MIXING

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

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

A. See Section 321123 for construction of base course for work of this Section.

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Ensure excess material from subbase surface is removed before concrete is placed.

3.4 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 REINFORCEMENT

A. Place reinforcement at top of slabs-on-grade.

B. Interrupt reinforcement at contraction and expansion joints.

3.6 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.

3.7 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Place concrete in accordance with ACI 301 in reference to:

1. measuring, mixing, transporting, and placing, mechanically vibrating, rodding, and tamping.

C. Do not place concrete when base surface is wet.

D. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

E. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

F. Apply surface retarder only to surfaces indicated in accordance with manufacturer's instructions.

3.8 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Place 1/4 inch (6 mm) wide expansion joints at 20 foot (6 m) intervals and to separate paving from vertical surfaces and other components.

1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch (13 mm) of finished surface.

2. Secure to resist movement by wet concrete.

3.9 FINISHING

A. Area Paving: Light broom, texture perpendicular to pavement direction.

B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius (6 mm radius).

C. Curbs and Gutters: Light broom, texture parallel to pavement direction.

D. Inclined Vehicular Ramps: Broomed perpendicular to slope.

E. Place sealer on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.10 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch (6 mm) in 10 ft (3 m).

B. Maximum Variation From True Position: 1/4 inch (6 mm).

3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.

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

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

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

B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd (76 cu m) or less of each class of concrete placed.

1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

2. Perform one slump test for each set of test cylinders taken.

C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

END OF SECTION

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SECTION 321723.13 - PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Parking lot markings, including parking bays, crosswalks, handicapped symbols, and curb markings.

1.2 RELATED REQUIREMENTS

A. Section 321216 - Asphalt Paving.

B. Section 321313 - Concrete Paving.

1.3 REFERENCE STANDARDS

A. FS TT-B-1325 - Beads (Glass Spheres); Retro-Reflective 2007d (Validated 2017).

B. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.

C. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration Current Edition.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Certificates: Submit for each batch of paint and glass beads stating compliance with specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint in containers of at least 5 gallons (18 L) accompanied by batch certificate.

B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment accompanied by batch certificate.

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MATERIALS

A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; white.

1. Parking Lots: White.
2. Handicapped Symbols: Blue.

B. Reflective Glass Beads: FS TT-B-1325, Type I (low index of refraction), Gradation A (coarse, drop-on) ; with silicone or other suitable waterproofing coating to ensure free flow.

C. Temporary Marking Tape: Preformed, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

D. Obtain all pavement marking paint from one manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.

1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

F. Temporary Pavement Markings: When required or directed by Engineer, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.

1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.

2. At Contractor's option, temporary marking tape may be used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.3 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F (10 degrees C) or more than 95 degrees F (35 degrees C).

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown, and comply with the USDOJ's "2010 ADA Standards for Accessible Design".

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.

1. Apply paint in one coat only.

2. Wet Film Thickness: 0.015 inch (0.4 mm), minimum.

3. Length Tolerance: Plus or minus 3 inches (75 mm).

4. Width Tolerance: Plus or minus 1/8 inch (3 mm).

G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.

1. Mark the International Handicapped Symbol at indicated parking spaces.
2. Hand application by pneumatic spray is acceptable.

H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.4 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.

D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.

F. Replace removed markings at no additional cost to Owner.

END OF SECTION

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SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Posts, rails, and frames.

B. Wire fabric.

C. Barbed wire.

D. Concrete.

E. Manual gates with related hardware.

F. Automatic motor operated gates.

G. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete anchorage for posts.

1.3 REFERENCE STANDARDS

A. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.

B. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire 2013 (Reapproved 2017).

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.

E. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric 2011a (Reapproved 2017).

F. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2020.

G. ASTM F567 - Standard Practice for Installation of Chain-Link Fence 2014a.

H. ASTM F2200 - Standard Specification for Automated Vehicular Gate Construction 2020.

I. CLFMI CLF-PM0610 - Product Manual 2017.

J. CLFMI CLF-SFR0111 - Security Fencing Recommendations 2014.

K. FS RR-F-191/1D - Fencing, Wire and Post Metal (Chain-Link Fence Fabric) 1990.

L. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.

M. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

O. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

P. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.

D. Manufacturer's Installation Instructions: Indicate installation requirements for each main fencing and gate component.

E. Manufacturer's Qualification Statement.

F. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines.

G. Field Inspection Records: Provide installation inspection records that include post settings, framework, fabric, barbed wire, fittings and accessories, gates, and workmanship.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Fence Installer: Company with demonstrated successful experience installing similar projects and products, with not less than five years of documented experience.

1.6 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Chain Link Fences and Gates:

1. Master-Halco, Inc: www.masterhalco.com
2. Merchants Metals: www.merchantsmetals.com
3. Substitutions: See Section 016000 - Product Requirements.

B. Automatic Gate Operators:

1. HySecurity: www.hysecurity.com
2. Doorking: www.doorking.com
3. Tymetal Corp: www.tymetal.com
4. Substitutions: See Section 016000 - Product Requirements.

2.2 COMPONENTS

A. Line Posts: 2.38 inch (60 mm) diameter.

B. Corner and Terminal Posts: 2.88 inch (73 mm) diameter.

C. Cantilever Gate: 26 foot length.

1. Gate Posts: 4.0 inch (101.6 mm) diameter.
2. Concrete Footing: 12 inch (304.8 mm) diameter, 36" (914.4 mm) depth.
3. Gate Frame: 2.5 inch (63.5 mm) diameter for fittings and truss rod fabrication.

D. Top and Brace Rail: 1.66 inch (42 mm) diameter, plain end, sleeve coupled.

E. Truss Rod: 5/16 inch diameter truss rod, as indicated on construction drawings.

2.3 MATERIALS

A. Gates:

1. Gate Framework: PC LG-40 Pipe.
2. Gate Post: PC Import Schedule 40 Pipe

B. Tension Wire: 7 gauge smooth galvanized wire.

1. Installation: Weave into wire mesh fabric or utilize 11 gauge hog ring wire ties installed at 24 inches on center.

C. Tension Band: 12 gauge x 3/4 inch band constructed of steel and installed at a maximum of 15 inches on center.

D. Stretcher Bar: 3/16 inch x 3/4 inch galvanized steel stretcher bar, full height for fencing installation. nnnniki

1. Installation: Woven into wire fabric.

E. Tie Wire: Aluminum alloy 9 gauge wire, compliant with ASTM B211.

1. Center Brace: Installed at 24 inches on center.
2. Top Railing: Installed at 24 inches on center.
3. Line Post: Installed at 12 inches on center.
4. Gate Frame: Installed at 24 inches on center.
5. Line Posts: Type I round in accordance with FS RR-F-191/1D
6. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.

F. Wire Fabric: 2" Galvanized Mesh:

1. Height as indicated on construction drawings.
2. Wire: 9 Gage.
3. ASTM A392 zinc coated steel chain link fabric.
4. Comply with CLFMI CLF-PM0610.

G. Barbed Wire

1. Zinc-coated steel, complying with ASTM A121 Type Z Coating Class 1; 3 strands of 12.5 gague wire, with 4-pointed barbs at 4 inches (102 mm) on center.

H. Concrete:

1. Ready-mixed, complying with ASTM C94/C94M; normal Portland cement; 2,500 psi (17 MPa) strength at 28 days, 3 inch (75 mm) slump.

2.4 MANUAL GATES AND RELATED HARDWARE

A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches (1,525 mm) high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

B. Hinges: Finished to match fence components.

C. Latches: Finished to match fence components.

2.5 AUTOMATIC GATE OPERATORS

A. Sliding Gates: Pre-wired, post mounted gate operator for horizontal sliding gates, per ASTM F2200 and UL 325.

1. Class: Class I.
2. Operating type: roller chain.
    a. 20 feet (6m) of #40 roller chain, chain brackets, and hardware.
3. Control Functions: Open, Pause, Close.
4. Maximum Open/Close Time: 10 seconds.
5. Speed: Approximately 10 in/sec (254 mm/sec).
6. Access: Card.
7. Maximum gate weight: 1,000 pounds (373 kilograms).
8. Maximum Gate Length: 30 feet (9.1 m).
9. Motor Requirements:

a. Horsepower Rating: 1/2 HP

b. Continuous Duty

c. AC Motor

10. Entrapment Protection Devices: Provide sensing devices and safety mechanisms complying with UL 325.
11. Frame: G90 Galvanized steel.
12. Cover: Steel, plated and painted.
13. Primary Reduction: Single cog belt.
14. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
    a. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
15. Electrical Input: 115 VAC, 60 Hz, 5.4A
16. Temperature Rating: 10 degrees F (-12 degrees C) to 140 degrees F (60 degrees C)

2.6 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Extension Arms: Cast steel galvanized, to accommodate 3 strands of barbed wire, single arm, sloped to 45 degrees.

C. Gate Fittings: Regular Brace Band and Black Carriage Bolt, Aluminum Rail End,3 Wire 45 Degree Barb Arm, Aluminum Dome Cap, 5/8" Regular Galvanized Steel Tension Bar, Regular Tension Band, and Carriage Bolt

2.7 FINISHES

A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot (530 g/sq m).

B. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.

C. Accessories: Same finish as framing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

3.2 PREPARATION

A. Removal: Obstructions or debris.

3.3 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Place fabric on outside of posts and rails.

C. Line Post Footing Depth Below Finish Grade: ASTM F567.

D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.

E. Brace each gate and corner post to adjacent line post with horizontal center brace rail as indicated. Install brace rail one bay from end and gate posts.

F. Provide top rail through line post tops and splice with 6 inch (150 mm) long rail sleeves.

G. Do not stretch fabric until concrete foundation has cured 28 days.

H. Position bottom of fabric 2 inches (50 mm) above finished grade.

I. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at spacing indicated on construction drawings and specifications.

J. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

K. Install bottom tension wire stretched taut between terminal posts.

L. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

M. Perform three random field inspections confirming proper installation.

N. Install operator in accordance with manufacturer's instructions and in accordance with NFPA 70.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.

C. Post Settings: Randomly inspect three locations against design for:

1. Hole diameter.

2. Hole depth.

3. Hole spacing.

D. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.

E. Barbed Wire: Randomly inspect three locations against design for:

1. Spacing of barb wire.

F. Gates: Inspect for level, plumb, and alignment.

3.5 CLEANING

A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

B. Clean fence with mild household detergent and clean water rinse well.

C. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.

D. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

END OF SECTION

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SECTION 329219 - SEEDING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Preparation of subsoil.

B. Placing topsoil.

C. Hydroseeding, mulching and fertilizer.

1.2 RELATED REQUIREMENTS

A. Section 312200 - Grading: Topsoil material.

B. Section 312200 - Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.

C. Section 312323 - Fill: Topsoil material.

D. Section 320190 - Operation and Maintenance of Planting: Post-occupancy maintenance.

1.3 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass, and any other non intended vegitative cover.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Certificate: Certify seed mixture approval by seed manufacturer.

C. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer .

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

2.2 SEED MIXTURE

A. Seed Mixture:

1. Tall Fescue (Cool Season): 100 percent
2. Drought Tolerant Burmuda Grass (Warm Season): 100 percent
3. See Seeding Schedule on detail sheets for additional information.

2.3 SOIL MATERIALS

A. Topsoil: As specified in Section 312323.

2.4 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

B. Fertilizer: Lesco Starter Lawn or Approved Equal; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.

C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

D. Erosion Fabric: As described in erosion conrol plans.

2.5 TESTS

A. Provide analysis of topsoil fill under provisions of Section 014000.

B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this Section.

3.2 PREPARATION

A. Prepare subgrade in accordance with Section 312200.

B. Place topsoil in accordance with Section 312200.

3.3 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to roller compaction.

C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

D. Mix thoroughly into upper 2 inches (50 mm) of topsoil.

E. Lightly water to aid the dissipation of fertilizer.

3.4 SEEDING

A. Apply seed at a rate in accordance with the manufacturers reccomendations, and apply evenly in two intersecting directions. Rake in lightly.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Planting Season: Warm Season (May 1st - October 1st) - Cool Season (October 1st - May 1st).

D. Do not sow immediately following rain, when ground is too dry, or during windy periods.

E. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.

F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.

G. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.5 HYDROSEEDING

A. Apply seeded slurry with a hydraulic seeder at a rate specified by the manufacturer, applied evenly in two intersecting directions.

B. Do not hydroseed area in excess of that which can be mulched on same day.

C. Immediately following seeding, apply mulch to a thickness of 1/8 inches (3 mm). Maintain clear of shrubs and trees.

D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches (100 mm) of soil.

E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches (100 by 100 mm).

3.6 PROTECTION

A. Cover seeded slopes where grade is 4 inches per foot (101.6 mm per m) or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.

B. Lay fabric smoothly on surface, bury top end of each section in 6 inch (150 mm) deep excavated topsoil trench. Provide 12 inch (300 mm) overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

C. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

D. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches (150 mm).

3.7 MAINTENANCE

A. See Section 320190 - Operation and Maintenance of Planting for post-occupancy maintenance.

END OF SECTION

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SECTION 329300 - PLANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Preparation of subsoil.

B. Topsoil bedding.

C. New trees, plants, and ground cover.

D. Mulch and Fertilizer.

E. Tree Pruning.

1.2 RELATED REQUIREMENTS

A. Section 312200 - Grading: Topsoil material.

B. Section 312323 - Fill: Topsoil material.

C. Section 320190 - Operation and Maintenance of Planting: Post-occupancy maintenance.

1.3 DEFINITIONS

A. Weeds: Any plant life not specified or scheduled.

B. Balled and Burlapped Plants: Field dug plants with soil in which they are grown that are wrapped, tied, and supported as described in ANSI Z60.1.

C. Container-Grown Plants: Healthy, vigorous, and well rooted plants that have been grown in properly sized containers. All container and plant sizes shall meet descriptions in ANSI Z.60.1.

D. Girdling Roots: Roots that have a circular direction around the base or trunk of plant due from imprioper growing conditions. Plants with girdling roots will not be accepted.

E. Finished Grade:Elevation of the final graded surface of planting soil.

F. Planting Soil: Existing or imported topsoil, modified surface soil mixed with required amendments.

G. Plants: Living trees, plants, and ground cover specified in this Section , and described in ANSI Z60.1.

H. Subgrade: Elevation of existing subsoil prior to adding top soil or planting soil.

1.4 REFERENCE STANDARDS

A. ANSI/AHIA Z60.1 - American National Standard for Nursery Stock 2014.

B. ANSI A300 Part 1 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices 2017.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Certificate: Certify fertilizer and herbicide mixture approval by authority having jurisdiction.

C. Certificate: Submit certificate for plants free of disease or hazardous insects; certified by federal department of agriculture; free of disease or hazardous insects.

D. Maintenance Data: Include cutting and trimming method ; types, application frequency, and recommended coverage of fertilizer .

E. Submit list of plant life sources.

F. Material Test Reports: For imported and native topsoil, existing subsoil, and manufactured planting soil. Provide percentages or organic matter; gradation of sand, silt, and clay; pH; capacity of cation exchange;deleterious material; and plant nurtient and mineral content. Provide reccomendations for quantities of NPK and micronutrients to achieve optimal plant growth and establishment.

G. Vendor Reciepts, Purchases, Quantities.

1.6 QUALITY ASSURANCE

A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.

B. Installer Qualifications: Company specializing in installing and planting the plants with three years experience.

C. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.

D. Tree Pruning: Comply with ANSI A300 Part 1.

E. Maintenance Services: Performed by installer.

F. Non-native, Invasive Plant Species: Do not introduce, grow, or cultivate plant species that are non-native to the ecosystem of the project site, and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

G. Soil Testing Laboratory: Laboratory must be recognized by the Department of Agricultureand be an independant laboratory with experience testing soil suitability for plant growth and establishment.

H. Comply with laws regulating non-native and invasive plant species in the State in which the Project is located.

I. Plant Material: Must comply with plans, details, and planting schedule. Quality and size must meet requirements in ANSI Z60.1. Each plant must be tagged or labeled with genus, species, and variety.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Unless approved, do not prine plant material prior to arriving to site. It is the responsibility of the contractor to ensure plant maaterial is not damaged during transport and handling. Damage or mishandled plant material will not be accepted at arrival or at install.

C. Protect and maintain plant life until planted and during the warranty period. Any plant material stored onsite must be watered to keep soil moist and protected from weather, construction, and vandalism.

D. Deliver plant life materials immediately prior to placement. Keep plants moist.

E. Do not remove container grown material from container before time of planting.

1.8 FIELD CONDITIONS

A. Do not install plant life when ambient temperatures may drop below 35 degrees F (2 degrees C) or rise above 90 degrees F (32 degrees C).

B. Do note install plant material during muddy and wet conditions.

C. Do not install plant life when wind velocity exceeds 30 mph (48 k/hr).

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide one year warranty on all plant material from the day of substantial completion.

C. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.

D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

1.10 MAINTENANCE (SEE END OF SECTION)

A. The contractor is responsible for maintenance of all plant material until the date of final completion. This includes watering, weeding, fertilizing, and other required operations to

ensure healthy and viable plant material.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of plants, fertilizer and herbicide mixture.

C. Plant Materials: Certified by federal department of agriculture; free of disease or hazardous insects.

2.2 PLANTS

A. Plants: Must meet requirements of ANSI Z60.1, schedule, plans, and details. All plant material shall be free of disease;presence of insects including larve and eggs;defects including knots, decay, bores, sin scald, abrasions, and injury.

B. All plant material must be balled and burlapped or container grown unless otherwise specified. Each mst be labeled with genus, spceies, and variety with waterproof labels.

C. Trees: Unless Multi-stem trees are specified, all trees must have straight trunks and an unpruned central leader. Root crown or root flare must be visible and free of soil. Any tree not meeting these requirements will be rejected.

2.3 PLANTING SOILS

A. Topsoil: As specified in Section 312323.

B. Commercial planting soil: Commercially available planting mix appropriate for type of tree planted.

2.4 SOIL AMENDMENT MATERIALS

A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.

B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.

C. Commercial Products: Mushroom compost, manure, or planting mix that is approved by the engineer.

D. Lime: Ground limestone, dolomite type, minimum 95 percent carbonates.

E. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

2.5 MULCH MATERIALS

A. Mulching Material: Double Hammered Hardwood species wood shavings, free of growth or germination inhibiting ingredients. Apply mulch to a depth of 3"-4". Mulch should not touch tree trunks, base of shrubs, or root flare.

2.6 TOP SOIL MIX

A. A uniform mixture of 1 part soil amendment and 3 parts topsoil by volume. Unless otherwise specified on plans and details.

2.7 SOURCE QUALITY CONTROL

A. Provide analysis of topsoil; comply with requirements of Section 014000.

B. Provide testing of imported topsoil.

C. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt and organic matter; pH value and micro nutrients.

D. Submit minimum 10 oz (280 g) sample of topsoil proposed. Forward sample to testing laboratory in sealed containers to prevent contamination.

E. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that prepared subsoil and planters are ready to receive work.

B. Saturate soil with water to test drainage.

C. Verify that all utilities have been marked.

3.2 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove construction debris, stones larger than 1 inch, foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil. Dispose all materials legally off site.

C. Scarify subsoil to a depth of 3 inches (75 mm) where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

D. Dig pits for shrubs and ornamental grasses 3 times larger than the rootball or container size;2 times larger for ground cover.

3.3 PLANTING BED ESTABLISHMENT

A. Spread topsoil to a minimum depth of 6 inches (150 mm) for all exterior beds and 12" for parking islands or between hardscapes when soil areas are less than 100sf.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

D. Grade and rake topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches (150 mm).

3.4 PLANTING

A. Place plants as indicated.

B. Place plants as indicated for review and final orientation by Engineer.

C. Set plants vertical.

D. All plants shall be installed in accordance to planting details.

E. Remove non-biodegradable root containers.

F. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches (of 150 mm) under each plant. Remove burlap, ropes, and wires, from the root ball.

G. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch (150 mm) layers. Maintain plant life in vertical position.

H. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.5 PLANT SUPPORT

A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:

1. Tree Support Method: 3 guy wires with eye bolts and turn buckles

3.6 TREE PRUNING

A. Prune trees as recommended in ANSI A300 Part 1.

B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.7 MAINTENANCE

A. See Section 320190 - Operation and Maintenance of Planting for post-occupancy maintenance.

END OF SECTION

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SECTION 330110.58 - DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Disinfection of site water distribution, potable water process, fire supply, and building domestic water piping.

B. Disinfection of water storage tanks, including potable water pump wetwells.

C. Disinfection of potable water treatment system components.

D. Testing and reporting results.

1.2 RELATED REQUIREMENTS

A. Section 331416 - Site Water Utility Distribution Piping.

B. Section 331636 - Prestressed Concrete Storage Tank.

C. Section 033000 - Cast In Place Concrete

1.3 REFERENCE STANDARDS

A. AWWA C653 - Disinfection of Water Treatment Plants.

B. AWWA B300 - Hypochlorites 2018.

C. AWWA B302 - Ammonium Sulfate 2016.

D. AWWA B303 - Sodium Chlorite 2018.

E. AWWA C651 - Disinfecting Water Mains 2014.

F. AWWA C652 - Disinfection of Water-Storage Facilities 2011.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

1. Disinfection Procedure:

a. Submit a narrative of the disinfection procedure for engineer approval. The narrative shall include type of disinfectant planned and calculations indicating quantities of disinfectants required to produce a specified chlorine concentration to achieve disinfection.

b. Disinfection of storage tanks: Comply with Sections 3 and 4 of AWWA C652.

2. Product Data: Submit manufacturer data for proposed doses and treatment chemicals

3. Manufacturer's Certificate: Certification from manufacturer that indicates and certifies that the product meets or exceeds the specified requirements and AWWA Standards.

4. Qualification Statements:

a. Submit qualifications for manufacturer and applicator.

B. Test Reports: Indicate results comparative to specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Disinfection report:

1. Type and form of disinfectant used.

2. Date and time of disinfectant injection start and time of completion.

3. Test locations.

4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.

5. Date and time of flushing start and completion.

6. Disinfectant residual after flushing in ppm for each outlet tested.

B. Certify that final water complies with disinfectant quality standards of the authorities having jurisdiction.

C. Bacteriological report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water complies, or fails to comply, with local bacterial standards of for potable water.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651, AWWA C652, and AWWA C653.

B. Applicator: Company specializing in disinfecting specified in this Section with minimum three years documented experience.

C. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the State in which the Project is located.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Piping system disinfection chemicals: AWWA B300 Hypochlorite, AWWA B302 Ammonium Sulfate, and AWWA B303 Sodium Chlorite.

B. Storage tank disinfection chemicals: AWWA C652, Section 4 compliant Chlorine.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping system and water storage tanks have been cleaned, inspected, and pressure and leak tested.

B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

C. Tank Inspection:

1. Conduct visual inspection of tank prior to disinfection procedures.
2. Verify that interior of tank has been properly cleaned and is free of dirt and other miscellaneous construction debris.
3. Inspect all piping and vent connections for proper sealing and potential obstructions.
4. Disinfection procedure shall not proceed until paint is fully cured per manufacturer's instructions.

3.2 DISINFECTION

A. Site water distribution, potable water process, fire supply, building domestic water piping, and potable water treatment system components.

1. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651 and AWWA C653.
2. Provide and attach equipment required to perform the work.

3. Introduce treatment into piping system.
4. Maintain disinfectant in system for 24 hours.
5. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
6. Replace permanent system devices removed for disinfection.

B. Water Storage Tanks, including pump wetwells:

1. Utilize one or more methods below per AWWA C652 , Section 4:

a. Methods 2 or 3 shall be used for disinfection of the tank in accordance with the above referenced standards for potable water storage tank disinfection.

b. When method 3 is selected, the required disinfection plan shall address any compatibility issues with the form of chlorine utilized for disinfecting the storage tank with the type of disinfectant used in the normal production of the water used to fill the tank.

3.3 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 014000.

B. Use potable water for cleaning and testing system components and tanks. Coordinate filling schedule and water use flow rate with the Owner prior to filling. Potable water used for initial filling and testing will be furnished by the Owner free of charge. Water used for any retesting due to failed bacteriological tests may incur water rate charges at the prevailing rate at the discretion of the Owner. All costs of cleaning, pressure testing, and bacteriological tests are to be paid by the Contractor.

C. Disinfection, Flushing, and Sampling of Site Water Transmission, Distribution, and Treatment Systems Piping:

1. Conduct disinfection procedure in accordance with AWWA C651 and AWWA C653.
2. Upon completion of the specified retention period for the selected disinfection chemical, system shall be flushed until a point in which the water exiting the system has a concentration no higher than generally present in the existing system or is acceptable for domestic use by jurisdictions having authority.
3. Legally dispose of chlorinated water.
4. Deliver the sample to a qualified laboratory and provide copies of laboratory results indicating acceptable results.
5. Certify that final water complies with disinfectant quality standards of the authorities having jurisdiction.

D. Disinfection, Flushing, and Sampling of Water Storage Tanks:

1. Conduct disinfection procedure in accordance with AWWA C652.
2. Analyze water samples for bacterial contamination, residual chlorine, and any additional analytical requirements as specified by authorities having jurisdiction.
3. Collect samples of water from tank for bacteriological analysis in accordance with AWWA C652, Section 5, collected from both the inlet and outlet of tank.
4. Deliver the sample to a qualified laboratory and provide copies of laboratory results indicating acceptable results.
5. In the event a water sample fails to meet the state health standards for potable water, the contractor shall eliminate the source of contamination in water supply, repeat the disinfection procedure as specified, and retest the water quality following the repeated disinfection procedure.

END OF SECTION

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SECTION 330561 - CONCRETE MANHOLES, PRECAST UTILITY STRUCTURES, AND WASTEWATER CATCH BASINS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage, and accessories.

B. Precast concrete utility vaults with covers, hatch, and accessories.

C. Precast Reinforced Concrete Manholes for Stormwater

D. Catch Basins

1.2 RELATED REQUIREMENTS

A. Section 034100 - Precast Structural Concrete

B. Section 033000 - Cast-in-Place Concrete.

1.3 REFERENCE STANDARDS

A. ASTM C858-19 - Standard Specification fro Underground Precast Concrete Utility Structures

B. ASTM C857 - Standard Practive for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

C. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2003 (Reapproved 2016).

D. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections 2019.

E. ASTM C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections (Metric) 2019.

F. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric) 2018.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide concrete mix design information, hatches, component construction, features, configuration, and dimensions.

C. Shop Drawings: Indicate locations, elevations, piping sizes and elevations of penetrations.

D. Manufacturer's Qualification Statement.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 MATERIALS

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 (ASTM C478M), with resilient connectors complying with ASTM C923 (ASTM C923M).

B. Concrete: As specified in Section 034100, 033000.

C. Concrete Reinforcement: As specified in Sections 034100, 033000.

D. Utility vaults shall comply with ASTM C858-19 and ASTM C857-19.

E. Precast Reinforced Concrete Manholes for Stormwater shall comply with material standards per Georgia Department of Transporation Standards.

2.2 COMPONENTS

A. Frame and Cover: ASTM A48/A48M Class 30B cast iron construction, machined flat bearing surface; hinged; sealing gasket.

B. Utility Vault Hatch: Removable, lockable; closed hatch design, of aluminum construction.

C. Utility Vault Ladder: Provide one of the following;

1. Integrally cast ladder provided by the utility vault manufacturer.

2. Retrofit ladder compliant with section 055133 to precast structure.

D. Manhole Steps: Formed galvanized steel rungs; 3/4 inch (19 mm) diameter. Formed integral with manhole sections.

2.3 CONFIGURATION

A. Manhole Configuration

1. Shaft Construction: Concentric with concentric cone top section; lipped male/female dry joints; sleeved to receive pipe sections.

2. Shape: Cylindrical.

3. Clear Inside Dimensions: 48 inches (1,200 mm) diameter.

4. Design Depth: As indicated.

5. Clear Lid Opening: 26 inches (660 mm) diameter.

6. Pipe Entry: Provide openings as indicated.

7. Steps: As required by code.

B. Stormwater Manhole Configuration:

1. As indicated in the Construction Drawings and as specified per Georgia Department of Transporation Standards.

C. Utility Vault Configuration

1. Pre cast utility vault configuration as shown on Project construction drawings.

2. Shape: Rectangular

3. Clear Inside Dimensions: As indicated

4. Design Depth: As indicated

5. Pipe Entry: Provide openings as indicated.

6. Ladder access: Provide integrally cast ladder to precast structure from utility vault manufacturer or retrofit structure with access ladder per 055133.

7. Entry Hatch: Rectangular, Single leaf aluminum hatch. Sizing as Indicated.

2.4 CATCH BASINS (CB-1, CB-2)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Advanced Drainage Systems, Inc.: www.ads-pipe.com

2. Substitutions: See Section016000-Product Requirements.

B. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermoforming process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.

1. For dissimilar pipe to catch basin connection: disimilar materials adaptor with double wide marmac coupler wrapped around connection. This adaptor to be provided by the catch basin manufacturer.

C. Frames and Covers: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange, and 26-inch-diameter flat cover.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify that built-in items are in proper location, and ready for roughing into Work.

C. Verify excavation for manholes is correct.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.3 UTILITY VAULTS

A. Place gravel base pad, fine grade top surface for level.

B. Place vault sections plumb and level, trim to correct elevations.

C. Cut and fit for pipe.

D. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.

E. Set cover frames and covers level without tipping, to correct elevations.

F. Coordinate with other sections of work to provide correct size, shape, and location.

3.4 MASONRY WORK

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

B. Lay masonry units in running bond. Course one unit and one mortar joint to equal 8 inches (200 mm).

C. Form concave mortar joints.

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

E. Install joint reinforcement 16 inches (400 mm) on center.

F. Place joint reinforcement in first and second horizontal joints above base pad and below lid frame opening.

END OF SECTION

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SECTION 331416 - SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water pipe for site conveyance lines.

B. Pipe valves.

C. Freeze proof yard hydrants.

D. Fire Hydrants.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for thrust restraints.

B. Section 099113 - Exterior Painting.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 330110.58 - Disinfection of Water Utility Piping Systems: Disinfection of site service utility water piping.

1.3 REFERENCE STANDARDS

A. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2015, with Editorial Revision (2018).

B. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2017.

C. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.

D. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges 2011.

E. AWWA C502 - Dry-Barrel Fire Hydrants 2018.

F. AWWA C504 - Rubber-Seated Butterfly Valves 2015.

G. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS 2017.

H. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service 2015.

I. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances 2017.

J. AWWA C602 - Cement-Mortar Lining of Water Pipelines in Place, 4 In. (100 mm) and Larger 2017.

K. AWWA C606 - Grooved and Shouldered Joints 2015.

L. AWWA C800 - Underground Service Line Valves and Fittings 2014.

M. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution 2016.

N. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service 2017.

O. UL 246 - Hydrants for Fire-Protection Service Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to

subsoil conditions or discovery of uncharted utilities.

1.5 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

1.6 MAINTENANCE MATERIALS

A. Furnish one tee operating wrench from manufacturer of yard hydrant of required length.

B. Furnish one tee operating wrench from valve manufacturer for every 5 gate valves and every 5 butterfly valves or fraction thereof furnished.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seal hydrant ends to prevent entry of foreign matter into piping.

B. Store materials in accordance to manufacturer's instructions.

PART 2 PRODUCTS

2.1 PVC WATER PIPE

A. PVC Pipe under 4 inch size: ASTM D1785 Schedule 80.

1. Fittings: ASTM D2466, PVC.

2. Joints: ASTM D2855, solvent weld.

B. PVC Pipe 4 inch size and greater: AWWA C900 Class 235 DR 18, with bell and spigot ends having gasket in bell end.:

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Gaskets: AWWA C111, rubber.

2. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

2.2 DUCTILE IRON WATER PIPE

A. Basic specification: For pipe with mechanical joints, provide ANSI/AWWA C151/A21.51 ductile iron pipe having pressure class as determined from embedment tables for bedding class and trench depth for actual installation for minimum 250 PSIG rate working pressure, laying condition 2, and depth of cover 2.5 or 5 feet, whichever requires the greater wall thickness. For pipe with flanges joints or grooved joints, provide ANSI/AWWA C115/A21.15 ductile iron pipe having minimum thickness class 53.

1. Pipe Lining: Provide standard cement mortar pipe lining complying with ANSI/AWWA C104/A21.4, and standard asphaltic coating over lining. For piping that is exposed and receives a finished paint system, delete exterior asphaltic seal coat and provide a corrosion resistant universal phenolic primer that is lead and chromate free on pipe exterior.

2. Fittings: Use gray or ductile iron fittings complying with ANSI/AWWA C110/A21.10 and C111/A21.11 for minimum 250 PSI working pressure rating, lined and coated same as connecting pipe. At Contractor's option, ductile iron compact fittings complying with ANSI/AWWA C153/A21.53 for a minimum 350 psi working pressure rating, lined and coated same as connecting pipe may be used for pipe with push-on joints or mechanical joints.

3. Joints: For pipe, fittings and valves, use the following joint types indicated for the specified locations, unless otherwise specified or shown.

a. Flanged Joint (FJ): ANSI/AWWA C115/A21.15 flanged joint complying with ANSI B16.1 for class 125 pound drilling, unless class 250 pound drilling is indicated on Drawings or is required for connecting valves. Use corrosion resistant alloy steel bolts and nuts, and rubber gaskets complying with Appendix A to ANSI/AWWA C115/A21.15. Provide flanged joints for normally visible piping, unless noted otherwise. For direct burial piping with flanged joints, use 18-8 stainless steel nuts and bolts.

b. Mechanical Joint (MJ): Mechanical joint complying with ANSI/AWWA C111/A21.11. Use corrosion resistant alloy steel bolts and nuts. Provide mechanical joints for direct burial piping or concealed piping within structures, for piping installed in tunnel liner, or, at Contractor option, for direct burial piping outside structures.

c. Push-On Joint (POJ): Push-on type joint complying with ANSI/AWWA C111/A21.11. Provide push-on joints for direct burial piping outside structures.

d. Restrained Joint (RJ): Factory fabricated joint restraint system to resist pressurized pipe thrust forces. For push-on type joint, use boltless system of rubber gasket embedded with equally spaced stainless steel segments to grip the pipe, with allowance for joint deflection, and rated for 250 psi working pressure. For mechanical joint, use assembly of ductile iron retainer gland and corrosion resistant alloy steel bolts and nuts having a minimum 250 psi working pressure rating and permitting joint deflection. Provide restrained joints where indicated on the Drawings and, at Contractor option, for direct burial piping thrust restraint in lieu of concrete and metal tie rods and bands.

2.3 COPPER TUBING: ASTM B88, TYPE K, ANNEALED.

A. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.

B. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.

2.4 POLYETHYLENE PIPE

A. PE, AWWA Pipe: AWWA C901, DR No. 9; with PE compound number required to give pressure rating not less than 200 psig, for sizes 2" and less.

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 200 psig.

2. Copper Fittings: Fittings for copper tubing and polyethylene tubing shall be red brass containing 85% copper, 5% lead, 5% tin, and 5% zinc in conformance with ASTM B 62.

a. Fittings may be flared or compression as applicable, in accordance with AWWA C 800.

b. Compression fittings shall utilize a compression nut and/or split clamp with tightening screw.

c. Stab type fittings are not approved.

2.5 VALVES

A. Gate Valves Up To 3 Inches (75 mm):

1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.

B. Gate Valves 3 Inches (75 mm) and Over:

1. AWWA C509 iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat.

a. Buried applications: mechanical joints, valve box with extension to grade.

b. Above ground applications: flanged ends, position indicator, and handwheel operator or square nut operator as shown on the Drawings.

C. Ball Valves Up To 2 Inches (50 mm):

1. Manufacturers:

a. Spears Manufacturing; www.spearsmfg.com.

b. NDS Inc.; www.ndspro.com.

c. Matco-Norca; www.matco-norca.com.

d. Substitutions: See Section 016000 - Product Requirements.

2. Schedule 80 PVC body, PVC ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, control rod, valve key, and extension box.

D. Butterfly Valves

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work for standardization with the Owner's system are the following:

a. Crispin/K-Flo.

b. Milliken Valve Company.

c. Mueller Co.; Water Products Div.

d. Pratt, Henry Company.

e. Val-Matic Valve and Manufacturing Corp. (American BFV).

2. General Description:

a. Rubber-seated, bubble-tight closing butterfly valves complying with AWWA C504 Class 150B, cast or ductile iron body, suitable for throttling service with AWWA C550 and ANSI/NSF 61 certified interior coating system, and further suitable for both frequent operation and for applications where valve operation occurs after long periods of inactivity. Furnish valves of design and metallurgy such that 18-8 stainless steel or Ni-Resist alloy cast iron forms mating seat against rubber seat, all retaining devices are constructed of corrosion resistant material, valve discs rotate to become streamlined with fluid flow in the full open position, and shaft seals are permanent self-adjusting type. Unless otherwise shown or specified, provide enclosed gear manual actuators. Furnish valves with epoxy interior coating system having a minimum dry film thickness of 4 mils and complying with AWWA C550. Provide butterfly valves with the following features depending upon valve installed location:

3. All except direct burial locations: Flanged ends for minimum 150 PSIG working pressure and complying with ANSI B16.1 for class 125 pound drilling.

a. Manual worm gear reducer type operator with cast body and non-ferrous trim providing torque outputs meeting or exceeding AWWA C504 requirements with hand wheel and valve position indicator.

b. Coordinate valve service actuator positions to allow easy access and so as not to interfere with other piping, structures, and equipment or to interfere with walkways and access routes; position above or beside valve accordingly.

4. Direct burial locations: conforming to the following:

a. Mechanical joint ends with fully gasketed, permanently sealed operating gear box suitable for underground service and submergence in water to 25 feet, and equipped with square wrench operating nut. All exposed nuts and bolts on the valve exterior, except those used in mechanical joints, must be 18-8 stainless steel. Utilize "Corten" bolts or approved equal for mechanical joints. Equip valves with enclosed traveling nut manual actuators. Furnish valves with epoxy exterior coating system having a minimum dry film thickness of 8 mils complying with AWWA C550 and suitable for submerged application. Where depth of valve is too great for operation by standard wrench, provide suitable, permanently installed valve stem extension and guide. For each valve, furnish valve box complying with Valve Boxes specification below.

E. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter. Valve box shall have drop type lid with "Stay Put" features, and extensions necessary to adjust to finish grade.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2. Where depth of valve is too great for operation of standard wrench, provide suitable, permanently installed valve stem extension and guide.

F. Flange Adapter:

1. Ductile iron flanged joint adapter suitable for minimum 150 PSIG working pressure and complying with ANSI B16.1 for class 125 pound drilling, unless class 250 pound drilling is indicated on Drawings or is required for connecting valves. Provide flanged adapter which utilizes ductile iron set screws and a standard mechanical joint gasket to join plain end pipe to integral flanged ends without welding or threading.

2. Firms offering products to comply with these requirements include:

a. EBAA Iron Sales, Inc.

b. Megalug

c. NAPPCO, Inc.

d. Uni-Flange

2.6 FREEZE PROOF YARD HYDRANTS

A. Manufacturers:

1. Woodford Manufacturing

2. Ferguson Enterprises, Inc.

3. Simmons Manufacturing Company

4. Substitutions: See Section 016000-Product Requirements.

B. Operation: Cam-type, cast iron lever control, and galvanized steel operating rod.

C. 1" diameter N.P.T. inlet with 1" NPSH hose nozzle outlet.

D. Drain holes shall be located at an elevation below the typical frost line at the Project Site to allow the yard hydrant to drain per manufacturers intent.

E. Description:

1. Type: Non-Freeze

2. Unit shall contain a method in which to be locked from unauthorized use.

3. All materials to be compatible with water and environmental conditions.

2.7 FIRE HYDRANTS

A. Manufacturers:

1. For standardization of fire hydrants on the Owner's system, furnish one of the following units:

a. Mueller Company, Centurion Fire Hydrant.

b. McWane, Inc.; M&H Traffic Model Style 129 Fire Hydrant.

c. American-Darling Mark 73-2 Fire Hydrant.

B. Dry-Barrel Fire Hydrants:

1. Description: Freestanding, traffic model ("breakable"), compression type, dry barrel 3-way fire hydrant, with one NPS 4-1/2 and two NPS 2-1/2 outlets, shut-off valve 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating

according to AWWA C550. Furnish cast-iron body, with harnessing lugs for optional reaction bracing, and with 6 inch size inlet connection compatible with connecting pipe. Provide positive shut-off main valve who minimum orifice diameter is at least 4-1/4 inches.

a. Standard: AWWA C502.

b. Pressure Rating: minimum 150 psig.

c. Outlet Thread: NFPA 1963 external hose thread for use by local fire department. Include cast-iron caps with steel chains.

d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.

e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.

f. Exterior Finish: Shop paint above grade portion with silver enamel. Apply one field finish coat of bright silver enamel to hydrant barrel.

g. Installation: Select depth of bury appropriate to actual hydrant installation (forty-two (42) inches minimum unless otherwise indicated).

h. Additional: Furnish one (1) operating wrench for each ten (10) hydrant furnished, or fraction thereof.

2.8 CHECK VALVES:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. McWane, Inc.; Clow Valve Co. Div. (Osklaloosa).

2. McWane, Inc.; M&H Valve Company Div.

3. Mueller Co.; Water Products Div.

B. Description: Iron body, bronze mounted, rubber faced disc, full opening check valves with flanged ends and stainless steel hinge points.

1. Standard: AWWA C508, equipped with outside weight and lever.

2. Interior Coating: Complying with AWWA C550.

3. Pressure Rating: 175 psig.

2.9 DOUBLE DETECTOR CHECK VALVES (DCVW)

A. Double Detector Check Valves:

1. Description: Iron body, full opening detector check valve with flanged or grooved joint ends and by-pass meter complying with AWWA C510.

a. Standards: UL 312 and FMG approved.

b. Pressure Rating: 175 psig.

2. In addition to detector check valves, furnish gate valve on each side of check valves and on either side of meter.

2.10 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies (TSVW):

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).

b. Ford Meter Box Company, Inc.

c. JCM Industries, Inc.

d. Romac Industries, Inc.

2. Description: Sleeve and valve compatible with drilling machine.
    a. Standard: MSS SP-60.
    b. Tapping Sleeve: Mechanical joint split sleeve and gate valve assembly suitable for working pressures up to 200 psig. Cast- or ductile-iron, two-piece bolted sleeve with recessed flanged outlet for new branch connection.
    c. Tapping Sleeve at Contractor's opinion or due to existing pipe material: Stainless steel tapping sleeve and gate valve assembly complying with AWWA C223 and suitable for working pressures up to 150 psig and testing pressures up to 225 psig. Fabricate sleeve unit, including shell, lugs, nuts, bolts, flange and test plug, from 18-8 stainless steel. Provide sleeve lining gasket and flange gasket of styrene butadiene rubber suitable for potable water service.
    d. Valve: Furnish gate valve and valve box complying with preceding Gate Valve specifications except provide one raised face flange mating tapping-sleeve flange.

2.11 CORPORATION STOP AND CURB STOP:

A. Manufacturers:
    1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
        a. Mueller Company, Division of Walter Industries, Inc.
        b. Ford Meter Box Company, Inc. (The); Pipe Products Div.

B. Service-Saddle Assemblies: Comply with AWWA C800. Provide assemblies suitable for 200 psig cold water working pressure. Include dual strap saddles and valve compatible with tapping machine.
    1. Service Saddles for Ferrous Pipe: Extra heavy, hot dripped galvanized malleable iron bodies with galvanized or cadmium plated double straps and nuts, retained neoprene gasket, and threads mating those of the corporation stop used.
    2. Service Saddles for Non-Ferrous Pipe: Heavy cast bronze or waterworks brass body and straps, bronze, brass or stainless steel screws or nuts and bolts, retained O-rings seal, and threads mating those of the corporation stop used.

C. Corporation Stops: Cast brass or bronze with end threads conforming with AWWA C800, and consisting of precision tapered, and individually lapped, key and body surfaces. Shop test each stop for leakproof shutoff at specified working pressure.

D. Curb Stops: Brass or bronze body with resilient plug, permanently non-grease lubricated, and with end connections appropriate to connecting tubing or pipe conforming with AWWA C800. Use stops rated not less than 175 psig working pressure at 180 Degrees F.

2.12 WATER METER BOXES

A. Description: High-density, reinforced plastic body with one piece cast iron lid, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length fit to over service piping, unless otherwise approved by the City. Provide box of size and height appropriate to installation of meter and accessories required.

2.13 WATER METER

A. Water Meters up to 2-inch size are furnished by the Owner for installation by the Contractor.

B. Bypass piping configuration and metering shall be provided for 2-inch and greater water meter configurations compliant with the standards and details of the Plans.

2.14 BACKFLOW PREVENTERS

A. Backflow Preventers (BFP): Reduced pressure type suitable for 150 psig working pressure and complying with ASSE 1013 and AWWA C511 specifications. Use flanged cast iron body with bronze trim. Furnish complete unit including preventer, strainer, and test cocks.

2.15 ACCESSORIES:

A. Pipe Detection Tape:

1. Metal core enclosed 3 inch wide protective plastic jacket which can be readily detected by electronic pipe locator instruments in general use. Provide blue color jacket with block letters reading "Buried Water Line Below".

B. Pipe Tracer Wire:

1. No. 12 AWG solid soft drawn copper having not less than 98 percent conductivity with NEC type THHN, THWN or XHHW insulation jacket. For splices, use direct bury kit DBY/DBR as manufactured by 3M or approved equal.

2.16 ANCHORAGE/SUPPORT MATERIALS:

A. Direct Burial Locations:

1. Concrete: Concrete conforming to ASTM C94 having a minimum compressive strength of 2,000 psi at 28 days.

2. Metal Tie Rods, Bands and Accessories: 18-8 stainless steel or other acceptable corrosion resistant components which when combined as a system resist applied thrust at test and working pressures, with suitable allowance for water hammer.

B. Course Granular Material for Pipe Bedding:

1. Crushed stone, crushed gravel, natural gravel, or similar material complying with ASTM C33, and having No. 67 gradation (3/4 inch to No. 4 sieve).

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.2 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.3 TRENCHING

A. See the sections on excavation and fill for additional requirements.

3.4 INSTALLATION - PIPE

A. Route pipe in straight line.

B. Install pipe to allow for expansion and contraction without stressing pipe or joints.

C. Slope water pipe and position drains at low points.

D. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

E. Install PVC Pipe in accordance with AWWA C605.

F. Install ductile iron pipe in accordance with AWWA C600.

G. Install HDPE pipe in accordance with ASTM D3261, ASTM F1962, and ASTM F2164.

H. Lay pipe at depth dictated by field conditions, but with distance from top of pipe to finished grade not less than forty-two (42) inches unless otherwise shown or specified.

I. Bed pipe on coarse granular material in flat bottom trench with entire pipe barrel bearing uniformly on course granular material, except for an approximately eighteen (18) inch gap pipe balance point for sling removal. Hand excavate and backfill as required to provide uniform and continuous bearing and support for the pipe. Do not support pipe on hubs or end bells. Consolidate coarse granular material under and around pipe up to pipe centerline by tamping.

J. Join pipe with bells facing direction in which laying operating is progressing. Lay pipe upgrade wherever line grade exceeds ten (10) percent.

3.5 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set fire hydrants plumb and with ground line index within one tenth (0.1) foot of actual final ground level. When fire hydrants are adjacent to streets, set pumper connection perpendicular to curb or edge of pavement.

D. When valves are installed in areas not subject to vehicular traffic, provide 18 inch square by 4 inch thick concrete pad around top of valve box and a 5 inch square by 4 foot long concrete valve marker. Install valve marker with 18 inches exposed above finished grade and letter "V" facing valve.

3.6 INSTALLATION - FREEZE PROOF YARD HYDRANTS

A. Install yard hydrants per Construction Plans and in accordance with manufacturers instructions.

B. Ensure proper drainage of hydrant following installation.

3.7 ANCHORAGE INSTALLATION:

A. Anchorage, General: Anchorage detailed on drawings, if any, represents minimum anchorage to be installed. Field conditions may require additional anchorage, and it is the contractor's responsibility to recognize such additional requirements and to provide appropriate additional anchorage.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches.

C. Apply full coat of asphalt or other acceptable corrosion resistant material to surfaces of installed ferrous anchorage devices.

D. Non-Direct Burial Locations:

1. Place hangers, anchors and other supports as required to prevent excessive sagging or undue strain on joints or equipment. Use factory fabricated hangers only, sized amply for imposed loads.

2. Provide effective anchorage for all pressure piping as necessary to resist thrust caused by unbalanced pressure, giving due allowance for test pressures and water hammer.

3. Install hangers and support in accordance with MSS SP-69.

E. Direct Burial Locations:

1. Anchor all bends, valves, tees, fire hydrants, reducers and other points of unbalanced pressure as necessary to resist thrust at test and working pressures, with suitable allowance for water-hammer. Also anchor piping system installed on steep slopes where gravitational force might otherwise cause piping displacement. Accomplish piping system anchorage by use of concrete reaction bracing, metal tie rods and bands, and/or restrained joint systems. When using concrete reaction bracing, pour concrete against firm earth and allow it to cure for at least five days before placing main under pressure. Position concrete blocks of sufficient size to counteract the magnitude and direction of the resultant force.

2. Accomplish fire hydrant assembly anchorage by use of metal tie rods and bands and/or restrained joint systems. Keep joints and hydrant drain openings clear and accessible. Provide special support blocks at plastic pipes according to manufacturer's recommendation. When using bands and tie rods in conjunction with reaction bracing, provide a separate band for each tie rod. Use corrosion resistant materials throughout. When using restrained joint systems, utilize methods and place these special joints at appropriate fittings and pipe joints in accordance with manufacturer's recommendation.

3.8 SPECIAL CONSTRUCTION

A. Where constructing on piers, supporting pipe on bridges, or other special work, use safe and generally accepted construction methods to accomplish the required work.

B. When installing water mains across creeks, streams or other drainage channels with flowing water, make installation using directional drilling techniques.

3.9 LINE CLEANING

A. Avoid permitting dirt, rubbish, construction materials, etc. to enter lines and appurtenances during construction. Use whatever means are necessary to obtain a clean and internally smooth system prior to final acceptance.

B. Limit use of flushing water to rates and quantities which will not interfere with service to water customers.

3.10 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Perform field inspection and testing in accordance with Section 014000.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

D. General Leakage Requirements:

1. Make entire water line system as near watertight as practicable. Eliminate all detectable leakage regardless of test results hereinafter required.

E. Testing:

1. Furnish and use appropriate test equipment and methods. Include gage, meter, pump and connections.

2. Bleed all air from system prior to testing, providing any necessary corporation stops and piping installations.

3. Pressure test all elements of the piping system. Where piping is buried or otherwise concealed, maintain the pressure for not less than six hours. Visible piping may be tested for a lesser time period, if approved by the Engineer. Conduct pressure testing at 200 psig unless a lower pressure is recommended by a manufacturer of an element of the system. When a manufacturer does recommend a lower test pressure, furnish the Engineer with a detailed written explanation before commencing test work. In no event may the lower test pressure be less than 110 percent of the nominal working pressure of the pipe comprising the system. Measure pressure for testing referred to the elevational datum of the lowest pipe of the line section being tested.

4. Where possible, use methods and perform construction work in such a sequence as necessary to accomplish pressure testing as work progresses. Do not pressure test more than one mile length of pipe at one time. Provide temporary piping and accessories if required to isolate test sections.

5. Makeup water required to maintain test pressure in gallons per hour per 1,000 feet of pipe under test, over the test period may not exceed the quantities shown in the following table:

Pipe Size (Inches)	Quantity (Gal. per Hour)	Pipe Size (Inches)	Quantity (Gal. per Hour)
2	0.16	16	1.26
3	0.24	18	1.42
4	0.32	20	1.58
6	0.47	24	1.89
8	0.63	30	2.37
10	0.79	36	2.84
12	0.95	42	3.31
14	1.10	48	3.79

6. Repair all breaks, detectable leaks or other defects and retest as many times as necessary to obtain passing test.

END OF SECTION

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SECTION 331636 - PRESTRESSED CONCRETE STORAGE TANK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Prestressed, non-elevated concrete water storage tanks.

B. Tension-fabric baffle curtain systems.

1.2 RELATED REQUIREMENTS

A. Section 012100 - Allowances: Cash, testing, and contingency allowances.

B. Section 013000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

C. Section 014000 - Quality Requirements: Procedures for testing, inspection, mock-ups, reports, certificates; use of reference standards.

D. Section 016000 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.

E. Section 017800 - Closeout Submittals: Project record documents, operation and maintenance (O&M) data, warranties and bonds.

F. Section 033000 - Cast-in-Place Concrete.

G. Section 033713 - Shotcrete.

H. Section 099600 - High Performance Coatings.

I. Section 312316 - Excavation.

J. Section 330110.58 - Disinfection of Water Utility Piping Systems.

K. Section 460506 - Water Treatment Piping.

1.3 REFERENCE STANDARDS

A. ACI 301 - Specifications for Structural Concrete 2016.

B. ACI 506.2 - Specification for Shotcrete 2013.

C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.

D. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.

E. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

G. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete 2020.

H. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.

I. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).

J. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field 2021.

K. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.

L. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.

M. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete 2020a.

N. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2020.

O. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber 2020.

P. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications 2018.

Q. ASTM D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications 2016.

R. ASTM D751 - Standard Test Methods for Coated Fabrics 2019.

S. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 2012.

T. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges 2011.

U. AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe 2014.

V. AWWA D110 - Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks 2013 (Reapproved 2018).

W. COE CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstop 1974.

X. NSF 61 - Drinking Water System Components - Health Effects 2020.

Y. SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).

Z. SSPC-SP 10 - Near-White Blast Cleaning 2007.

AA. ACI 372R - Design and Construction of Circular wire and Strand Wrapped Prestressed Concrete Structures

BB. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

CC. ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

DD. ASTM 506.2 - Standard Specification for Shotcrete.

EE. ASTM A821 - Standard Specification for Steel Wire, Hard-Drawn for Prestressed Concrete Tanks.

FF. NSF 54 - Flexible Membrane Liners.

GG. ASTM 4437 - Standard Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes

HH. COE CRD-C 572 - Corps Of Engineers Specifications For PolyvinylchlorideWaterstops.

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

JJ. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturers product data, including materials, dimensions, installation and use instructions and recommended application rates for the following items:

1. Waterstop.
2. Vibration equipment.
3. Bearing pads.

4. Joint sealant.
5. Prestress wire.
6. Steel plates and shapes.
7. Bolts and anchorage hardware.
8. Roof hatch.
9. Roof ventilator.
10. Ladders and railings.
11. Wall manhole.
12. Piping and fittings.
13. Baffle curtain fabric and fasteners.
14. Coatings.

C. Shop Drawings: Provide digital shop drawings to include the following:
1. Complete plan, elevation, and sectional views showing critical dimensions.
2. Indicate details of reinforcing steel, prestress tendons, joint design, concrete mix design, and openings.
3. Thickness of all parts of tanks structure including floor, core wall, dome, and covercoat.
4. Location and details of all accessories required.
5. Curtain baffle configuration, with associated calculations and anchoring details.
6. Prestressing schedule including number and placement of prestressing on the tank wall and total applied force per foot of wall height.

D. Certificate: Certify that products of this section meet or exceed specified requirements.

E. Design Data: Submit structural calculations for the tank, signed and sealed by a professional engineer registered in the state where the Project is located.

F. Manufacturer's Qualification Statement in accordance with specified manufacturer requirements.

G. Cleaning and disinfection plan: Submit a cleaning and disinfection plan in accordance with project specifications.

H. Submit concrete batch tickets and concrete design mix in accordance with ASTM C94 with the following information at minimum:
1. Type, Name and quantity of admixtures,
2. Type, brand, and quantity of cement.
3. Total water content.
4. Maximum aggregate size.
5. Weights of fine and coarse aggregate in mixture.

I. Submit reports of concrete strength tests, slump tests, air contents test, and strength tests for engineer review as completed.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least five years of documented experience.

B. Materials in contact with potable water shall be certified to NSF 61/372.

C. Welder Qualifications: AWS qualified welder with previous 1 year employed for weld types required.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Precast Units:

1. Transport in accordance with lifting and handling as indicated by manufacturer utilizing lifting points as designed.

2. Do not place units in positions capable of causing overstress, warping, or twisting.

3. Stacked units shall be separated with battens that are located across the full widths of each bearing surface.

B. Reinforcing Steel:

1. On site fabricated reinforcing steel: Store with waterproof tags indicating grade, size and other relevant identification information. Store elevated and not in direct contact with ground.

2. Off site fabricated reinforcing steel: Identify fabricated bundles by structure and shop drawing ID number. Store elevated and not in direct contact with ground.

3. Store in a manner to protect from rust inducing conditions.

C. Ductile Iron Pipe:

1. Cover materials stored and elevate items so as not to be in direct contact with ground.

2. Handle in a manner recommended by manufacturer to prevent damage during moving, loading, and other common handling scenarios.

1.8 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations, layout, and final configuration of all water storage tanks and associated accessories.

1.9 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for workmanship and materials on the complete structural portion of the tank and coating systems beginning at the Date of Substantial Completion. Repairs within warranty period shall be made at no expense to the Owner. Liquid loss in excess of 0.050 percent of tank test volume over a 24 hour period is considered excessive leakage. In addition, damp spots on the exterior wall surface or measurable leakage at the wall base are considered defective and must be repaired.

C. Geo membrane manufacturer for baffle curtains shall certify material against deterioration due to ozone, UV exposure, or other normal weathering for 10 years following the Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PRESTRESSED CONCRETE STORAGE TANKS MANUFACTURERS

A. Crom Corporation; www.cromcorp.com.

B. Precon Corporation; www.precontanks.com.

C. Preload LLC.; www.preload.com.

D. Substitutions: See Section 016000 - Product Requirements.

2.2 DESIGN CRITERIA

A. Criteria: Design shall conform to relevant sections of ACI 372R - Design and Construction of Circular Wire and Strand Wrapped Prestressed Concrete Structures and ANSI/AWWA D110 - Wire and Strand-Wound, Circular, Prestressed Concrete Water Tanks with Type II core walls.

B. Sizing:

1. Minimum Capacity: 250,000 Gallons.

2. Minimum Dimensions: 70' Inside Diameter

C. Design Loads:

1. Dead Load: Estimated weight of permanent construction and fittings.
2. Live Fluid Load: weight of all liquid when the reservoir is filled to capacity. The unit weight of the liquid material shall be 62.4 lbs/ft^3.
3. Roof Live Loads: shall meet requirements set forth in ANSI/AWWA D110 and ASCE 7.
4. Wind Load: shall meet requirements set forth in ASCE 7.
5. Snow Load: shall meet requirements set forth in ASCE 7.
6. Seismic Loads: As required by ASCE 7.
    a. If sufficient freeboard height is not provided to prevent uplift forces due to water movement from seismic activity, the impulsive participation shall be increased due to the constrained motion of liquid, and the tank roof and its connection shall be designed to resist the uplift forces in accordance with P.K. Malhotra's "Earthquake Induced Sloshing in Tank with Insufficient Freeboard".
7. Soil Pressure: Earth loads shall be determined by rational methods of soil mechanics. Soil pressure shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.
8. Refer to structural drawings, sheet S0-1, for additional site specific load and design criteria.

D. Prestressed Walls:

1. Wire wound, prestressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, galvanized steel shell diaphragm.
2. The design of the core wall shall take into account the appropriate edge restraint.
3. Inside face reinforcement:
    a. The inside face of the core wall shall utilize the diaphragm as effective reinforcing.
    b. Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
4. Outside face reinforcement:
    a. Vertical reinforcing steel in the outside face of the core wall shall be at minimum: #4 bars at 12" on center.
    b. Additional vertical and horizontal reinforcing steel bars and mesh shall be used as required by design computations.
5. Minimum core wall thickness shall be 3.5 inches.

E. Floor Slab:

1. Concrete membrane floors shall be a minimum of four (4) inches thick, with a minimum thickness of eight (8) inches of concrete over all pipe encasements and around sumps.
2. Floor shall be placed monolithically and without construction joints.

F. Footings:

1. Above or below floor grade, placed monolithically with floor.

G. Domed Roof:

1. Dome roof shall be constructed of reinforced concrete and shall be circumferentially prestressed.
2. Dome shall be fixed to tank wall without columns or interior supports.

3. Rise to Span Ratio: Within range of 1:8 to 1:14.
4. Typical dome thickness and steel reinforcement shall meet the requirements as set forth in ANSI/AWWA D110. Thickness of dome shall be no less than three (3) inches.

H. Prestressing:

1. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn high carbon steel wire placed under high tension.
2. A substantial allowance shall be made for prestressing losses due to shrinkage,plastic flow in the shotcrete, and due to relaxation in the prestressing steel.
3. Prestress design shall conform with the following minimum requirements:
   a. Working stress of tank wall: 115,000 psi maximum.
   b. Working stress of dome ring: 120,000 psi maximum.
   c. The allowable design tensile stress in the prestressing wire before losses shall be 145,600 psi or no greater than 0.63 * the ultimate strength of the wire used.
   d. Areas to be prestressed will contain no fewer than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge.
   e. A maximum of 24 wires per layer per foot for 8 gauge and 20 wires per layer per foot for 6 gauge will be allowed.

I. Wall Openings:

1. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall provide no less than 18" clear space at the bottom of the wall to provide sufficient clear area or the prestressing wires. The prestressing wires required at the pipe elevation shall be distributed into circumferential bands immediately above and below the opening to maintain the required prestressing force while leaving an unbanded strip around the entire tank.
2. Unbanded strips shall have a vertical dimension of no more than 36" unless an axisymmetric shell analysis performed to account for compressive forces plus shear and moment caused by displacement of the prestressing wires into adjacent bands.

J. Baffle Curtain System:

1. All parts of the baffle shall be designed for installation in potable water. All parts shall be made from corrosion resistant and chemical resistant materials suitable for service treated water storage facilities and comply with current AWWA and ANSI/NSF 61 standards.
2. The suspended baffles and accessory materials shall be capable of withstanding exposure to chlorine and ammonia, extreme temperatures, rips, and hydraulic shock.
3. The system shall be suitable for expected water levels with daily fluctuations and shall have adequate strength to resist 0.5 inch of water elevation difference across the baffle.
4. Baffles shall be erected and anchored to the floor, walls, and roof as shown in the plans to provide a flow path for maximum contact time for potable water in the tank.

2.3 MATERIALS

A. Piping and fittings:

1. Ductile iron compliant with AWWA C150/A21.50 .
2. Interior piping shall comply with AWWA C115/A21.15.
3. Yard piping shall comply with requirements set forth in Section 460506.
4. Fittings: Ductile iron, compliant with AWWA C110/A21.10.

B. Coatings:

1. Color for coatings shall be approved by engineer and owner during submittal process.

2. Coating selection shall comply with manufacturers recommendation and Section 099600 - High Performance Coatings.
3. Exterior Tank Walls and Dome:
    a. Prepare exterior surfaces per SSPC-SP 1.
    b. Two coats of Modified Waterborne Acrylate with a dry film thickness of 4.0-6.0 mils per coat.
    c. Exterior coating shall be recommended by tank manufacturer with documented usage of paint utilized in exterior concrete tank coating applications.
4. Interior Exposed Piping:
    a. Prepare exterior pipe surfaces per SSPC-SP 10.
    b. Manufacturers standard zinc rich primer or epoxy primer compatible with finish coat wit a minimum of 3.0 mils dry film thickness. Provide finish coats for submerged service as specified in Section 099600.

C. Concrete
1. Concrete shall conform to ACI 301.
2. Portland Cement: Comply with ASTM C33/C33M, Type I or II Portland Cement.
3. A maximum of 25% of cementitious material may be fly ash.
4. Aggregate shall comply with ASTM C33/C33M.
    a. Fine aggregate shall be washed natural sand. Weighted percentage of loss not more than 12 percent by weight when subjected to five cycles of magnesium sulfate soundness test in accordance with ASTM C88.
    b. Coarse aggregate shall not exceed a percentage of wear of 45 percent when tested in accordance with ASTM C535.
5. Concrete Mix Requirements:

Mix	Compressive Strength (psi)	Minimum Cement Content (lbs)	Maximum Aggregate Size (in)	Maximum W/C Ratio	Slump (in)
Floor	4000	560	3/4	0.45	4.5" ± 1.5"
Dome	4000	600	3/8	0.45	4.5" ± 1.5"

6. Admixtures:
    a. Air Entraining: Comply with ASTM C260/C260M.

D. Shotcrete:
1. Shotcrete shall comply with ACI 506.2 and with general requirements set forth in this Section and Section 033713 Shotcrete.
2. General Requirements:
    a. Portland Cement: Comply with ASTM C33/C33M, Type I or II Portland Cement.
    b. A maximum of 25% of cementitious material may be fly ash.
    c. All shotcrete in contact with diaphragm of prestressing wire shall be proportioned to consist of not more than three parts sand to one part Portland cement by weight. All other shotcrete shall be proportioned to consist of not more than four parts sand to one part Portland cement by weight.
    d. Admixtures shall not contain more than trace amounts of chlorides, fluorides, sulfides, or nitrates.
3. Shotcrete Mix Requirements:

Mix	Compressive Strength (psi)	Maximum W/C Ratio	Slump (in)

Core Wall	4000	0.42	5.0" ± 1.0"
Covercoat	4000	0.42	5.0" ± 1.0"

E. Pre Stressed Reinforcement:

1. Pre stressed reinforcement material shall meet ASTM A821
2. Wire:
   a. Cold drawn, high carbon.
   b. Minimum ultimate tensile strength:
      1) 8 gauge: 231,000 psi.
      2) 6 gauge: 222,000 psi.
3. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the prestressing reinforcement and shall develop the full strength of the wire.

F. Non-prestressed Reinforcement:

1. Non-prestressed mild reinforcing steel shall comply with ASTM A615/A615M
   a. Grade 60.
2. Welded steel wire fabric shall be plain wire confirming to the requirements of ASTM A1064/A1064M.
3. All reinforcement steel shall be accurately formed and free of rust and other contaminants that are capable of reducing strength of bonds and welds.

G. Galvanized Steel Diaphragm:

1. Galvanized steel diaphragm shall comply with ASTM A653/A653M with a minimum thickness of 26 gauge.
2. Diaphragm shall be vertically rubbed with re-entrant angles and erected so that a mechanical key is created between shotcrete and diaphragm.
3. Joints:
   a. Horizontal joints shall not be permitted.
   b. Vertical joints shall be sealed using epoxy injection.

H. Baffle Curtain Assembly:

1. Fabric:
   a. NSF61 compliant for use in potable water. Fabric shall have a knitted polymer coated polyester fabric with a 6.5 oz/SY minimum weight.
   b. Fabric shall be of good appearance and free of all defects such as holes, tears, blisters, and any other defects that may affect its serviceability.
   c. The coated fabric shall not be less than 30 mils thickness with a +10% allowable variation. There shall not be less than 7 mils thickness of polymer coating over the base fabric.
   d. Polyester fabric shall be non-wicking and UV stable (black or black/white).
   e. Physical Properties: The fabric shall at minimum meet the following criteria.
      1) Tear Strength: 35/35 lb min. (ASTM D751 - Trapezoid Tear)
      2) Breaking Yield Strength/Bonded Seam Strength: 550/550 lb min. (ASTM D751 - Grab Tensile Procedure A)
      3) Adhesion Heat Sealed Seam: 35lb/2 in min.(ASTM D751 - Dielectric Weld)
      4) Dead Load Seam Shear Strength: 2 inch seam, 1 inch strip. 210 lb @ 70 degrees Fahrenheit, 105 lb @ 160 degrees Fahrenheit. (ASTM D751 - Ball Tip)
      5) Bursting Strength: 350 lb min, 800 lb typical. (ASTM D751 - Method A)

6) Hydrostatic Resistance: 800 psi min. (ASTM D751 - Method A)

f. Factory seams shall be made by thermal fusion methods. All factory seams shall have a minimum scrim to scrum overlap of 1.5 inches when fabricated. Fabricated seams found having less than the specified minimum overlap shall be repaired by adding an overlap or cap strip that provides the specified minimum overlap. All seams shall be made so that thermal fusion bond extends fully along the width of the sheet so that no loose edges are present.

g. The shear seam strength of factory welds shall be tested in accordance with ASTM D751 as modified in Annex A of ANSI/NSF 54. Peel adhesion shall be tested in accordance with ASTM 4437 as modified in Annex A of ANSI/NSF 54.

2. Fasteners and Hardware:

a. All bolts, washers, nuts, and expansion anchors shall by type 316 stainless steel, with a minimum diameter of 3/8 inches.

b. Curtain connection shall be fiberglass angle, minimum dimensions of 1/4" thickness x 2" wide x 2" depth.

c. Suspension and tension for the top and open ends of the curtains shall be 3/16" diameter cable of 316 stainless steel with cable clamps and thimbles of 316 stainless steel.

I. Minor Components Materials:

1. Moisture Barrier

a. 6 mil, class A polyethylene conforming to ASTM D4397 .

2. Waterstops:

a. Waterstops shall conform to the requirements set forth in COE CRD-C 572.

b. Material: polyvinyl chloride (PVC).

c. Profile and size of waterstop shall be suitable for the hydrostatic pressure and movements to which it is exposed.

3. Bearing Pads:

a. Bearing pads shall be of neoprene, natural rubber, or polyvinyl chloride compliant with ASTM D2000.

4. Joint Filler

a. ASTM D1056, type 2 closed cell neoprene.

5. Epoxy Sealant:

a. Conform to the requirements of ASTM ASTM C881/C881M.

b. Epoxy used for sealing the diaphragm shall be Type III, grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy.

c. Epoxy used for placing the waterstop shall be Type II, Grade 2, and shall be 100% solids, moisture insensitive, low exotherm epoxy.

d. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77 degrees Fahrenheit.

e. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC, and steel.

J. Tank Accessories:

1. Roof Hatch

a. Material: Fiberglass reinforced polyester resin with minimum 3/16 inch thick and reinforced as required to support a minimum 200 pound live load.

b. Size and installation location: Hinged, insect proof, not less than 30 inches square set on a minium 4 inch high curb with necessary hardware of stainless steel as

indicated on drawings.

c. Security: Locking hasp with a bronze cylinder lock.

2. Roof Ventilator

a. Dome type fiberglass reinforced polyester resin with glass content not less than 30 percent by weight and a minimum thickness of 3/16 inch. Provide white gel-coat finish on all exposed surfaces. Provide air passage of not less than 25 inches diameter. Protect opening with 20 mesh corrosion resistant (other than galvanized) screen with gross screen area not less than 820 square inches. Mount screen so that in the event of cloggage and negative pressures developed within the tank, the screen will displace to relieve tank pressure prior to any structural damage or distress occurring to the tank. Screen shall be mounted with stainless steel bolts.

3. Access Components:

a. Ladders: Design and fabricate all ladders in compliance with OSHA standards utilizing intermediate platform and cages, or rigid safety rail method at Contractor option. If rigid rail method is selected, furnish one complete climbing harness and accessories.

1) Exterior Ladder: Provide exterior aluminum vertical fixed ladder beginning 8 feet above tank foundation affording access to roof. On bottom ladder segment, provide climb preventive shield consisting of hinged, minimum 6 foot high aluminum shield with angled sides and hardware. Where roof is not flat enough to walk on safely, provide a fixed roof ladder for access to center of tank. Omit exterior ladder if exterior finished grade at roof hatch location is within 8 feet of top of tank wall.

2) Interior Ladder: Fabricate from fiberglass with Type 316 stainless steel fasteners.

b. Handrail: Aluminum complying with OSHA requirements. Locate handrail around roof hatch generally as indicated on the Drawings.

4. Wall Manhole

a. Material: 316 stainless steel.

b. Capable of withstanding maximum hydraulic forces without excessive deflection.

5. Overflow: Provide four precast concrete overflow cap and weir components near edge of the dome capable of discharging at a minimum rate of 2,000 gpm each. Cover opening with removable, fiberglass 20 mesh screen anchored by stainless steel hardware and fiberglass eyelid cover over top of overflow.

6. Mounting Pads: Provide shotcrete bosses as required for connection and support of conduit, piping, ladders, handrail and other accessories.

PART 3 EXECUTION

3.1 EXAMINATION

A. Comply with general requirements as set forth in section 017000 - Execution.

B. Verification of Conditions: Verify that subgrade elevations and grading for storage tank and location of storage tank are as indicated on construction drawings..

3.2 INSTALLATION

A. Excavation and Backfill:

1. Conduct excavation and backfill in accordance with Section 312316 - Excavation.

B. Concrete:

1. Concrete installation and formwork as specified in Section 033000 - Cast-in-place Concrete.

C. Shotcrete:

1. Shotcrete installation as specified in Section 033713 - Shotcrete.

D. Reinforcement:

1. Installation of reinforcement as specified in Section 033000 - Cast-in-place Concrete.

E. Floor and wall footings:

1. Construct floor and wall footings to dimensions as indicated on Drawings.
2. Place vapor retarder as specified over subbase, overlapping joints a minimum of six (6) inches, or as otherwise recommended by manufacturer.
3. Install inlet, outlet, drain pipes, overflow pipes, and other penetrations as indicated through floor and encase in concrete.
4. Install floor and wall footings monolithically. Construction joints in the floor or between the floor and wall footings are not permitted.
5. Vertical Waterstop:
    a. Install and support such that bottom of center bulb is at elevation of top of footing.
    b. Support waterstop without puncturing material.
    c. Splice waterstop using thermostatically controlled sealing iron.
    d. Bend test waterstop following welding following procedures indicated by manufacturer..
6. Floor shall be water cured for seven days.

F. Tank wall:

1. Shotcrete as specified in this section and Section 033713 - Shotcrete.
2. All shotcrete shall be applied by or under direct supervision of experienced nozzlemen certified by the American Concrete Institute.
3. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding to following layer.
4. No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.
5. No less than 1/8" thick shotcrete shall separate reinforcing steel and prestressing wire.
6. The diaphragm shall be encased and protected with no less than 1" of shotcrete in all locations.
7. The interior shotcrete shall receive a light broom finish.
8. Shotcrete shall be water cured for a minimum of 7 days or until prestressing is completed.

G. Epoxy Injection for Penetration sealing: Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure. Epoxy injection shall proceed only after the diaphragm has been fully encased inside and outside with shotcrete.

H. Tank dome:

1. All concrete shall be consolidated by means of a vibrator for proper encasement of reinforcing steel and welded wire fabric.
2. All surfaces at the joint between the wall and the dome shall be coated with bonding epoxy which complies with Section 2.8 Epoxy.
3. Plastic bolsters shall be used to support reinforcing steel and welded wire reinforcement to ensure positive control on placement of steel.
4. The exterior surface of the dome shall receive a light broom finish. The dome shall be water cured for a minimum of 7 days after casting or until dome band prestressing is completed.

I. Steel Diaphragms:

1. Install steel diaphragm extending within 3 inches of full height of wall within horizontal joints.
2. Joints:
    a. Joints formed through roll-seaming or fastening with firm mechanical lock. If edge is not roll-seamed, an edge sealant must be utilized at the joint.
3. Openings: Holes shall not be made in the diaphragm, except for those required for pipe sleeves, reinforcing steel, or other special appurtenances. Seal surrounding opening with joint sealant.

J. Accessories:

1. Coordinate placement and orientation of tank accessories to be level, plumb and in alignment with adjoining work.
2. Utilize joint sealant as required to set and seal metal items.
3. Anchors:
    a. Provide and embed anchors and inserts in sufficient number for proper fastening of accessories. Embedment shall align with metalwork.
4. Fasteners:
    a. Drill holes as required in supports and metalwork, concealing fasteners when possible.

K. Prestressing:

1. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive force equal to that indicated on the design drawings.
2. Splicing of the wire shall be permitted only when completing the application of a full coil or wire or when removing a defective section of wire after installation.
3. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.
4. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire.
5. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.
6. When multiple layers are required, shotcrete cover between layers hall be no less than 1/8 inch thick.
7. Stress Recording:
    a. Furnish calibrated recording device that can be recalibrated to determine wire stress levels on wall during and after prestressing procedures. Calibrated machine shall be accurate to within 2%.
    b. Collect readings at an interval recommended by tank manufacturer.
    c. Take stress readings on straight length of wire.
    d. Record stress readings and identify height and layer of wire for each reading.
    e. Keep written records of readings.
    f. When applied stresses fall below the design stress in steel, provide additional wire to bring stress to the required design value.
    g. When stress in steel is more than 7 percent over required design stress, discontinue and adjust stressing procedure to achieve the specified value.

8. Covercoat:
    a. Following all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1" shall be placed over the prestressing wires.

L. Painting:
1. Apply approved coatings and paint per manufacturers instructions.

M. Baffle Curtain:
1. Tank contractor shall provide thickened areas beneath the membrane slab as required for securing the base of the baffle curtain.
2. Contractor shall field verify dimensions and provide the field dimensions to the baffle curtain fabricator prior to fabrication of the baffle curtains.
3. All work shall be fabricated and erected in accordance with the approved submittal drawings and verified dimensions. No field seaming shall be allowed.
4. Baffle shall be secured to the floor and wall with fiberglass angles with expansion anchors or cast in place threaded inserts constructed of 316 stainless steel.
5. Provide fiberglass NSF approved or stainless steel angle sandwiching the baffle curtain on the top edge and pen end of the baffle wall with 3/8 inch bolts for attaching the baffle to the top and the open end wall of the tank.
6. Provide 3/16" diameter cable of 316 stainless steel from the tank roof/wall to the top edge or open end of the baffle curtain to tension or suspend the baffle curtain.
7. Hardware and fasteners shall be of 316 stainless steel unless otherwise noted..

3.3 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Testing Agency: Engage a qualified geotechnical testing agency to perform concrete and shotcrete tests and inspections below as Owner's responsibility to be paid under the testing and inspections allowance of Section 012100, Allowances.

C. Concrete and Shotcrete Testing:
1. Sample frequency: At the start of placement of each class of concrete. Following the first sampling event, a total of 5 cylinders shall be collected for every 50 yards of concrete/shotcrete used. Slump tests and air contents tests shall be conducted at this frequency for concrete.
2. Compressive Strength Tests:
    a. Determine concrete strength from standard test specimens made and cured according to ASTM C31/C31M, and testing in accordance with ASTM C39/C39M.
    b. Test two (2) cylinders at seven (7) days,
    c. Test two (2) cylinders at 28 days.
3. Slump Tests (concrete only): ASTM C143/C143M
4. Air Contents Tests (concrete only): ASTM C231, ASTM C173/C173M.
5. Core drilling and testing:
    a. Frequency: as directed by engineer.
    b. Testing shall conform to ASTM C42/42M, ASTM C94/C94M.

D. Hydrostatic Testing:
1. Tanks shall be tested for water tightness upon completion of construction.
2. Contractor shall notify Engineer at least one (1) week prior to testing event.
3. Testing shall be completed following the minimum guidelines as follows:

a. Testing shall be conducted in dry weather conditions.

b. Tank shall be filled to maximum level for a minimum of 24 hours.

c. Inspect tank exterior and footing for dampness and signs of leakage.

d. All areas of leakage through wall, base, or wall-base joint shall be repaired and the testing procedure repeated until acceptance of testing is achieved.

E. Baffle Curtain Inspection:

1. Upon completion of baffle wall installation, contractor shall visually inspect the baffle walls for damage from ground level. Any repairs shall be made with newly manufactured material cut with rounded corners extending 4 inches in each direction from the damaged area. The entire repair shall be completely welded to the baffle wall.

3.4 CLEANING AND DISINFECTION

A. The interior of the tank shall be cleaned to remove debris, construction items, and equipment prior to testing and disinfection.

B. Disinfection shall be conducted per Section 330110.58 - Disinfection of Water Utility Piping Systems.

END OF SECTION

SECTION 333113 - SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to septic systems.

C. Cleanout access.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

B. Section 312316 - Excavation: Excavating of trenches.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 312323 - Fill: Bedding and backfilling.

E. Section 330561 - Concrete Manholes, Precast Utility Structures, and Wastewater Catch Basins.

1.3 REFERENCE STANDARDS

A. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe 2018.

B. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2015, with Editorial Revision (2018).

C. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2020.

D. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2017.

E. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories, and fittings.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

E. Field Quality Control Submittals: Document results of field quality control testing.

F. Project Record Documents:

1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS

A. Ductile Iron Pipe: ASTM A746, Pressure Class 350, with asphaltic lining, inside nominal diameter as indicated on drawings, bell and spigot end.

B. Joint Seals for Ductile Iron Pipe: AWWA C111/A21.11; styrene butadiene rubber (SBR) or vulcanized SBR gaskets.

C. Plastic Pipe: ASTM D2729, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter as indicated on construction drawings, bell and spigot style solvent sealed joint end.

D. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.2 PIPE ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.

2.3 CLEANOUT MANHOLE

A. Lid and Frame: Cast iron construction, hinged lid.

1. Lid Design: Open checkerboard grille.

2. Nominal Lid and Frame Size: 26 inches (660 mm).

B. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches (300 mm); nominal shaft diameter of 36 inches (900 mm).

C. Base Pad: Cast-in-place concrete of type specified in Section 033000, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

2.4 BEDDING AND COVER MATERIALS

A. Pipe Bedding Material: As specified in Section 312323.

B. Pipe Cover Material: As specified in Section 312323.

PART 3 EXECUTION

3.1 GENERAL

A. Perform work in accordance with applicable code(s).

3.2 TRENCHING

A. See Section 312316.13 for additional requirements.

B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.3 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

1. Plastic Pipe: Also comply with ASTM D2321.

C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

D. Connect to building sanitary sewer outlet and site septic system.

E. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

3.4 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.5 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 014000.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.6 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

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SECTION 333413 - SEPTIC TANKS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Septic tank, distribution box, and filter drainage field system.

1.2 RELATED REQUIREMENTS

A. Section 312200 - Grading: Soil cover over tank and drainage field.

B. Section 312316 - Excavation: General requirements for trenching for drainage field and connecting piping.

C. Section 312316.13 - Trenching: General requirements for trenching for drainage field and connecting piping including compaction testing.

D. Section 312323 - Fill: General requirements for backfilling piping trenches including compaction testing.

E. Section 312323 - Fill: Soil cover over tank and drainage field.

1.3 REFERENCE STANDARDS

A. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2017.

B. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate plan, location and inverts of drainage field, inverts of connecting piping.

C. Product Data: Provide data on tank accessories.

D. Project Record Documents: Accurately record actual locations and inverts of buried pipe, components, and connections.

1.5 QUALITY ASSURANCE

A. Comply with applicable code and regulations for work of this section.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of systems.

PART 2 PRODUCTS

2.1 SEPTIC TANK AND DISTRIBUTION BOX

A. Manufacturers: Georgia Department of Public Health, Environmental Health Section; Approved Concrete Septic Tank Manufacturers

1. 3G Tanks.
2. Bartow Precast, Inc.
3. Candler Concrete Products, Inc.
4. Oldcastle Precast, Inc.
5. Substitutions: See Section 016000 - Product Requirements.

B. Septic Tank: State Approved precast concrete construction, 4,000 psi (27.5 MPa) 28 day minimum strength, concrete partitioned chambers, concrete lid with lift rings, vent, inlet inspection hole, inlet turned down minimum 12 inches (300 mm) below effluent level.

C. Tank Capacity: 1,000 gallon (3,785 liter).

D. Distribution Box: Reinforced concrete, single inlet, two outlets, gate, removable cover with lift ring.

2.2 CONNECTING PIPE MATERIALS

A. Ductile Iron Pipe: ASTM A746 extra heavy grade, plain end joint; nominal inside diameter of 6-inches.

1. Joint Device: AWWA C111/A21.11 ribbed styrene butadiene rubber (SBR) or vulcanized SBR gasket; stainless steel clamp ring, expanding sleeve.

B. Plastic Pipe (PVC) Type Solid: ASTM D2729; nominal inside diameter of 6-inches, bell and spigot solvent sealed joints.

C. Fittings: Same material as pipe, tee bends, elbows, cleanouts, reducers, ends to suit pipe joint.

2.3 FILTER DRAIN PIPE MATERIALS

A. Plastic Pipe (PVC) Type Perforted: ASTM D2729; plain end, nominal inside diameter required by the absorption field chambers to be installed.

B. Use perforated pipe at filter field system; unperforated through sleeves and at junction with distribution box.

2.4 BEDDING AND BACKFILL MATERIALS

A. Provide bedding and backfill materials as specified in Section 312323 and as follows:

B. Tank Bedding Material: Granular fill.

C. Tank Backfill Material: Granular fill.

D. Connecting Piping Bedding Material: Granular fill.

E. Connecting Piping Backfill Material: Granular fill.

F. Filter Drain Bedding Material: Granular fill.

G. Filter Drain Cover Material: Granular fill.

2.5 CHAMBER FIELD DRAINAGE SYSTEM

A. Chamber System to be Quick4, High Capacity Leach Field Chambers by Infiltrator Water Technologies, or approved equivalent, and installed as shown in The Plans.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that building sanitary sewer connection, size, location and invert are as indicated.

3.2 PREPARATION

A. Consult with Hall County Health Department prior to start of installation.

B. Ream pipe ends and remove burrs.

C. Remove scale and dirt from components before assembly.

D. Establish invert elevations for all components in the system.

3.3 EXCAVATING AND TRENCHING

A. See Section 312316 and Section 312323 for general requirements.

3.4 TANK INSTALLATION

A. Hand trim excavation for accurate placement of tank to elevations indicated.

B. Place bedding material level in one continuous layer not exceeding 6 inches (150 mm) compacted depth, compact to 95 percent.

C. Install septic tank and distribution box and related components on bedding in accordance with manufacturer's instructions.

D. Backfill around sides of tank, tamped in place and compacted to 95 percent.

3.5 CONNECTING PIPING INSTALLATION

A. Connect outlet between building sanitary piping and septic tank, between septic tank and distribution box, between distribution box and filter field header according to the Plans..

B. Slope piping to each successive component, minimum of 1/4 inch per foot (19 mm per m).

C. Cover pipe with backfill, sides and top.

3.6 INSTALLATION - DRAINAGE FIELD CHAMBER SYSTEM

A. Installation of the leaching chamber system shall be in accordance with the Georgia Department of Public Health, Environmental Health Section's "Manual for On-site Sewage Management Systems" and the "Rules of the Department of Public Health; Chapter 511-3-1.

B. Install Chamber System components to comply with the above standards and the manufacturer's installation instructions.

3.7 PROTECTION

A. Do not permit vehicular traffic over drainage field.

END OF SECTION

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SECTION 334100 - SUBDRAINAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Building Perimeter, Retaining Wall, and Under-Slab Drainage Systems.

B. Filter aggregate and fabric and bedding.

1.2 RELATED REQUIREMENTS

A. Section 312316 - Excavation: Excavating for subdrainage system piping and surrounding filter aggregate.

B. Section 312316.13 - Trenching: Excavating and backfilling for site subdrainage systems.

C. Section 312323 - Fill: Backfilling over filter aggregate, up to subgrade elevation.

1.3 REFERENCE STANDARDS

A. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2017.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe drainage products, pipe accessories, and aggregates for foundation, embedment and backfill..

C. Shop Drawings: Indicate dimensions, layout of piping, high and low points of pipe inverts, gradient of slope between corners and intersections.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Comply with applicable code for materials and installation of the work of this section.

2.2 PIPE MATERIALS

A. Manufacturers:

1. Hawk Plastic, LLC - Childersburg, AL.
2. Charlotte Pipe and Foundary, Charlotte, NC.
3. Diamond Plastics Corporation, Grand Island NE.
4. Substitutions: See Section 016000 - Product Requirements.

B. Polyvinyl Chloride Pipe: ASTM D2729; plain end, 6 inch (150 mm) inside diameter; with required fittings.

C. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.3 AGGREGATE AND BEDDING

A. Filter Aggregate and Bedding Material: Granular fill as specified in Section 312323.

2.4 ACCESSORIES

A. Pipe Couplings: Solid plastic.

B. Filter Fabric: Water pervious type, non woven fabric complying with GDOT Section 881, for Plastic Filter Fabrics.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that excavated base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 INSTALLATION

A. Place non woven filter fabric, aligned with the excavation. Provide fabric of sufficient width in order to ensure 3' of fabric overlap, upon completion of the installation of Bedding and pipe materials. Fabric overlaps, perpendicular to the excavation shall be no less that 5 feet.

B. Place a supporting layer of Fine Aggregate and Bedding material over compacted subgrade where drainage pipe is to be laid, and to the depth indicated or, if not indicated, to a compacted depth of not less than 6 inches.

C. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.

D. Place drainage pipe on compacted impervious fill.

E. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

F. Place pipe with perforations facing down.

G. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches (300 mm).

H. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.

I. Place aggregate in maximum 4 inch (100 mm) lifts, consolidating each lift.

J. Refer to Section 312323 for compaction requirements. Do not displace or damage pipe when compacting.

K. Connect to storm sewer system with unperforated pipe , through installed sleeves.

L. Coordinate the Work with connection to storm sewer system, and trenching.

3.3 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

SECTION 334211 - STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Storm drainage piping, fittings, and accessories.

B. Trench drains and Site surface drainage.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

B. Section 312316 - Excavation: Excavating of trenches.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 312323 - Fill: Bedding and backfilling.

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 REFERENCE STANDARDS

A. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe 2018.

B. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-MM (12- to 60-in.) Diameter 2018.

C. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe 2020.

D. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric) 2020.

E. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets 2020.

F. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric) 2020.

G. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2020.

H. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material 2014.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

B. Scheduling: Coordinate installation of stormwater gravity piping, trench drains, and other utilities so as to be completed so as not to disturb paving, fine grading, or grassing..

1.6 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Field Quality Control Submittals: Document results of field quality control testing.

E. Project Record Documents:

1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Comply with applicable code for materials and installation of the Work of this section.

2.2 STORMWATER PIPE MATERIALS

A. Provide products that comply with applicable code(s).

B. Ductile Iron Pipe: Utilized for storm and chemical catchment area, ANSI 151 ductile iron pipe and ANSI C153 fittings, utilizing MJ connections to connect to specified valves; Inside nominal diameter of 8 inches.

C. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class II with Wall type A; mesh reinforcement; inside nominal diameter of 18 inches (203.2 mm), bell and spigot end joints.

D. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.

E. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner; inside nominal diameter of 15" and 18" or otherwise indicated in the construction drawings. Piping shall be evaluated by the National Transportation Product Evaluation Program (NTPEP) or other approved test facility, meet the requirements of AASHTO M 294, Type S, soil-tight, fittings and couplings as recommended by the manufacturer, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.

1. Manufacturers:

a. Advanced Drainage Solutions

b. Substitutions: See Section 016000-Product Requirements.

2.3 PIPE ACCESSORIES

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.4 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

A. Catch Basin materials and installation shall be meet all applicable Georgia State Department of Transportation Standards.

B. Lids and Drain Covers: Gray Iron, ASTM A48, class 35b.

1. Trench Drain:

a. Lid Design: Linear grate.

b. Nominal Lid and Frame Size: 12 inches (304.8 mm) width.

c. Manufacturers:

1) CP&P; www.concretepandp.com

2) Hubbel Power Systems, Inc.; www.hubbell.com

3) Substitutions: See Section 016000 - Product Requirements.

C. Trench Drain System: Trench drain system assembled from factory fabricated, polymer concrete castings in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and grating.

1. Trench Nominal Width: 12 inches (305 mm).

2. Trench Section Length: 24 inches (609.6 mm).

3. Grating Support Frame: Like material to grating.

4. Loading: HS20 loading or greater.

5. Materials conforming to general requirements as set forth in ASTM C890 and ASTM C913.

2.5 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.1 TRENCHING

A. See Section 312316.13 - Trenching for additional requirements.

B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.2 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

1. Plastic Pipe: Also comply with ASTM D2321.

C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

D. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.

3.3 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND CLEANOUTS

A. Catch basins shall be installed per applicable Georgia State Department of Transportation Standards.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

D. Establish elevations and pipe inverts for inlets and outlets as indicated.

E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

F. Prefabricated trench drains:

1. Excavate; prepare substrate and supports according to the manufacturer's printed installation instructions.

2. Install prefabricated trench drain system according to the manufacturer's printed installation instructions.

3. Expansion, Construction, and Control Joints: Do not locate trench drain system on an expansion, construction or control joint in concrete or pavement. Where concrete or pavement joints running transverse to direction of flow cross the trench drain system, locate concrete or pavement joints and trench drain system joints so that both coincide.

4. Concrete Trench Support: 3000 pounds per square inch (20.68 MPa) compressive strength, minimum.

a. Provide support on all sides of trench in minimum thickness recommended by trench drain system manufacturer.

b. Screed and finish top edge of concrete flush with top surface of trench drain system.

c. Do not use secondary edge finishing tools.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 014000 - Quality Requirements.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.5 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 334213 - STORMWATER CULVERTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe culvert, joints and accessories.

B. Bedding and slope protection at pipe end.

1.2 RELATED REQUIREMENTS

A. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

A. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe 2020.

B. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric) 2020.

C. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets 2020.

D. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric) 2020.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe, fittings and accessories.

C. Accurately record actual locations of pipe runs, connections, and invert elevations.

PART 2 PRODUCTS

2.1 CULVERT PIPE, GENERAL

A. Regulatory Requirements: Comply with applicable code for materials and installation of the work of this section.

2.2 CONCRETE CULVERT PIPE

A. Manufacturers:

1. Forterra; www.forterrabp.com.
2. Foley Company; www.foleyproducts.com
3. Park USA; www.parkusa.com
4. Substitutions: See Section 016000 - Product Requirements.

B. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class III with Wall Type B; mesh reinforcement; bell and spigot end joints:

1. Shape: Circular with a nominal diameter of 18 inches or as indicated on the construction drawings.

C. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.

2.3 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

2.4 ACCESSORIES

A. Filter Fabric: Non-biodegradable, woven.

B. Fill at Pipe Ends: Riprap as specified on the Drawings. Fill to be constructed and arranged per applicable stormwater details on construction drawings.

PART 3 EXECUTION

3.1 EXCAVATING

A. See Section 312316.13 - Trenching for additional requirements.

B. Excavate culvert trench to 12 inches (300 mm) below pipe invert. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Place filter fabric over compacted backfill.

3.2 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe and accessories in accordance with manufacturer's instructions

C. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

D. Shore pipe to required position; retain in place until after compaction of adjacent fills. Ensure pipe remains in correct position and to required slope.

3.3 PIPE ENDS

A. Place fill at pipe ends, as indicated.

3.4 TOLERANCES

A. Lay pipe to alignment and slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

B. Maximum Variation From Intended Elevation of Culvert Invert: 1/2 inch (12 mm).

C. Maximum Offset of Pipe From True Alignment: 1 inch (25 mm).

D. Maximum Variation in Profile of Structure From Intended Position: 1 percent.

3.5 PROTECTION

A. Protect pipe and bedding from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 334500 - STORM WATER TREATMENT DEVICE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Section includes the furnishing and installation of storm water treatment units, complete and operable as shown and as specified herein, in accordance with the requirements of the plans and contract documents.

1.2 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

B. Section 312316 : Excavation Support and Protection

C. Section 312323 : Fill

D. Section 015630 : Temporary Erosion and Sediment Control

1.3 REFERENCE STANDARDS

A. ASTM C478 - Circular Precast Reinforced Concrete Manholes

B. ASTM C857 - Structural Design Loading for Underground Precast Utility Structures

C. ASTM C858 - Underground Precast Concrete Utility Structures

D. ASTM C150 - Portland Cement

E. ASTM C33 - Concrete Aggregates

F. ASTM C990 - Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

G. ASTM A320 - Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

H. ASTM D-4097 - Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

I. ASTM A48 - Gray Iron Castings

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of the SWTD with size, location and installation of service utilities.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide cut sheets for chosen manufacturer and model.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least five years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Contech Engineering Solutions; www.conteches.com.

B. Hydro-International; www.hydro-int.com/en.

C. Oldcastle Infrastructure; www.oldcastleinfrastructure.com.

D. Substitutions: See Section 016000 - Product Requirements.

2.2 SWTD SYSTEM

A. Basis of Design Manufacturer: Contech Engineering Solutions; Model CS-5.

B. Performance:

1. The SWTD shall be sized to treat at least 2 cubic feet per second (Water Quality Volume designated by the Georgia Stormwater Management Manual).

2. The SWTD shall be sized using the OK-110 particle distribution having particles ranging from 53 microns to 212 microns with a d50 of around 110 microns.

3. The SWTD shall be designed with a sump chamber for the storage of captured sediments and other negatively buoyant pollutants in between maintenance cycles. The minimum storage capacity provided by the sump chamber shall be 1.09 cubic yards. The boundaries for the sump chamber shall be limited to that which do not degrade the SWTD's treatment efficiency as captured pollutants accumulate. In order to not restrict the Owner's ability to maintain the SWTD, the minimum dimension providing access from the ground surface to the sump chamber shall be 16 inches in diameter.

4. The SWTD shall convey the flow from the peak storm event of the drainage network, in accordance with the required hydraulic upstream conditions as defined by the Engineer. If a substitute SWTD is proposed, supporting documentation shall be submitted that demonstrates equal or better upstream hydraulic conditions compared to that specified herein. The documentation shall be signed and sealed by a Professional Engineer registered in the State of the work. All costs associated with preparing and certifying this documentation shall be born solely by the Contractor.

2.3 MATERIALS

A. Housing unit of stormwater treatment device shall be constructed of pre-cast or cast-in-place concrete, no exceptions. Precast concrete components shall conform to applicable sections of ASTM C 478, ASTM C 857 and ASTM C 858 and the following:

1. Concrete shall achieve a minimum 28-day compressive strength of 4,000 pounds per square-inch (psi);

2. Unless otherwise noted, the precast concrete sections shall be designed to withstand lateral earth and AASHTO H-20 traffic loads;

3. Cement shall be Type III Portland Cement conforming to ASTM C 150;

4. Aggregates shall conform to ASTM C 33;

5. Reinforcing steel shall be deformed billet-steel bars, welded steel wire or deformed welded steel wire conforming to ASTM A 615, A 185, or A 497;

6. Joints shall be sealed with preformed joint sealing compound conforming to ASTM C 990;

7. Shipping of components shall not be initiated until a minimum compressive strength of 4,000 psi is attained or five (5) calendar days after fabrication has expired, whichever occurs first.

B. Internal Components and appurtenances shall conform to the following:

1. Hardware shall be manufactured of Type 316 stainless steel conforming to ASTM A 320;

2. Support brackets shall be manufactured of 5052 aluminum;

3. Fiberglass components shall conform to applicable sections of ASTM D-4097;

4. Manhole castings shall be designed to withstand AASHTO H-20 loadings and manufactured of cast-iron conforming to ASTM A 48 Class 30.

PART 3 EXECUTION

3.1 INSTALLATION

A. The contractor shall exercise care in the storage and handling of the SWTD components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commented shall be borne by the contractor.

B. Install in accordance with manufacturer's instructions.

C. The manufacturer shall provide the contractor installation instructions and offer on-site guidance during the important stages of the installation as identified by the manufacturer at no additional expense. A minimum of 72 hours notice shall be provided to the manufacturer prior to their performance of the services included under this subsection.

D. The contractor shall fill all voids associated with lifting provisions provided by the manufacturer. These voids shall be filled with non-shrinking grout providing a finished surface consistent with adjacent surfaces. The contractor shall trim all protruding lifting provisions flush with the adjacent concrete surface in a manner, which leaves no sharp points or edges.

3.2 CLEANING

A. The contractor shall removal all loose material and pooling water from the SWTD prior to the transfer of operational responsibility to the Owner.

END OF SECTION

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TANK DATASHEETS

1. Sodium Hypochlorite (NaOCl) DayTank

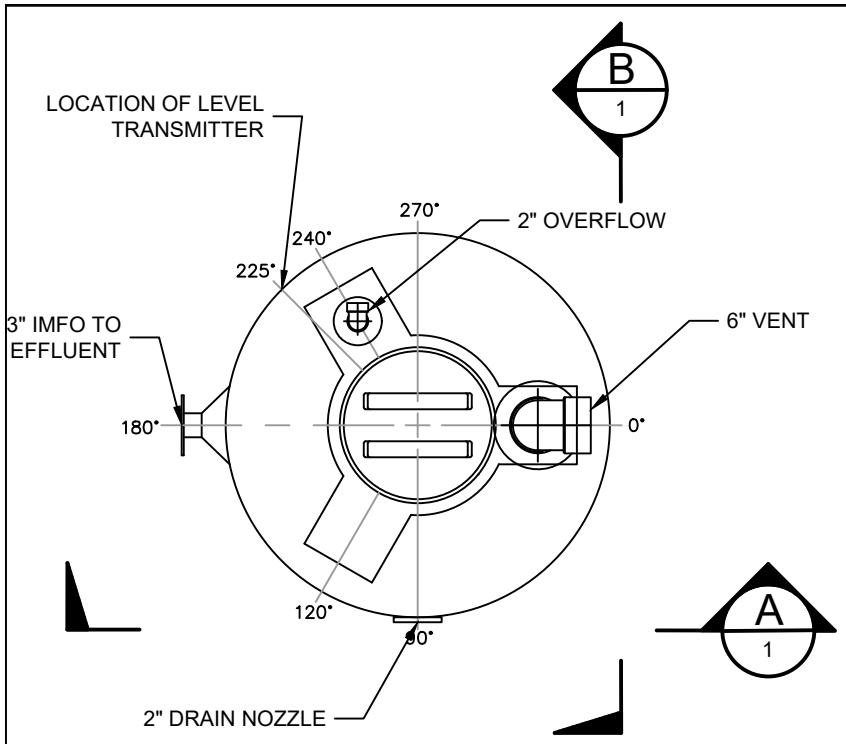
Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	Sodium Hypochlorite (NaOCl) Day Tank T-5002	**Contents**	Sodium Hypochlorite (NaOCl) 12.5%
Temperature	Standard Operation to 100F	**Minimum Volume**	280 Gallon
Maximum Height	4' 7.5"	**Maximum Diameter**	4' 00"
Environment	Interior	**UV Protection**	Not Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	N/A
Material Of Construction	Cross Linked Polyethylene, Black, with Antioxidant Interior Lining		

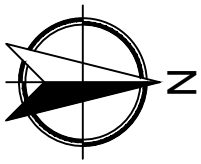
OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent – From Bulk Tank	1	2”	Runway Flat	Bolted Flange Fitting
Effluent	Effluent	1	0.5"	Lower Sidewall	Bolted Flange Fitting W/ Flex Fitting and Internal Siphon Leg
Manway	Manway	1	17” Diameter	Top of Tank	Threaded
Vent	Vent	1	6"	Runway Flat	Bolted Flange Fitting
Overflow	Overflow - To Containment	1	2"	Upper Sidewall	Bolted Flange Fitting
Drain	Drain - To Containment	1	3"	Lower Sidewall	IMFO Drain Flg. W/ Flex Fitting
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

Notes:

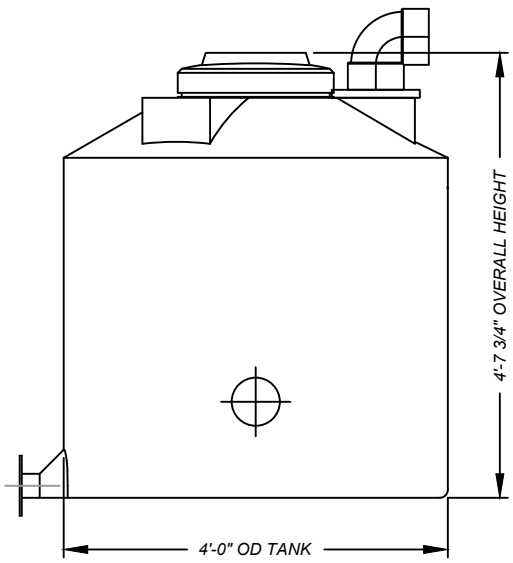
1.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.





NOTE:
MUST USE FLEXIBLE CONNECTIONS ALL LOWER SIDEWALL FITTINGS.

PLAN
1/2" = 1'-0"



SECTION A
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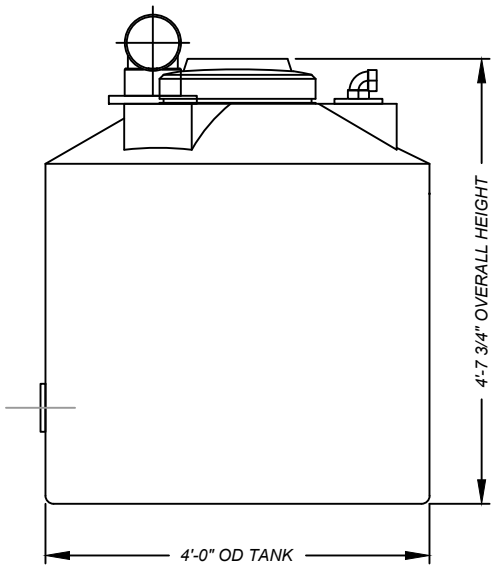

SECTION B
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SCALE:	1/2" = 1'-0"
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DRAWN BY:	TLC
DATE:	04/14/21

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keckwood.com

Buford Water Works Replacement
SODIUM HYPOCHLORITE DAY TANK
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG. 1

2. Sodium Hypochlorite (NaOCl) Bulk Tank A

Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	Sodium Hypochlorite (NaOCl) Bulk Tank A T-5001	**Contents**	Sodium Hypochlorite (NaOCl) 12.5%
Temperature	Standard Operation to 100F	**Minimum Volume**	2560 Gallon
Maximum Height	10'-3.5"	**Maximum Diameter**	7'-1"
Environment	Exterior, Covered	**UV Protection**	Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	2” Polyfoam Insulation with Mastic Coating. Silicone Pad Heaters and Heat tracing as recommended by manufacturer.
Material Of Construction	Cross Linked Polyethylene, Black, with Antioxidant Interior Lining		

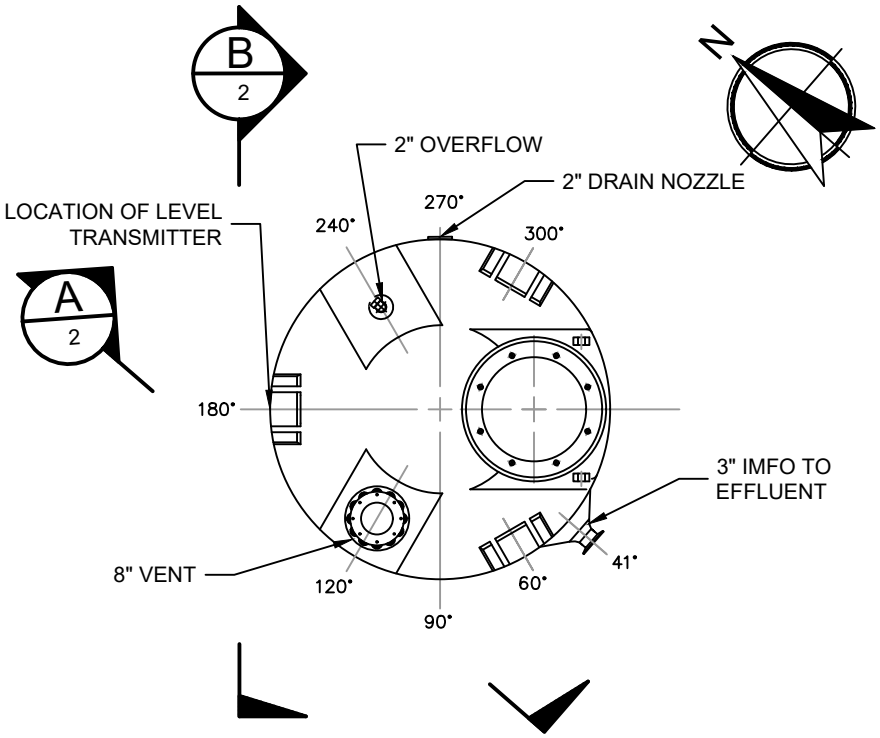
OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent Fill - Delivery	1	2”	Runway Flat	Bolted Flange Fitting
Effluent	Effluent to Day Tank	1	3”	Lower Sidewall	IMFO Drain Flg. W/ Flex Fitting
Manway	Manway	1	24” Diameter	Top of Tank	Bolted
Vent	Mushroom Vent	1	8"	Runway Flat	Bolted Flange Fitting
Overflow	Overflow - To Containment	1	2"	Upper Sidewall	Bolted Flange Fitting
Drain	Drain - To Containment	1	2"	Lower Sidewall	Bolted Flange Fitting W/ Flex Fitting
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

Notes:

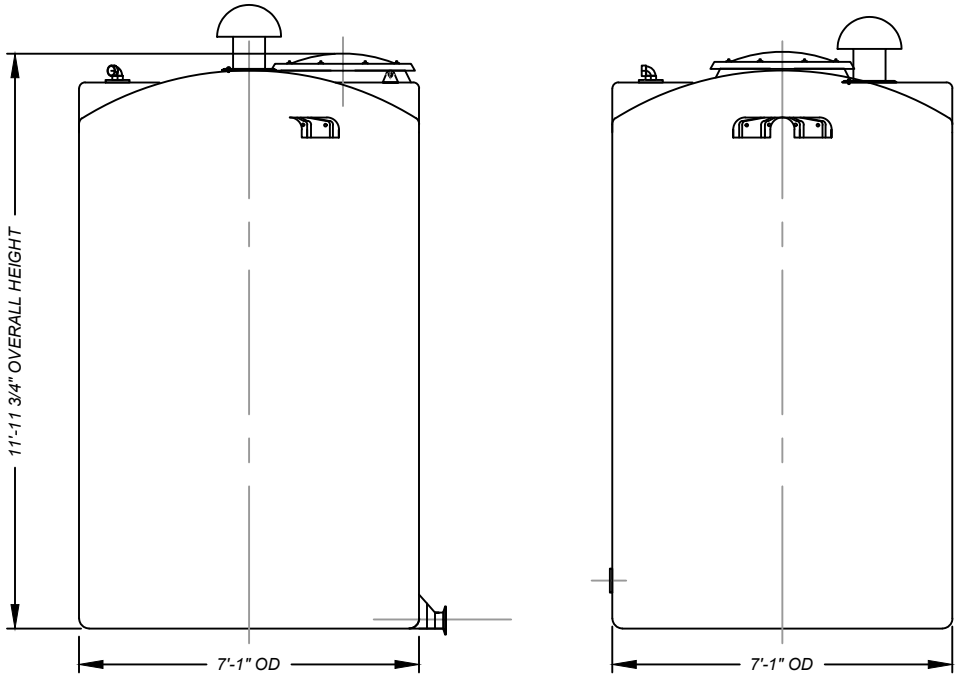
1.) Outside tank ladder to be provided, see specification 13200 for details.

2.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.



NOTE:
MUST USE FLEXIBLE CONNECTIONS ALL LOWER SIDEWALL FITTINGS.

PLAN
1/4" = 1'-0"



SECTION A
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SECTION B
1/4" = 1'-0"

SCALE:	1/4" = 1'-0"
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DATE:	04/14/21

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Buford Water Works Replacement
SODIUM HYPOCHLORITE BULK TANK A
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG.
2

3. Sodium Hypochlorite (NaOCl) Bulk Tank B

Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	Sodium Hypochlorite (NaOCl) Bulk Tank B T-5051	**Contents**	Sodium Hypochlorite (NaOCl) 12.5%
Temperature	Standard Operation to 100F	**Minimum Volume**	2560 Gallon
Maximum Height	10' 3.5"	**Maximum Diameter**	7' 1"
Environment	Exterior, Covered	**UV Protection**	Required
Bottom Type	Flat, IMFO		
Material Of Construction	Cross Linked Polyethylene, Black, with Antioxidant Interior Lining	**Heat Tracing and Insulation Requirements**	2” Polyfoam Insulation with Mastic Coating. Silicone Pad Heaters and Heat tracing as recommended by manufacturer.

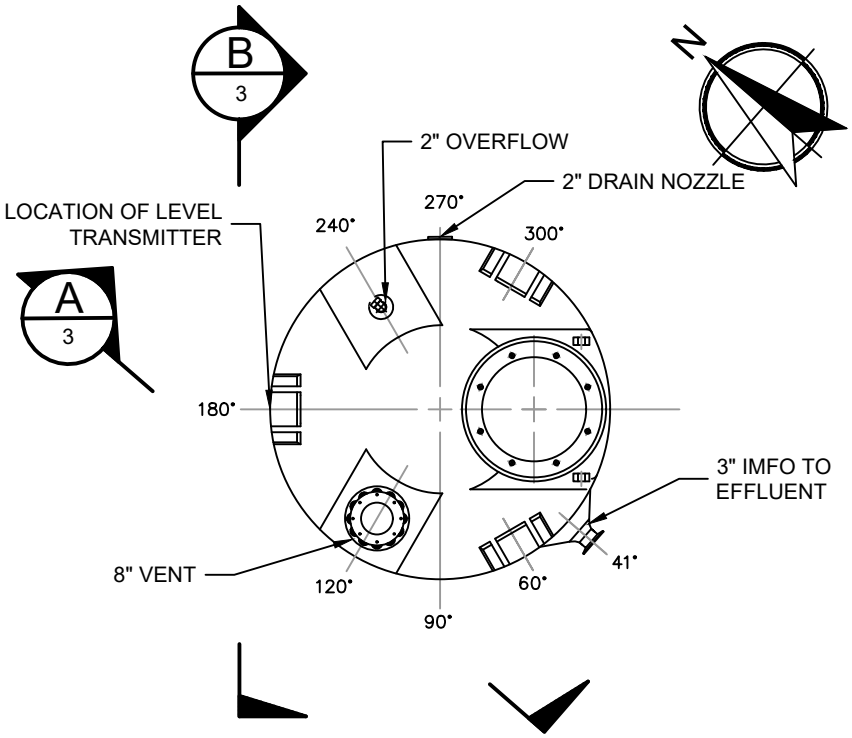
OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent Fill - Delivery	1	2"	Tank Dome	Universal Ball Dome Flange Fitting
Effluent	Effluent to Day Tank	1	3"	Lower Sidewall	IMFO Drain Flg. W/ Flex Fitting
Manway	Manway	1	24” Diameter	Top of Tank	Bolted
Vent	Mushroom Vent	1	8"	Tank Dome	Universal Ball Dome Flange Fitting
Overflow	Overflow - To Containment	1	2"	Upper Sidewall	Bolted Flange Fitting
Drain	Drain - To Containment	1	2"	Lower Sidewall	Bolted Flange Fitting W/ Flex Fitting
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

Notes:

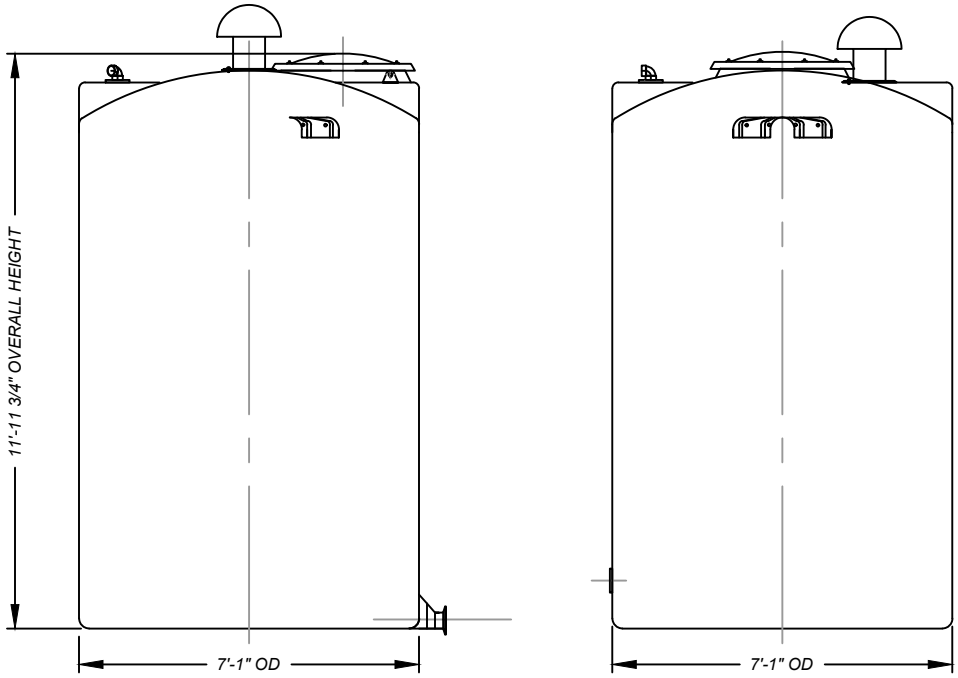
1.) Outside tank ladder to be provided, see specification 13200 for details.

2.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.



NOTE:
MUST USE FLEXIBLE CONNECTIONS ALL LOWER SIDEWALL FITTINGS.

PLAN
1/4" = 1'-0"



SECTION A
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SECTION B
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Buford Water Works Replacement
SODIUM HYPOCHLORITE BULK TANK B
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG. 3

4. Hydrofluorosilicic Acid (H2SiF6) Day Tank

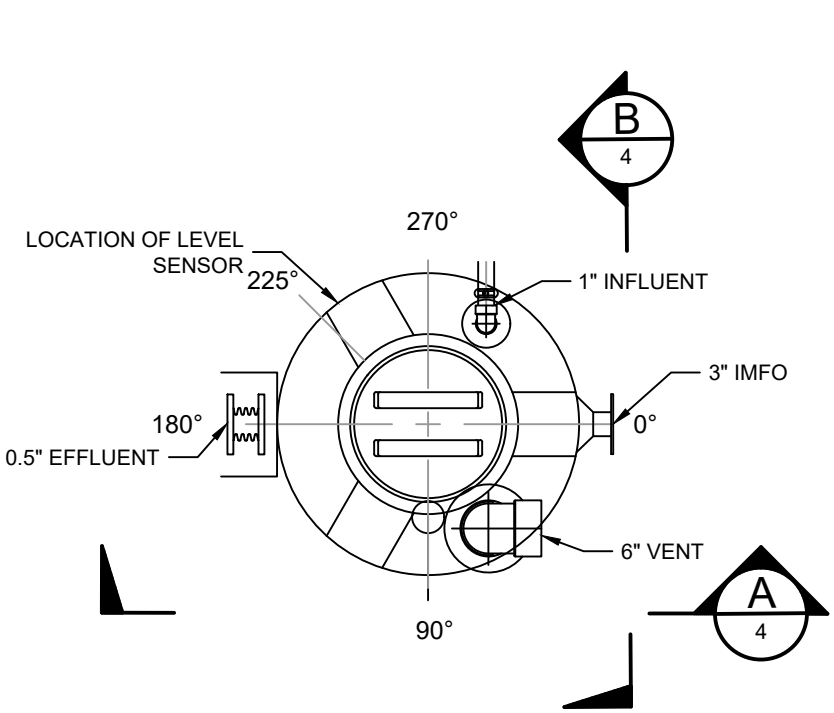
Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	Hydrofluorosilicic Acid (H2SiF6) Day Tank T-5039	**Contents**	Hydrofluorosilicic Acid (H2SiF6) 23%
Temperature	Standard Operation to 100F	**Minimum Volume**	205 Gallon
Maximum Height	4’ 10.75”	**Maximum Diameter**	3’ 2”
Environment	Interior	**UV Protection**	Not Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	N/A
Material Of Construction	Cross Linked Polyethylene		

OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent – From Bulk Tank	1	1”	Runway Flat	Bolted Flange Fitting
Effluent	Effluent	1	0.5"	Lower Sidewall	Bolted Flange Fitting w/ Flex Fitting and Internal Siphon Leg
Vent	Vent	1	6”	Runway Flat	Bolted Flange Fitting
Manway	Manway	1	17” Diameter	Top of Tank	Threaded
Overflow	Overflow - To Containment	1	1"	Upper Sidewall	Bolted Flange Fitting
Drain	Overflow - To Containment	1	3”	Lower Sidewall	IMFO Drain Flg. w/ Flex Fitting
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

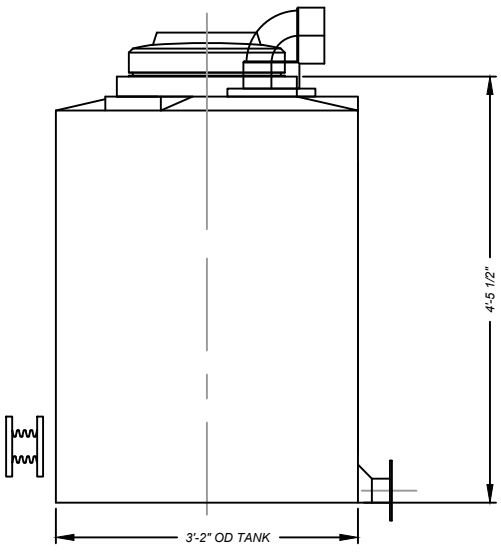
Notes:

1.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.

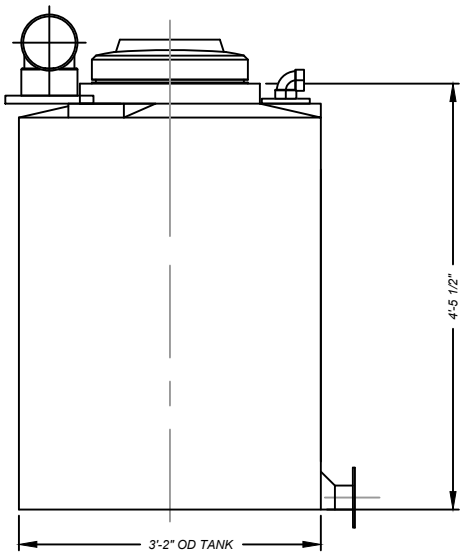


NOTE:
MUST USE FLEXIBLE CONNECTIONS ALL LOWER SIDEWALL FITTINGS.

PLAN
1/2" = 1'-0"



SECTION A
1/2" = 1'-0"



SECTION B
1/2" = 1'-0"

SCALE:	1/2" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

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Buford Water Works Replacement
HYDROFLUOROSILICIC ACID DAY TANK
For the City of Buford, Georgia
JOB NUMBER: 170110.00

DWG. 4

5. Hydrofluorosilicic Acid (H2SiF6) Bulk Tank

Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	Hydrofluorosilicic Acid (H2SiF6) Bulk Tank T-5036	**Contents**	Hydrofluorosilicic Acid (H2SiF6) 23%
Temperature	Standard Operation to 100F	**Minimum Volume**	850 Gallon
Maximum Height	10’ 5.5”	**Maximum Diameter**	4’ 0”
Environment	Interior	**UV Protection**	Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	N/A
Material Of Construction	Cross Linked Polyethylene		

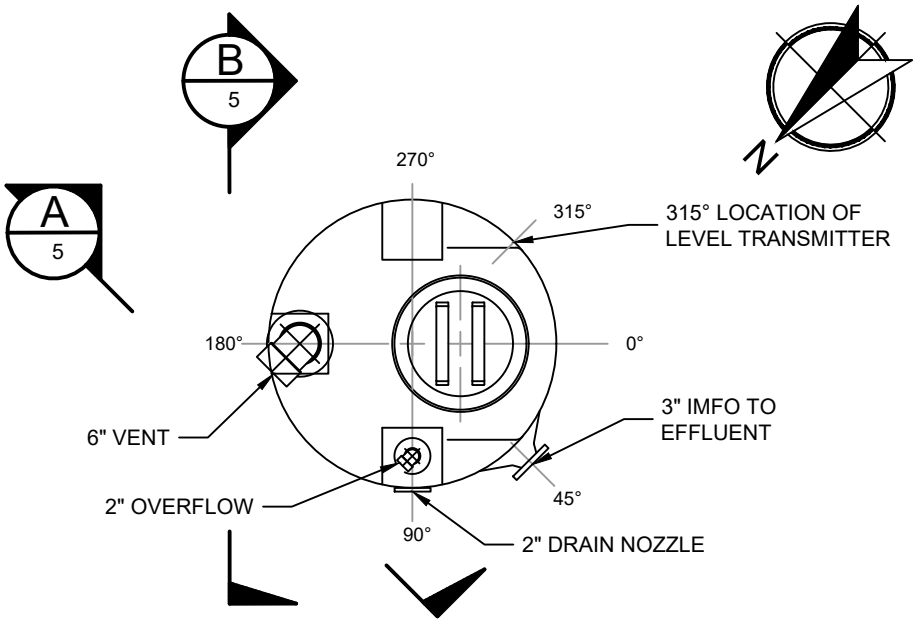
OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent – Delivery	1	2”	Runway Flat	Bolted Flange Fitting
Effluent	Effluent to Day Tank	1	3"	Lower Sidewall	IMFO Drain Flg. w/ Flex Fitting
Vent	Vent	1	6”	Runway Flat	Bolted Flange Fitting
Manway	Manway	1	24” Diameter	Top of Tank	Bolted
Overflow	Overflow - To Containment	1	2"	Upper Sidewall	Bolted Flange Fitting
Drain	Drain - To Containment	1	2"	Lower Sidewall	Bolted Flange Fitting w/ Flex Fitting
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

Notes:

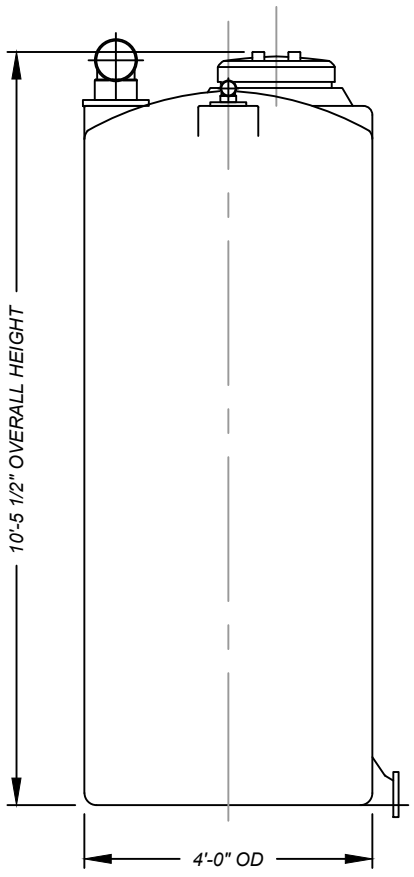
1.) Outside tank ladder to be provided, see specification 13200 for details.

2.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.

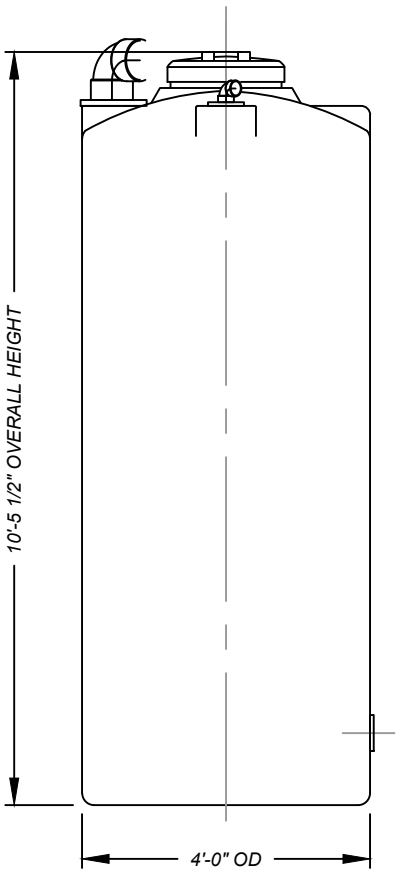


NOTE:
MUST USE FLEXIBLE CONNECTIONS
ALL LOWER SIDEWALL FITTINGS.

PLAN
3/8" = 1'-0"



SECTION A
3/8" = 1'-0"



SECTION B
3/8" = 1'-0"

850 GALLON IMFO TANK

SCALE:	3/8" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

Keck+Wood
COLLABORATION BY DESIGN
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Buford Water Works Replacement
HYDROFLUOROSILICIC ACID BULK TANK
For the City of Buford, Georgia
JOB NUMBER: 170110.00

DWG.
5

6. Corrosion Inhibitor (AquaMag) Bulk Tank

Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	Corrosion Inhibitor (AquaMag) Bulk Tank T-5030	**Contents**	Polyphosphate (AquaMag) 10%
Temperature	Standard Operation to 100F	**Minimum Volume**	850 Gallon
Maximum Height	10' 5.5"	**Maximum Diameter**	4' 0"
Environment	Exterior, Covered	**UV Protection**	Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	2” Polyfoam Insulation with Mastic Coating. Silicone Pad Heaters and Heat tracing as recommended by manufacturer.
Material Of Construction	Cross Linked Polyethylene		

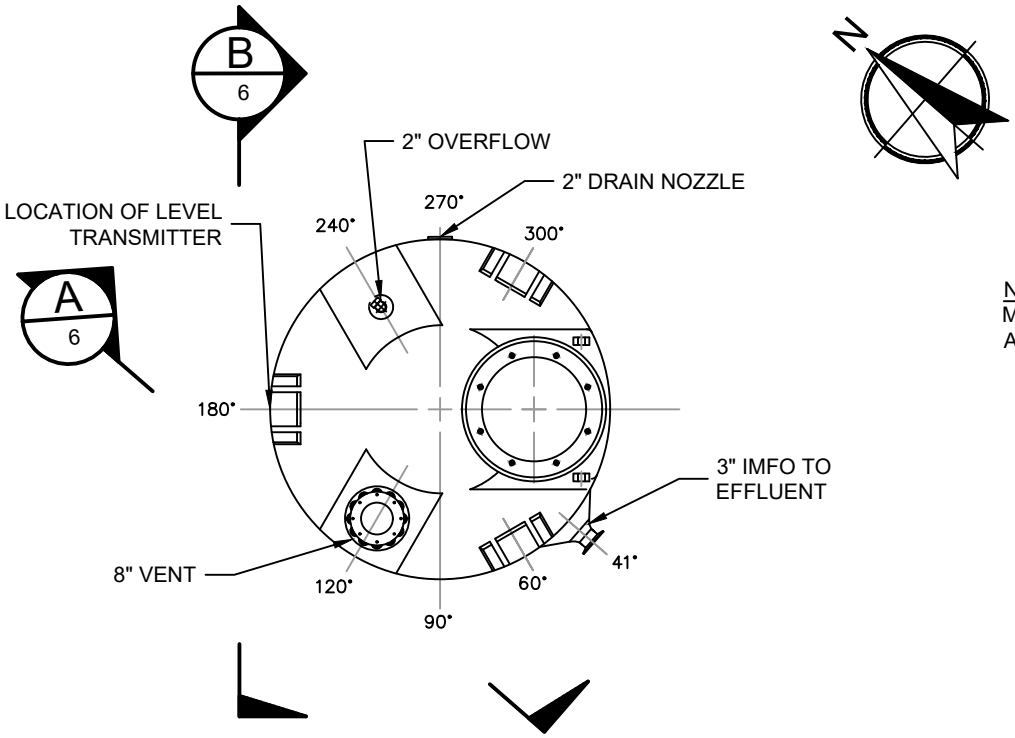
OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent - Delivery	1	2”	Runway Flat	Bolted Flange Fitting
Effluent	Effluent to Day Tank	1	3"	Lower Sidewall	IMFO Drain Flg. W/ Flex Fitting
Vent	Mushroom Vent	1	8”	Runway Flat	Bolted Flange Fitting
Manway	Manway	1	17" Diameter	Top of Tank	Threaded
Overflow	Overflow - To Containment	1	2"	Upper Sidewall	Bolted Flange Fitting
Drain	Overflow - To Containment	1	2"	Lower Sidewall	Bolted Flange Fitting W/ Flex Fitting
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

Notes:

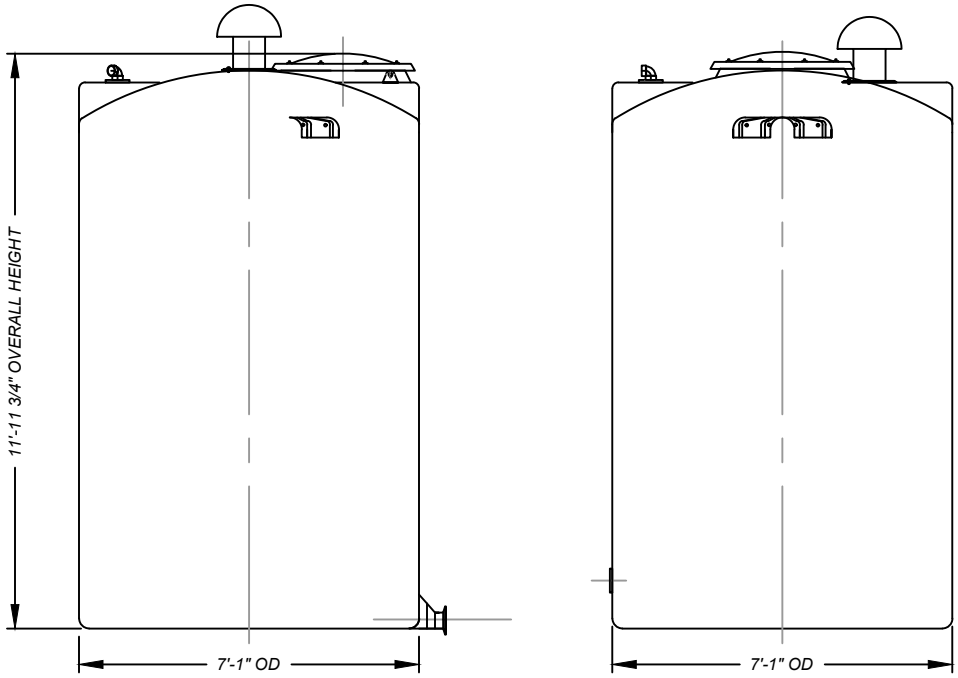
1.) Outside tank ladder to be provided, see specification 13200 for details.

2.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.



NOTE:
MUST USE FLEXIBLE CONNECTIONS ALL LOWER SIDEWALL FITTINGS.

PLAN
1/4" = 1'-0"



SECTION A
1/4" = 1'-0"

SECTION B
1/4" = 1'-0"

SCALE:	1/4" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

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Buford Water Works Replacement
CORROSION INHIBITOR BULK TANK
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG.
6

7. Corrosion Inhibitor (AquaMag) Day Tank

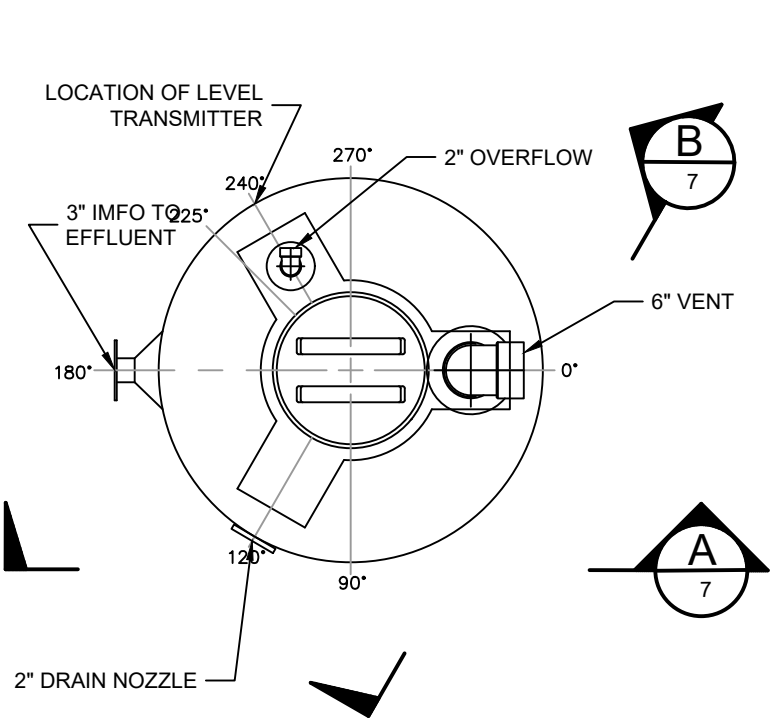
Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label:	Corrosion Inhibitor (AquaMag) Day Tank T-5033	**Contents**	Polyphosphate (AquaMag) 10%
Temperature	Standard Operation to 100F	**Minimum Volume**	280 Gallon
Maximum Height	4’ 7.5”	**Maximum Diameter**	4’ 00”
Environment	Interior	**UV Protection**	Not Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	N/A
Material Of Construction	Cross Linked Polyethylene		

OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent – From Bulk Tank	1	2”	Runway Flat	Bolted Flange Fitting
Effluent	Effluent	1	0.5"	Lower Sidewall	Bolted Flange Fitting W/ Flex Fitting and Internal Siphon Leg
Vent	Vent	1	6”	Runway Flat	Bolted Flange Fitting
Manway	Manway	1	17” Diameter	Top of Tank	Threaded
Overflow	Overflow - To Containment	1	2"	Upper Sidewall	Bolted Flange Fitting
Drain	Drain - To Containment	1	3"	Lower Sidewall	IMFO Drain Flg. W/ Flex Fitting
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

Notes:

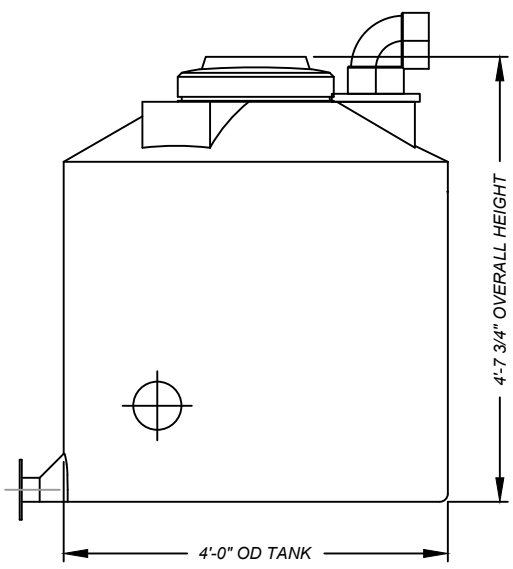
1.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.



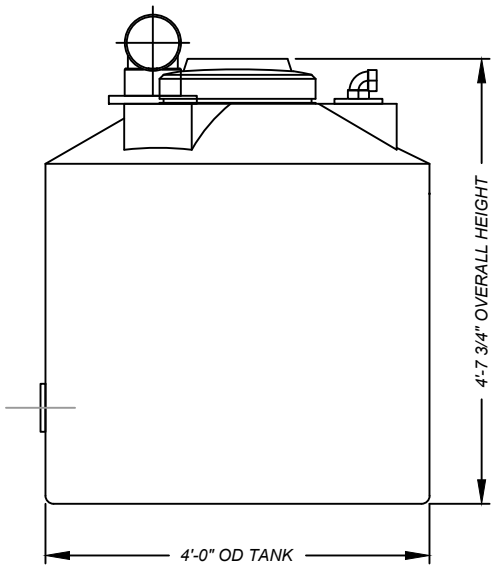
N

NOTE:
MUST USE FLEXIBLE CONNECTIONS ALL LOWER SIDEWALL FITTINGS.

PLAN
1/2" = 1'-0"



SECTION A
1/2" = 1'-0"



SECTION B
1/2" = 1'-0"

SCALE:	1/2" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

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Buford Water Works Replacement
CORROSION INHIBITOR DAY TANK
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG. 7

8. Backwash Tank

Client	The City of Buford	**Address**	3370 North Waterworks Road. Buford. GA 30518
Label	Backwash Tank TP-6001	**Contents**	Backwash Solution
Temperature	Standard Operation to 100F	**Minimum Volume**	1,250 Gallon
Maximum Height	10'	**Maximum Diameter**	5'
Environment	Interior	**UV Protection**	Not Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	N/A
Material Of Construction	Cross Linked Polyethylene		

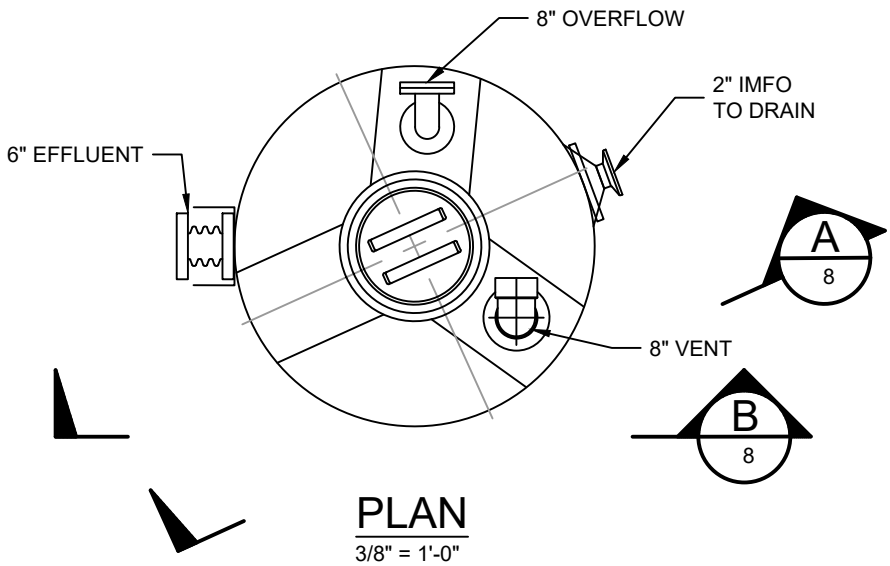
OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent	1	6”	Runway Flat	Bolted Flange Fitting W/ Flange Adapter
Effluent	Overflow	1	8”	Upper Sidewall	Bolted Flange Fitting
	Drain	1	2"	Lower Sidewall	IMFO Drain Flange W/ Flex Fitting
	Effluent	1	6"	Lower Sidewall	Bolted Flange Fitting W/ Flex Fitting and Internal Siphon Leg
Vent	Vent	1	8"	Top of Tank	Vented Manway
Manway	Manway	1	17” Diameter	Top of Tank	Threaded
Level Sensor	Level Indicating Transmitter	1	2"	As Recommended by Tank and Level Sensor Manufacturer	

Notes:

1.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.

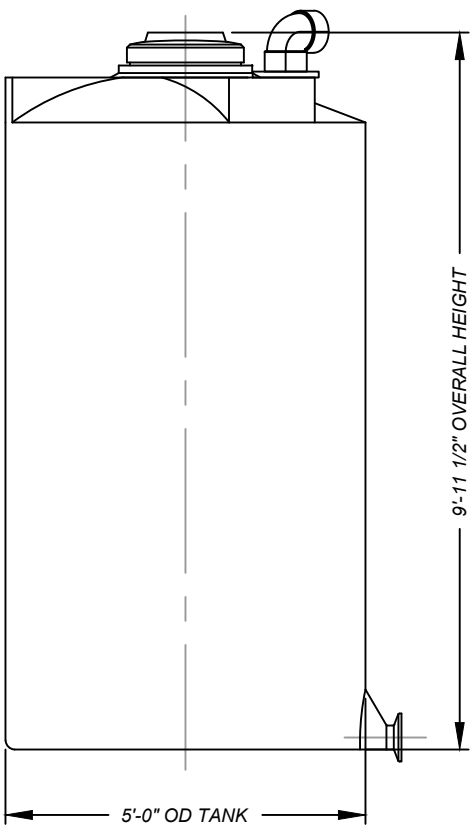
2.) Backwash Tank will be dosed with Sodium Hypochlorite (NaOCl) - 12.5%.



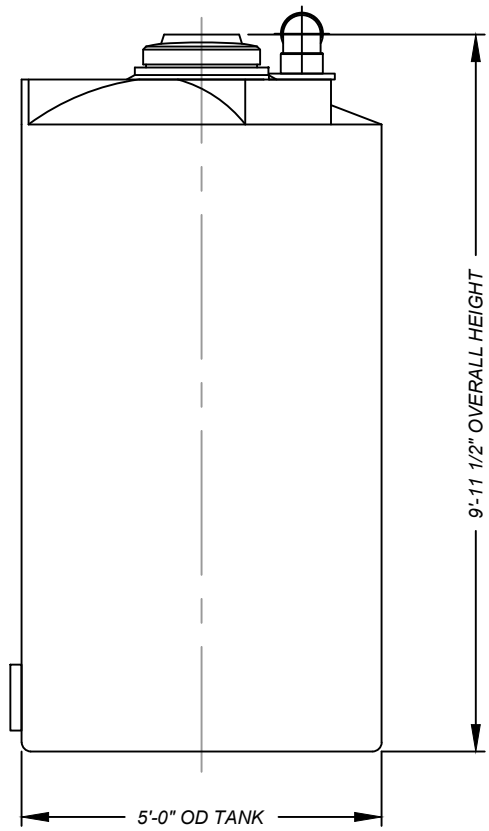
N

NOTE:
MUST USE FLEXIBLE CONNECTIONS
ALL LOWER SIDEWALL FITTINGS.

PLAN
3/8" = 1'-0"



SECTION A
3/8" = 1'-0"



SECTION B
3/8" = 1'-0"

SCALE:	3/8" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

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Buford Water Works Replacement
BACKWASH
TANK
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG.
8

9. Heating Tank

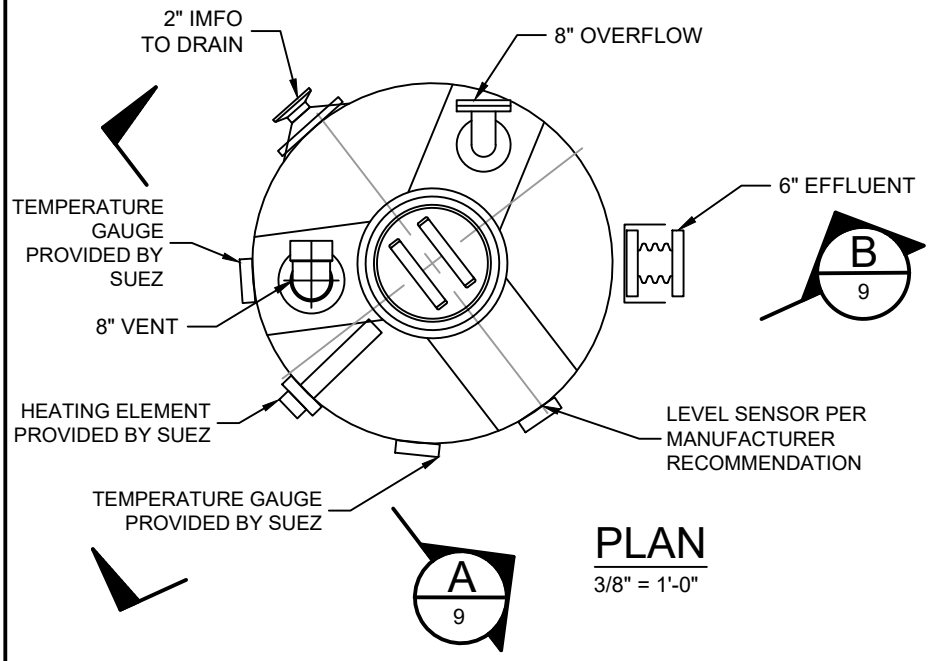
Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	Heating Tank TP-6006	**Contents**	Process Water
Temperature	Standard Operation to 140F	**Minimum Volume**	1,250 Gallons
Maximum Height	10'	**Maximum Diameter**	5'
Environment	Interior	**UV Protection**	Not Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	2” Polyfoam Insulation with Mastic Coating.
Material Of Construction	Cross Linked Polyethylene		

OPENINGS

Type	Label	Number	Size	Location	Connection Type
Influent	Influent	1	4”	Top of Tank	Bulkhead w/ Flx.Bolted Flange Fitting W/ Flange Adapter
Effluent	Overflow	1	8”	Upper Sidewall	Bolted Flange Fitting
	Drain	1	2"	Lower Sidewall	IMFO Drain Flange w/ Flex Fitting
	Effluent	1	6"	Lower Sidewall	Bolted Flange Fitting w/ Flex Fitting and Internal Siphon Leg
Vent	Vent	1	8"	Top of Tank	Vented Manway
Manway	Manway	1	17” Diameter	Top of Tank	Threaded
Level Sensor	Level	1	As Recommended by Tank and Level Sensor Manufacturer		
Level Indicating Transmitter	Level Transmitter	1	2"	As Recommended by Tank and Level Indicating Transmitter Manufacturer	
Temperature Transmitter	Temperature Switch	1	0.75"	As Recommended by Tank and Temperature Switch Manufacturer	
Temperature Transmitter	Temperature Transmitter	1	0.75"	As Recommended by Tank and Temperature Transmitter Manufacturer	
Temperature Indicator	Temperature Indicator	1	0.75"	As Recommended by Tank and Temperature Indicator Manufacturer	
Heater	Heater	1	6"	8" From Bottom of Tank	Bolted Flange Fitting

Notes:

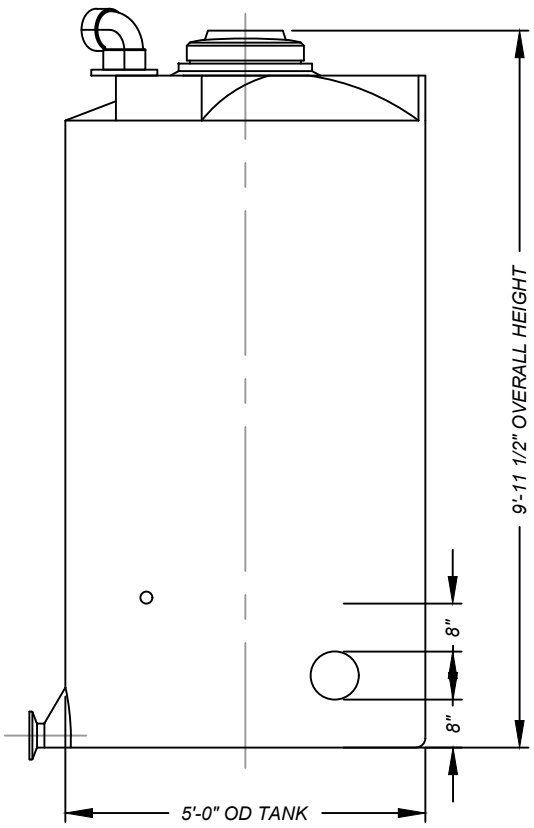
1.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.



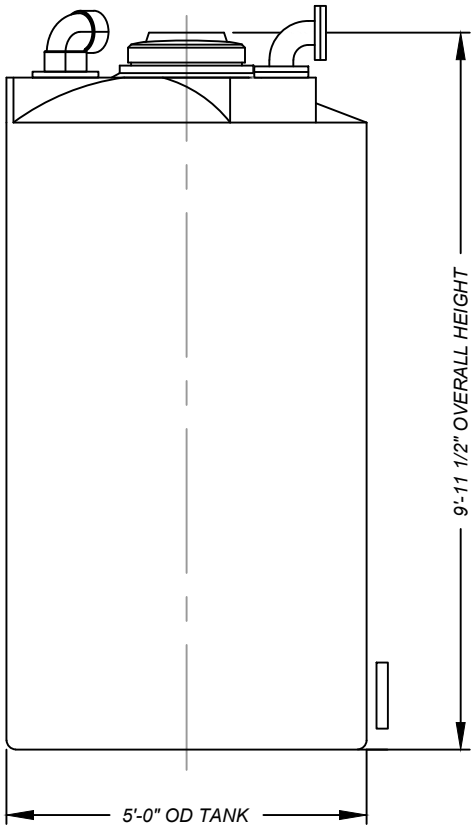
N

NOTE:
MUST USE FLEXIBLE CONNECTIONS
ALL LOWER SIDEWALL FITTINGS.

PLAN
3/8" = 1'-0"



SECTION A
3/8" = 1'-0"



SECTION B
3/8" = 1'-0"

SCALE:	3/8" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

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Buford Water Works Replacement
HEATING
TANK
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG.
9

10. CIP/MW Tank A

Client	The City of Buford	**Address**	3370 North Waterworks Road, Buford, GA 30518
Label	CIP/MW Tank A TP-6005	**Contents**	CIP/MW Solution
Temperature	Standard Operation to 100F	**Minimum Volume**	2,250 Gallons
Maximum Height	10’ 4”	**Maximum Diameter**	7’ 1”
Environment	Inside	**UV Protection**	Not Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	N/A
Material Of Construction	Cross Linked Polyethylene		

OPENINGS

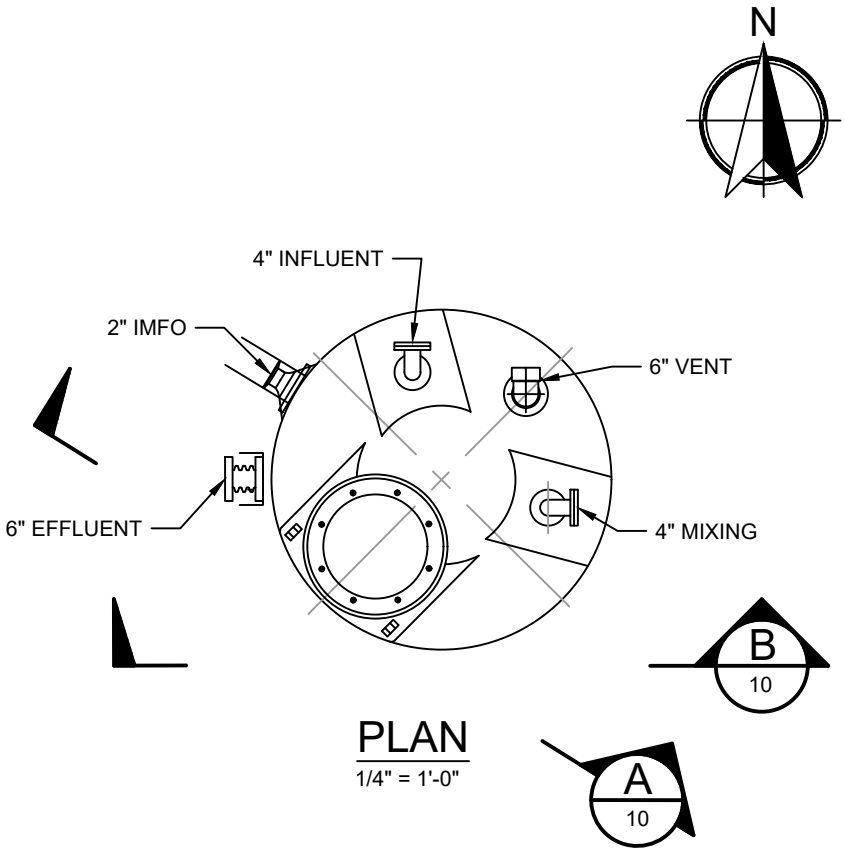
Type	Label	Number	Size	Location	Connection Type
Influent	Influent	1	4”	Runway Flat	Bolted Flange Fitting W/ Flange Adapter
	CIP Mixing	1	4”	Runway Flat	Bolted Flange Fitting W/ Flange Adapter
Effluent	Effluent	1	6"	Lower Sidewall	Bolted Flange Fitting w/ Flex Fitting and Internal Siphon Leg
	Overflow	1	8"	Upper Sidewall	Bolted Flange Fitting
	Drain	1	2"	Lower Sidewall	IMFO Drain Flg. w/ Flex Fitting
Vent	Vent	1	6”	Top of Tank	Bolted Flange Make Vertical Fitting
Manway	Manway	1	24” Diameter	Top of Tank	Bolted
Level Sensor	Level	1	2"	As Recommended by Tank and Level Sensor Manufacturer	
Spare	Spare	1	¾”	Lower Sidewall	Bolted Flange Fitting w/ Flex

Notes:

1.) CIP/MW Tanks will be dosed with the following chemicals for CIP, Neutralization, and MW procedures:

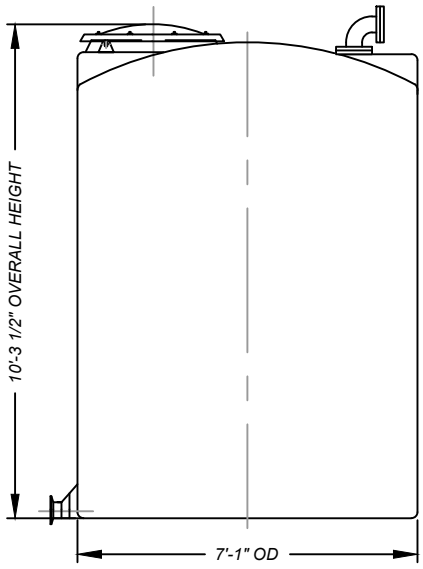
- Sodium Hypochlorite (NaOCl) - 12.5%
- Sodium Hydroxide (NaOH) - 40%
- Citric Acid (C6H8O7) - 50%
- Hydrochloric Acid (HCl) - 32%
- Sodium Bisulfite (NaHSO3) - 38%

2.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.

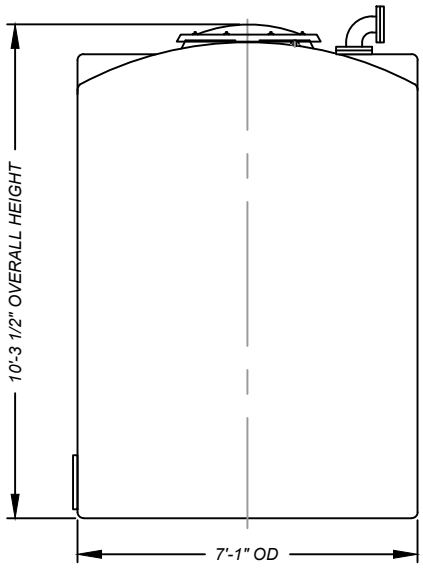


PLAN
1/4" = 1'-0"

NOTE:
MUST USE FLEXIBLE CONNECTIONS
ALL LOWER SIDEWALL FITTINGS.



SECTION A
1/4" = 1'-0"



SECTION B
1/4" = 1'-0"

SCALE:	1/4" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

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Buford Water Works Replacement
CIP/MW
TANK A
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG.
10

11. CIP/MW Tank B

Client	The City of Buford	**Address**	3370 North Waterworkd Road, Buford, GA 30518
Label	CIP/MW Tank B TP-6004	**Contents**	CIP/MW Solution
Temperature	Standard Operation to 100F	**Minimum Volume**	2,250 Gallons
Maximum Height	10' 4"	**Maximum Diameter**	7' 1"
Environment	Inside	**UV Protection**	Not Required
Bottom Type	Flat, IMFO	**Heat Tracing and Insulation Requirements**	N/A
Material Of Construction	Cross Linked Polyethylene		

OPENINGS

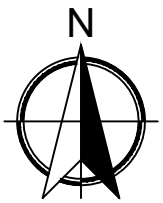
Type	Label	Number	Size	Location	Connection Type
Influent	Influent	1	4"	Runway Flat	Bolted Flange Fitting W/ Flange Adapter
	CIP Mixing	1	4"	Runway Flat	Bolted Flange Fitting W/ Flange Adapter
Effluent	Effluent	1	6"	Lower Sidewall	Bolted Flange Fitting w/ Flex Fitting and Internal Siphon Leg
	Overflow	1	8"	Upper Sidewall	Bolted Flange Fitting
	Drain	1	2"	Lower Sidewall	IMFO Drain Flange w/ Flex Fitting
Vent	Vent	1	6"	Top of Tank	Bolted Flange Make Vertical Fitting
Manway	Manway	1	24" Diameter	Top of Tank	Bolted
Level Sensor	Level	1	2"	As Recommended by Tank and Level Sensor Manufacturer	
Spare	Spare	1	3/4"	Lower Sidewall	Bolted Flange Fitting w/ Flex

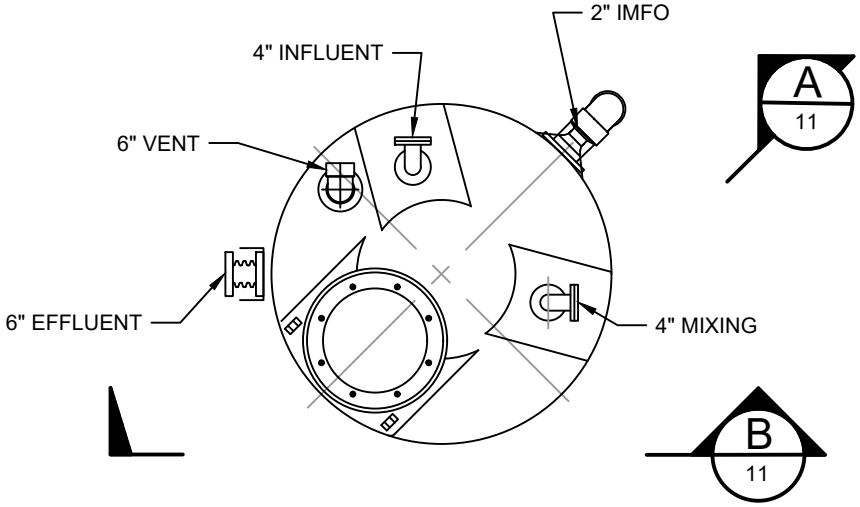
Notes:

1.) CIP/MW Tanks will be dosed with the following chemicals for CIP, Neutralization, and MW procedures:

- Sodium Hypochlorite (NaOCl) - 12.5%
- Sodium Hydroxide (NaOH) - 40%
- Citric Acid (C6H8O7) - 50%
- Hydrochloric Acid (HCl) - 32%
- Sodium Bisulfite (NaHSO3) - 38%

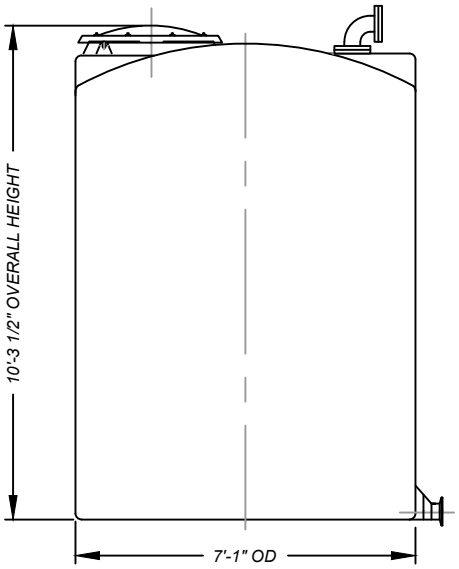
2.) Level Sensors shall be a continuous reading hydrostatic level sensor per Section 460923.

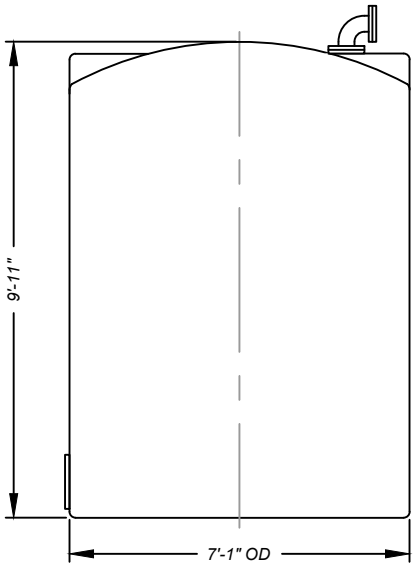




NOTE:
MUST USE FLEXIBLE CONNECTIONS
ALL LOWER SIDEWALL FITTINGS.

PLAN
1/4" = 1'-0"





SECTION A
1/4" = 1'-0"
11

SECTION B
1/4" = 1'-0"
11

SCALE:	1/4" = 1'-0"
CHECKED BY:	JAB
DRAWN BY:	TLC
DATE:	04/14/21

Keck+Wood
COLLABORATION BY DESIGN
keckwood.com

Buford Water Works Replacement
CIP/MW
TANK B
For the City of Buford, Georgia

JOB NUMBER: 170110.00

DWG.
11

SECTION 460106 - OPERATION AND MAINTENANCE MANUAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Operation and maintenance data submittals.

1.2 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

B. Section 460500 - Common Work Results For Water and Wastewater Equipment.

C. Individual Product Sections: Additional requirements for operation and maintenance data.

1.3 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 for submittal procedures.

PART 2 OPERATION AND MAINTENANCE MANUAL

2.1 DOCUMENT FORMATS

A. Editable Document Format: Microsoft Word 2010 or later, Open Document Format (ODF), or Rich Text Format (RTF); use for documents prepared specifically for this plant.

B. PDF Format: Adobe Reader version 7 or later; use for:

1. Approved submittals, such as product data, shop drawings, O&M data; furnish PDF of approved copy, not original
2. O&M documents prepared by manufacturers.
3. Project record documents, as described in Section 017800 - Closeout Submittals and in individual Sections.
4. Startup checklists and functional test reports.
5. Other documents that will not need to be modified in the future.

C. Drawings: Convert to PDF format, maintaining original document page size (i.e. do not reduce a large size drawing to 8-1/2 by 11, or any different size).

2.2 ORGANIZATION OF MANUAL

A. The function of this manual is to make needed information quickly and easily found and understood. To increase effectiveness the following general principles should be observed:

1. Generally, use less narrative and more diagrams, charts, and checklists.
2. An operator looking for a specific piece of information should not have to read an essay to find it.
3. Do not include information that is not specific to this plant.
4. If both graphic and text are needed for the same subject, place the graphic above the text.
5. If footnotes or legends are used, make them large enough to read easily and place above or to the left of the chart or table they refer to, so they are not overlooked.
6. If a graphic will fit in a page of a normal browser window, insert it as a picture in the page; if very large, link to it as an external PDF file.
7. Very large drawings and diagrams should not be used as a primary information source; if they are the only source of a particular item of information, consider snipping relevant portions to insert as pictures.
8. Content management system software uses HTML editors in which tables are often difficult to format; charts and tables may be made as pictures if the original editable

document is also furnished and linked to.

2.3 PLANT-WIDE INFORMATION

A. Provide the following information from a plant-wide point of view.

B. Plant Layout: Simple one-page plan-view diagram identifying buildings, structures, manholes, pipelines, major valves, and incoming utilities.

1. Include locations of equipment that first-responders would be concerned with, including incoming power lines, main breakers, gas meters, fuel tanks, chemical storage, backflow preventers, fire hydrants, etc.

2. Do not reduce construction site drawings unless they are legible at small size; otherwise, prepare simplified diagram with only necessary detail.

C. Overall Process Description: Briefly describe type(s) of treatment process used and summarize the unit processes involved.

1. Redundancy: Describe specific provisions that allow for continued operation in case of unit outages.

2. Future Development: Describe what provisions for future additions or expansion have been made, such as piping stubs, extra channels, etc.

D. Summary of Design Data: Tabular view of overall plant and individual unit processes; show design population, flows, design capacity, and effluent quality goals.

E. Flow Diagrams: Simple schematics showing individual unit processes and flow sequence, with separate diagrams for liquid and solids processes; diagrams that relate flows to actual physical layout are preferred.

F. Hydraulic Profile: Simple schematic of hydraulic profile through entire process.

G. Equipment Cross-Reference Lists: Tabular summary lists of all equipment items by:

1. Plant identification number in alphanumeric order.

2. Unit process in flow sequence order and plant identification in alphanumeric order.

3. Generic item type (e.g. valve, controller, pump) and plant identification number in alphanumeric order.

H. Electrical Power: Simple schematic of power distribution system, showing switchboards, panelboards, and circuits; diagrams that reflect actual physical layout are preferred.

I. Standby Power: Briefly describe nature of standby power and procedure for conversion to standby power and vice versa. (Details to be given in Unit Process - Main and Standby Power.)

J. Post-Disaster Startup: Assuming both normal and standby power go out, describe in detail the process of re-starting the plant.

1. Include a list of settings that are not saved upon power loss.

2. Identify which functions are critical and which are non-critical.

3. If sequencing is critical, describe the sequence of starting equipment and processes including clearing of lockouts.

K. O - Safety: Describe safety and accident prevention procedures.

1. Explain Confined Space entry precautions and define procedures.

2. Include first aid procedures for dealing with accidents or reference a first aid handbook and kit kept on hand.

L. "Manual on the Manual": Describe editing existing pages, creating new pages, modifying menus, linking to external files, moving to a different server or host, and restoring from backup.

1. Detail the steps in the backup process, the schedule for making backups, and where backups are stored.

2. Detail the login security policy, how to change access rights, and who can do so.
3. Provide a printable version of the "manual on the manual" (PDF) and include a link to it on the home page.

2.4 PLANT MANAGEMENT INFORMATION

A. O - Preventative Maintenance: Description of asset management system to be used to schedule and track maintenance activities.

B. O - Operator and Management Responsibilities: Describe plant operating and maintenance personnel required, operator certification requirements, and estimated work hours to operate and maintain the plant.
1. Include time allowances for continuing education.
2. Describe any necessary delegation of authority by permit holding organization.

2.5 PROCESS CONTROL SYSTEM INFORMATION

A. Description: Describe the general concept of the process control system; for example, is the control system intended to operate completely automatically or are there required manual functions?
1. Explain how to backup and re-install all software used in control system.

B. Process Control System Layouts: For each unit process, show schematic layout of network, control devices, and controlled equipment, with additional information necessary to identify all components; layout that approximates physical layout is preferred.

C. Network bandwidth calculations and measured values.

D. Unit Process Control Sequences: For each unit process, provide narrative of control sequence and diagram of control logic; clearly identify all deviations from Contract Documents.

E. Process Control Network Riser Diagrams: For each unit process, show all network devices, controllers, transmitters, and network terminators; schematic or tabular format may be used.

F. Points Schedule: For each unit process, show all input, output, calculated, virtual, and other points; for each point show at least:
1. Device address and NodeID.
2. General description.
3. Input and Output SNVTs including SNVT Name, Type and Description.
4. Hardware I/O, including Type (analog input, analog output, binary input, binary output, pulse accumulator).
5. Configuration settings.
6. Overrides.

G. Equipment Schedule: For each unit process, list each control device, instrument, and item of controlled equipment, with:
1. Project unique identifier.
2. Device or equipment description.
3. Manufacturer, model number, part number.
4. List of other submittals related to this item, by submittal number.

H. Wiring Diagrams: For each unit process, prepare functional wiring diagrams showing interconnection of conductors and cables to controllers and to terminals of input and output devices, starters, and controlled equipment.
1. Show each power supply and transformer not integral to a controller, starter, or equipment item.

2. Identify sources of power back to panel board circuit breaker number, controller enclosures, magnetic starter, or equipment control circuit.
3. Show necessary jumpers and ground connections.
4. Show connected volt-ampere load and power supply volt-ampere rating.
5. Show labels of conductors.

I. Software: Record copy of all user manuals.

J. Equipment: Provide O&M data for each device as specified for equipment.

K. List the process control system installer/integrator name, address, and contact information.

2.6 UNIT PROCESS INFORMATION

A. For each unit process, provide the following information; use a consistent format for all processes including the order of presentation of information.

B. See individual unit process sections for additional requirements.

C. Description: Describe in detail the treatment process employed (biological, chemical, physical, etc.) and each component and item of equipment used and its function.

1. Include alternate and bypass modes of operation.
2. For alternate and bypass modes include description of any change in treatment efficiency, additional monitoring required, safety concerns, and other consequences.

D. Design Data: Include flows, design capacity, and effluent quality targets.

E. List of Equipment: Identify each item of equipment by name, plant identification number, location.

1. For chemical feed equipment, and other equipment using consumable supplies, describe the required characteristics of each consumable.

F. Flow Diagram: Show influent feed; valve, gate, and pump locations and normal operating positions; outlets weirs and other structures.

G. Relationship to Other Processes: Identify upstream, downstream, and sidestream unit processes.

H. Process Controls: List each controlled element (valve, pump, chemical feed, motor starter, etc.), instrument, actuator, and controller involved with automatic control of the process, and reference inputs from and to other processes.

1. Provide a narrative description of each control function and its relationship to other control functions in the same process and other processes.
2. Identify normal operating ranges or levels and explain how they are maintained and what problems develop when not maintained.
3. Identify the parameters and setpoints of each instrument and/or controller and explain the significance of the parameters and setpoints.

I. Non-Control Monitoring: List each instrument that is used for monitoring but does not control any function or process.

1. If the instrument's parameters are to be used to make manual adjustments, provide the necessary formulas for calculations, with examples.

J. Equipment Controls: For equipment with internal operating controls, describe those controls, their functions, and any inputs from and outputs to the process control system.

K. Alarms: Describe all alarm functions provided for the process, including alarms internal to equipment, and describe actions to be taken by operators.

1. If such an alarm is described in a process control function, repeat a brief description here and identify the process control where it is described.
2. Identify local alarms such as flashing lights and audible horns and identify the process control function they relate to.

3. If an overload alarm condition will result in stopping or shutdown of equipment, identify the parameters that would trigger that condition and problem conditions that would result if the alarm is not attended to.
4. If an alarm condition must be manually reset prior to restarting equipment, describe procedures for doing so.

L. Electrical Power: Identify panelboards and circuits serving equipment.

M. Starting and Restarting: Describe the procedures for starting and restarting the unit process, including inspections, checklists, and personnel required.

1. Identify any limitations on restarting equipment after alarm, such as manual reset, clearing lockouts, and other relevant procedures.
2. For each item of equipment, include its original startup data recording form or latest modification, whichever is most accurate.

N. Common Operating and Control Problems: Describe common problems relevant to this process, indicators and symptoms (including visual and odors), likely causes, and possible remedies.

O. Safety: Describe safety precautions advisable in regard to the unit process, including methods for preventing hazardous conditions, procedures for testing for hazards.

1. Where Confined Space entry may be required, reference procedures defined under Plant Overview.

P. Unit Process Startup Reports:

1. Completed Pre-Functional Checklist.
2. Completed Functional Test report(s).

2.7 EQUIPMENT INFORMATION

A. For each individual item of equipment, provide the following information; use a consistent format for all equipment, including order of presentation of information and starting each item on a new page.

B. See individual product specification sections for additional requirements.

C. Equipment Summary Sheet:

1. Plant identification number; if there is more than one item that is exactly identical, use one sheet for all.
2. Generic name of item (e.g. Return Activated Sludge Pump).
3. Location in plant, such as Unit Process.
4. General description including component parts.
5. Manufacturer name, model or series name or number, serial number, and date installed.
6. Installer/Supplier name, address, contact name and phone number.
7. Service organization name, address, contact name and phone number.
8. Identify where spare parts and consumables are stored on site.

D. Design Data: List design capacity and other operating parameters.

1. Pumps: Include pump curve for the specific pump installed, shutoff head, discharge head, and suction head; identify impeller trim and motor horsepower.
2. Startup Form: Recorded actual values of design parameters at startup.
3. Manufacturer's design data sheets may be linked to or referenced.

E. Product Data: Project record copy of approved submittals.

1. If no approved product data submittal exists, provide manufacturer's current data sheet marked to clearly identify specific products and components that were

installed; delete or cross out inapplicable information.

F. Shop Drawings: Project record copy of approved shop drawings.

G. Wiring Diagrams: As installed.

H. Operating Procedures:

1. Describe start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

2. Manufacturer's printed procedures may be used, provided they are in electronic form.

3. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific equipment.

I. Maintenance Requirements:

1. Provide summary of necessary maintenance activities for this equipment in this particular plant, prepared from manufacturer data, with necessary frequency.

2. Describe routine procedures for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

3. Manufacturer's servicing and lubrication schedule, and list of lubricants required.

4. Manufacturer's illustrations, assembly drawings, and diagrams required for maintenance.

5. Manufacturer's printed procedures may be used, provided they are in electronic form.

6. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific equipment.

J. Tools: List of tools necessary for adjustment, operation, maintenance and disassembly; identify by manufacturer and model number any special tools that are specific to the equipment, not commonly encountered in repair shops, or only available from limited sources.

K. Replaceable Parts and Consumable Supplies:

1. Manufacturer's parts list with model numbers, prices, and edition date.

2. List of parts that manufacturer recommends having on hand, with quantities.

3. List of parts that require long lead time, with time estimates.

4. Nearby Sources: Name, address, phone number.

L. Equipment Startup Reports:

1. Completed Pre-Functional Checklist.

2. Completed Functional Test report.

M. Additional Requirements: As specified in individual product specification sections.

2.8 PROTECTIVE FINISHES INFORMATION

A. For each protective finish, provide the following information:

1. Product data, with catalog number, size, composition, and color and texture designations.

2. Information for ordering additional material.

3. Manufacturer's recommended inspection schedule.

4. Instructions for repair of damaged and deteriorated coatings, including surface preparation.

5. Additional information as specified in individual product specification sections.

B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the maintenance of the specific products.

PART 3 EXECUTION

3.1 INSTALLATION

A. Assemble and install Operation and Maintenance Manual in location designated by Owner.

END OF SECTION

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SECTION 460500 - COMMON WORK RESULTS FOR WATER AND WASTEWATER EQUIPMENT

PART 1 GENERAL

1.1 APPLICABILITY

A. Requirements of this section apply to other sections of Division 46.

B. Some requirements of this section are specified only in this section; these apply to other sections of Division 46 whether specifically cross-referenced or not.

C. Some requirements of this section amplify requirements of other sections of Division 46; these also apply to those sections unless a requirement of this section and another section cannot both be met; in that case, comply with the requirement of the other section.

1.2 SECTION INCLUDES

A. Administrative requirements applicable to all equipment, including:

1. Submittals relating to this section.
2. Quality assurance.
3. Delivery, storage, and handling.
4. Temporary water.

B. Product requirements applicable to all equipment, including:

1. General equipment requirements.
2. Requirements relating to equipment with moving parts.
3. Requirements relating to electrically operated equipment.
4. Enclosures for electrical, electronic, and instrumentation devices.
5. Language and units of measure.
6. Identification of equipment, piping, and enclosures.
7. Protective finishes.
8. Metals and construction materials used in equipment.
9. Joint and penetration seals.

C. Execution procedures applicable to all equipment, including:

1. Examination.
2. Equipment installation.
3. Welding.
4. Penetrations through building construction.
5. Field finishing.
6. Repair of zinc-coated surfaces.
7. Owner personnel training procedures.
8. Cleaning and protection.

1.3 RELATED REQUIREMENTS

A. Section 099113 - Exterior Painting: Finishes for outdoor architectural and structural surfaces.

B. Section 099123 - Interior Painting: Finishes for architectural and structural surfaces in the indoor dry zone.

C. Section 019113 - General Commissioning Requirements: Putting equipment and systems into complete operating condition, functional testing, and Owner personnel training.

D. Section 460106 - Operation and Maintenance Manual.

E. Section 460525 - Water Treatment Pumps: Identification.

F. Section 460916 - Control Valves: Identification.

1.4 DEFINITIONS

A. Buried: Equipment, piping, and structures are in contact with earth or which would be in contact with earth without the protection specified.

B. Corrosive Atmosphere Zone: Where raw sewage runs in open channels; surfaces subject to corrosive atmosphere include floors, walls, ceilings, structural members, and inside and outside of equipment housings.

C. Hazardous Atmosphere Zone: Chlorine gas storage and handling and spaces where explosion hazard exists.

D. Indoor Dry Zone: Enclosed spaces not connecting to open liquid surfaces, not subject to water vapor emissions, and not anticipating more than occasional, accidental water-based liquid contact; the following are considered "Indoor, Dry":

1. Administration areas, offices, laboratories.

2. Mechanical rooms and utility tunnels meeting this definition.

3. Electrical rooms.

E. Outdoors: Exposed to the outdoor ambient environment, whether under cover or not.

F. Splash Zone: Surfaces less than 12 inches (305 mm) above normal liquid level in process tanks and channels.

G. Submerged Zone: Below the surface of the liquid or solids process stream.

1.5 REFERENCE STANDARDS

A. 29 CFR 1910 - Occupational Safety and Health Standards current edition.

B. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015.

C. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings 2014.

D. ASME B31.1 - Power Piping 2020.

E. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications 2019.

F. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2014.

G. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).

H. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2003 (Reapproved 2016).

I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

J. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.

K. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings 2009 (Reapproved 2015).

L. ASTM B108/B108M - Standard Specification for Aluminum-Alloy Permanent Mold Castings 2019.

M. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position 2018.

N. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021.

O. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

P. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings 2018.

Q. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.

R. IEEE/ASTM SI 10 - American National Standard for Metric Practice 2016, with Errata (2017).

S. IEEE C37.13 - IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures 2015.

T. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.

U. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.

V. NEMA ICS 1 - Industrial Control and Systems General Requirements 2000 (Reaffirmed 2015).

W. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2000, with Errata (2008).

X. NEMA ICS 4 - Application Guideline for Terminal Blocks 2015.

Y. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices 2017.

Z. NEMA ICS 6 - Industrial Control and Systems: Enclosures 1993 (Reaffirmed 2016).

AA. NEMA ST 20 - Dry-Type Transformers for General Applications 2014.

BB. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

CC. NFPA 704 - Standard System for the Identification of the Hazards of Materials for Emergency Response 2017.

DD. UL 508 - Industrial Control Equipment Current Edition, Including All Revisions.

1.6 SUBMITTALS - GENERAL

A. See Section 013000 - Administrative Requirements, for submittal procedures.

1.7 SUBMITTALS - THIS SECTION

A. Plant Item Identification Scheme: Submit proposed scheme for approval of Engineer prior to submission of any submittals for equipment.

B. Temporary Water Supply and Disposal Plan.

C. Product Data: Submit manufacturer's technical data and installation instructions for:

1. Field applied protective finishes.

2. Joint and penetration seals.

D. Samples: Submit physical samples of:

1. Nameplates.

2. Piping identification materials and color coding scheme.

E. Operation and Maintenance Data: See Section 460106; submit for:

1. Field applied protective finishes.

F. Training Session Plans: Submit plan and date(s) for training sessions at least 4 weeks prior to anticipated date of training, for approval by Engineer and Owner.

1.8 QUALITY ASSURANCE

A. Welder Qualifications for Pipe Welding: Where welding by certified welders is specified in other sections, provide welders qualified in accordance with ASME BPVC-IX; welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1.

1.9 DELIVERY, STORAGE, AND HANDLING

A. See Section 016000 - Product Requirements for additional requirements.

B. Chemicals and Chemical Compounds: Deliver such products with attached Safety Data Sheet (SDS) in compliance with 29 CFR 1910.

1. This includes process feed chemicals and materials for construction, including solvents, solvent cements, glues, sealants, adhesives, and other materials that may contain hazardous compounds.

2. Handle in accordance with ASTM F402.

3. Provide storage facilities that comply with NFPA 704.

1.10 TEMPORARY WATER

A. Provide temporary water supply for testing, cleaning, and other purposes.

B. Water Source: Municipal Water.

C. Provide hoses, temporary pipes, ditches, and other items as required to properly dispose of water without damage to adjacent properties.

D. Dispose of or discharge temporary water in accordance with applicable regulations.

1.11 WARRANTIES

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

A. Unless otherwise indicated, provide products that are new and unused.

B. Where components serve the same function and are the same size, provide identical units from same manufacturer.

C. Provide components of a specific type by the same manufacturer.

D. Operating Equipment: For equipment that is electrically, hydraulically, or pneumatically operated, or has moving parts or electronic components, provide products that:

1. Are standard products of a manufacturer regularly engaged in manufacture of such products.

2. Essentially duplicate items that have been in satisfactory use for at least 2 years.

3. Is capable of operating in outdoor ambient temperature range anticipated at project site, unless located in a climate-controlled space or enclosure.

E. Provide necessary accessories, fittings, interconnections, services, and adjustments required for complete and operable system.

2.2 EQUIPMENT WITH MOVING PARTS

A. Protection from Moving Parts: Locate and guard belts, chains, pulleys, gears, projecting setscrews, keys, couplings, and other rotating and moving parts in accordance with OSHA requirements.

1. Make guards removable or so arranged as to allow access for maintenance.

2. A lockable housing without openings is considered a sufficient guard.

B. Lubrication: Provide adequate means of lubrication for moving parts subject to wear.

1. Unless otherwise indicated, provide lubrication by either grease or oil.

2. Grease Lubrication: Provide grease fittings; if grease fitting is not easily accessible, provide grease tubing to a convenient location.

3. Oil Lubrication: Provide oil reservoirs of liberal size with opening for filling, overflow opening at proper location to prevent overfilling, and drain opening at the lowest point;

vent reservoirs to prevent pressure build-up.

4. Provide equipment that is fully lubricated at Startup.

C. Bearings: Provide bearings complying with ABMA STD 9 or ABMA STD 11 as applicable to type of bearing.

1. Life Expectancy: Theoretical L-10 life expectancy.

2. Relief Ports: Provide to prevent build-up of pressure that might damage bearings or seals.

D. Locate drives, lubrication, and bearings that are accessible from walkways at or above ground level.

2.3 ELECTRICALLY OPERATED EQUIPMENT

A. Provide electrical components necessary for proper functioning of equipment, including but not limited to, motors, motor starters, VDFs as indicated, manual and automatic devices, electrical disconnecting means, conduit and raceways, and power and control wiring.

B. Motor Controls: NEMA ICS 1, NEMA ICS 2, NEMA ICS 4, and UL 508.

C. Motor Starters: Magnetic motor starter with thermal overload protection in each phase, short circuit protection, and other features required for the specified control function.

1. Overload Protective Devices: Thermal inverse-time-limit type giving adequate protection to motor windings, with manual-reset type pushbutton.

2. For Manual Operation: Provide Start-Stop pushbutton in enclosure cover.

3. For Automatic Operation: Provide Hand-Off-Automatic selector switch in enclosure cover.

D. Control Circuit and Pilot Devices: NEMA ICS 5.

E. Instrument and Control Transformers: Comply with IEEE C57.13 and NEMA ST 20.

F. Circuit Breakers: Thermal magnetic type, complying with IEEE C37.13.

1. Main Circuit Breaker: External handle mechanism, with positive locking device, mounted outside enclosure to permit operation of breaker from outside enclosure.

2. Main Circuit Breaker Capacity: Maximum of 150 percent of electrical load.

3. Branch Circuit Breakers: E-frame bolt-on type mounted on interior bus bar.

a. Provide a branch circuit breaker for each drive motor, control circuit, heating device, and receptacle.

b. Provide spaces for additional circuit breakers where indicated.

G. Wiring:

1. Control Circuits: No.14 gage (1.8 mm) stranded, 2/64 inch (1 mm) insulation, machine-tool wire with ring tongue compression type lugs.

2. Circuit Breaker and Power Circuits: Wire of necessary gage, minimum size No.12 gage (2.5 mm) with wire lugs.

3. Provide number tags on each end of wires.

4. Secure wires with either plastic ties or wiring duct, or both.

5. Secure wires going to components mounted on enclosure door in a cable-like bundle strapped to door and enclosure with sufficient slack to allow easy operation of door.

6. Terminate circuits requiring field connection on panel terminals.

2.4 ENCLOSURES FOR ELECTRICAL, ELECTRONIC, AND INSTRUMENTATION DEVICES

A. Enclosures: NEMA ICS 6 and NEMA 250 of types specified.

1. Corrosive Atmosphere Zone: Type 4X, stainless steel; painted steel not permitted.

2. Hazardous (NFPA 70 Classified) Locations: NEMA 250 Type qualified for particular location.
3. Outdoors: Type 4.
4. Mechanical Equipment Rooms: Type 1.
5. Indoor Dry Zone: Type 1, unless otherwise indicated.
6. Doors: Single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock; single, continuously hinged interior door.
7. Finish: Manufacturer's standard, unless otherwise indicated; repair or refinish damaged surfaces using original type finish.
8. Factory-install control components in enclosure, fully wired and tested.
9. Mount copy of external wiring connections and circuit breaker index print to inside of door.

B. Grounding: Provide solid copper ground bus or equivalent, securely anchored to enclosure so as to effectively ground entire structure.

1. Provide clamp-type terminals sized large enough to carry maximum expected current on ground bus for grounding cables.
2. Where a definite circuit ground is required, provide a single wire not less than #10 AWG running independently to ground bus and fastened to ground bus with bolted terminal lug.
3. Ground cases of instruments, relays and other devices through the steel structure of enclosure unless otherwise indicated.
4. Grounding Wire: Insulated wiring having continuous rated current of not less than the circuit fuse rating.
5. Solidly ground the grounding terminals of power receptacles to enclosure.

2.5 LANGUAGE AND UNITS OF MEASURE

A. Language: Use English language for forms of identification and human-machine interfaces (HMIs).

B. Units of Measure:

1. Use the same units of measure in each device measuring or displaying the same characteristic.
2. Metric Units of Measure: As defined in IEEE/ASTM SI 10, American National Standard for Metric Practice.

2.6 IDENTIFICATION OF EQUIPMENT, PIPING, AND ENCLOSURES

A. Plant Item Identification Scheme (Plant ID): Identify each item of equipment, device, and enclosure using a unique alphanumeric identifier and use the same identifier in each submittal and other documentation. IDs shall directly coorespond with those indicated in construction drawings.

B. Plant Item Nameplates: For each item of equipment, device, and enclosure, provide a nameplate permanently secured in a prominent, easily readable location.

1. Include Plant ID number and the generic name of the item.
   a. Pumps: See Section 460525 for additional requirements.
   b. Valves: See Section 460916 for additional requirements.
   c. Enclosures: Include both enclosure ID and internal device ID; where a single enclosure contains more than one device, show both enclosure ID and device IDs on outside nameplate with separate nameplates inside identifying each device.
   d. Motor Starters: Include both starter ID and name and ID of device controlled by starter.

2. Lettering: At least one inch (25 mm) high letters in color contrasting with background.
3. Nameplate Material: Engraved multicolor laminated plastic.
4. Attachment: Where exposed to weather or humid environment, use epoxy adhesive, other permanent adhesive, or screw attachment; other locations, permanent self-adhesive.

C. Manufacturer Nameplates: For each valve, item of equipment, and device, provide a nameplate permanently secured in a conspicuous location.

1. Nameplate Information: Manufacturer's name and address, type or style, model or serial number, and catalog number.
2. Nameplate Material: Same as Plant Item nameplates, or stainless steel or other corrosion-resistant material; information cast integrally need not be repeated on nameplate; manufacturer's original nameplates may be used provided they are in an easily readable location.

D. Piping Identification: Identify piping by its contents and flow direction every 20 feet (6100 mm) of straight run.

1. Provide additional identification at branch connections, inlets and outlets of equipment, upstream of valves, and within 3 feet (305 mm) of entrance to or exit from basins, foundation walls, and similar barriers.
2. Identify contents by color coding and lettering in contrasting color.
3. Lettering: At least 1 inch (25 mm) high; on horizontal piping, orient lettering horizontally; on vertical piping, orient lettering so it is readable when you tilt your head to the left.
4. Identify flow by large arrows.
5. For color coding, paint entire pipe in code color.
6. For contents identification, use either painted stenciled lettering or self-adhesive plastic tape pre-printed with supplemental attachment by plastic tape banding around pipe; for small diameter piping use any method that will provide durable, easily readable identification.
7. Paint: Use type of paint specified for application in Section 099113, Section 099123, and Section 099600.
8. Color scheme shall comply with the requirements set forth in Georgia Environmental Protection Division Minimum Standards for Public Water Systems and as indicated below.
    a. Water Lines:
        1) Raw or Recycle: Olive Green
        2) Settled or Clarified: Aqua
        3) Finished or Potable: Dark Blue
    b. Chemical Lines:
        1) Sodium Hydroxide (NaOH): Yellow with Green Band
        2) Hydrochloric Acid (HCl): Yellow
        3) Hydroflourosilicic Acid (H2SiF6):Light Blue with Red Band
        4) Aquamag (Polyphosphate): Light Gereen with Red Band
        5) Sodium Hypochlorite (NaOCl): Violet with Yellow Band
        6) Citric Acid (C6H8O7): Light Green with Blue Band
        7) Sodium Bisulfite (NaHSO3): Orange with Blue Band
    c. Waste Lines:

1) Backwash Waste: Light Brown
2) Sludge: Dark Brown
3) Sewer (Sanitary or Other): Dark Gray

d. Other:

1) Compressed Air: Dark Green
2) Gas: Red
3) Other Lines: Light Gray

9. For liquids or gases not listed above, a unique color scheme and labeling should be used. In situations where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color should be on one of the pipes at approximately 30 inch intervals. The name of the liquid or gas should also be on the pipe.

2.7 PROTECTIVE FINISHES

A. Surfaces related to unit processes are required to have a protective finish as specified, except that the following are not required to be separately finished unless otherwise specified:

1. Stainless steel.
2. Hot-dipped galvanized steel.
3. Fiberglass.
4. Aluminum, if not located in submerged, splash, or corrosive atmosphere zones.
5. Ductile iron.
6. PVC and CPVC.
7. Concrete, unless submerged or in splash zone.

B. Architectural and Structural Components: Finish exposed surfaces of the following using the specified finish, unless the material is not required to have a protective finish:

1. Walls, ceilings, and exposed overhead structure in corrosive atmosphere zone and hazardous atmosphere zone.
2. Walls in the splash zone.
3. Inside of concrete basins and channels.

C. Shop and Factory Finishes: Where finishing prior to delivery to project site is feasible, shop or factory-applied finishes are required, whether or not manufacturer's or fabricator's standard procedure; this requirement is non-negotiable, to achieve required corrosion resistance.

D. Field Finishes: Field finishing is permitted for the following:

1. Architectural and structural components.
2. Inside of concrete basins and channels.
3. Metallic piping, before installation of insulation.
4. Piping identification.
5. Finish painting of designated equipment in addition to specified factory/shop painting.

E. Finishes:

1. Apply coatings in accordance with coating manufacturer's recommendations and as specified.
2. Measure thickness of coatings using a commercial film thickness gage.
3. Test coatings with electric detector equipped with audible signal that operates when a flaw defect is detected, such as a 90-volt wet sponge type pinhole detector.

4. Coating Repair: If welding is required after finishing or finish is otherwise damaged, prepare, re-coat, and test in the same manner as specified for original coating.

F. Galvanizing: Hot-dipped zinc-alloy coating complying with ASTM A123/A123M or ASTM A153/A153M as applicable to item galvanized; electro-galvanized coating not acceptable; inspect for defects in factory; where repair is permitted by standard, use one of the methods specified in ASTM A780/A780M.

1. Stainless steel may be substituted where galvanizing is specified.

G. Galvanizing Repair Paint: ASTM A780/A780M.

2.8 METALS AND CONSTRUCTION MATERIALS USED IN EQUIPMENT

A. Stainless Steel: Type 304, Type 304L, Type 316, or Type 316L, unless otherwise indicated.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M and as specified in Section 051200.

C. Galvanized Steel Assemblies: Design to be field assembled using bolts without any welding.

D. Malleable Iron: ASTM A47/A47M, grade No. 32510, minimum.

E. Cast Iron: ASTM A48/A48M Class 30, minimum.

F. Aluminum Alloy Castings: ASTM B108/B108M.

G. Fiberglass Reinforced Plastic: Isophthalic polyester resins reinforced with glass fibers, minimum of 30 percent by weight; edges sealed and thermally cured in molds; free of voids and porosity.

1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.

2. Smoke Developed Index: 100 or less when tested in accordance with ASTM E84.

3. Rated as self-extinguishing when tested in accordance with ASTM D635.

2.9 JOINT AND PENETRATION SEALS

A. Firestopping: For above grade fire-rated wall and floor penetrations, provide firestopping as follows:

1. Rating: "F" rating not less than required fire resistance rating of penetrated assembly, tested in accordance with ASTM E814, and UL listed.

2. Materials: Permanent, moisture resistant, vibration resistant; where potential for liquid contact exists, provide material that is water resistant and provides a waterproof seal.

B. Interlocking Rubber Link Pipe Seals: Where waterproof seal is indicated, provide hydrostatic seals designed to seal opening between pipe or conduit and the perimeter of the opening; modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.

C. Joint Sealant: Silicone based, water resistant sealant.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify dimensions in the field before starting this work.

B. Notify Engineer of conditions that could prevent successful execution of the work.

3.2 EQUIPMENT INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations.

B. Equipment Bases: Unless otherwise indicated, provide concrete bases for equipment; furnish anchor bolts for proper placement in concrete.

C. Wiring Work: Comply with NFPA 70; use rigid metal conduit and fittings, except liquid tight flexible steel conduit may be used for short connections to motors and their controllers.

D. Adjust or replace units not complying with requirements; replace factory sealed devices, rather than adjusting.

E. Provide dielectric isolation where dissimilar metals are used for connection or support.

F. Regardless of whether indicated on drawings or not, provide equipment installed in piping with manual valves for shutoff, equalization, purging, and calibration.

3.3 WELDING

A. Protect adjacent construction, equipment, and vegetation from damage due to welding operations.

B. Use welders and procedures qualified as specified under QUALITY ASSURANCE article.

C. If possible, perform welding procedure qualifying tests on project site; notify Engineer at least 24 hours in advance of tests.

D. Weld piping and structural members in accordance with AWS D1.1/D1.1M.

E. Apply welder's assigned symbol near each weld as permanent record.

3.4 PENETRATIONS THROUGH BUILDING CONSTRUCTION

A. General:

1. Make penetrations and mounting holes in exterior construction watertight.

2. Make holes with proper equipment.

3. Use sealing materials compatible with existing construction.

B. Concrete Walls: For new construction provide steel pipe sleeves embedded in concrete.

1. Existing Concrete: Rotary drilled holes may be provided in lieu of sleeves.

2. Above Grade Applications In Nonsubmerged Areas: Sleeves hot-dipped galvanized after fabrication.

3. Buried, Submerged, and Splash Zones: Sleeves prefinished on surfaces with coal tar epoxy polyamide coating specified in this section.

C. Roof Penetrations: Provide pipe sleeve and flashing wherever piping passes through roof structures.

1. Pipe Sleeves: Galvanized steel.

2. Flashing Material: Lead sheet, 4 pound, 0.0625 inch (1.8 kg, 1.55 mm).

3. Above surface of roof, extend flashing 8 inches (200 mm) from the pipe in each direction, extend up the pipe at least 8 inches (200 mm), and seal top edge securely to pipe using non-metallic device.

4. Open-Top Vent Pipes: Turn flashing down inside pipe at least 2 inches (50 mm).

D. Submerged Wall Penetrations: Seal with interlocking rubber link pipe seals, unless otherwise indicated.

E. Below Grade Wall Penetrations:

1. Where indicated on drawings as "Waterproof Seal" or "Interlocking Rubber Link Type" use interlocking rubber link pipe seals.

2. In other locations, use joint sealant.

3.5 FIELD FINISHING

A. See PART 2 for surfaces and components that are permitted to be field finished, finish applications, materials, and preparation requirements.

B. Perform preparation and painting in accordance with paint manufacturer's instructions and recommendations.

1. Prepare surfaces for coating using methods specified.

2. Make allowances for inclement weather; do not apply coatings when substrate is wet or damp, when frost, ice, or snow is present, or when the substrate and/or surface temperature exceeds the recommendations of the coating manufacturer.
3. Apply coatings without pinholes, holidays (porosity), crazing cracks, inclusions and other defects and to specified thicknesses.
4. Examine coatings for flaws and test for thickness, both wet and dry, using a commercial film thickness gage.

C. Repair of Factory and Field Coatings: If coating does not meet requirements or is damaged, including specifically by welding after application of coating, remove and replace coating in defective or damaged area using same materials and methods specified for original coating; for blast cleaning preparation, blast clean to bare metal.

3.6 REPAIR OF ZINC-COATED SURFACES

A. Inspect galvanized items for damage to zinc coating.

B. Welding of galvanized items should be avoided if possible.

C. Repair damaged zinc coatings using one of the methods specified in ASTM A780/A780M.

3.7 FIELD QUALITY CONTROL

A. See other specification sections for requirements.

3.8 OWNER PERSONNEL TRAINING

A. See individual specification sections for training required.

B. Training of operating personnel is to be complete prior to Startup and training of maintenance personnel is to be complete prior to the end of the Startup Period; see Section 460103.

C. Owner will designate personnel to be trained; if number of personnel to be trained is not indicated, provide training materials for 5 (five) attendees per session.

D. Trainer(s): Personnel familiar with the operation and maintenance of the systems and equipment covered by the training, capable of answering advanced technical questions not explicitly covered by training materials; preferably a technical representative of the equipment manufacturer.

E. Training Content: As specified; if no details are specified, design training to be a directed review of the O&M Manual plus hands-on experience.

1. For purposes of planning training, assume attendees will be high-school graduates with experience with water treatment plants.
2. When both operating and maintenance personnel are to be trained in the same session, organize training so that operating personnel can conveniently skip the maintenance training, and vice versa where appropriate.

F. Training Workbook: Provide a workbook that can function for instructor-led training and for self-directed training.

1. Organize the workbook into lessons that parallel the O&M Manual.
2. For each lesson, reference the O&M Manual for detailed instructional material.
3. Do not repeat in the workbook material that is included in the O&M Manual, unless absolutely necessary for instructional purposes.
4. State at least 4 learning objectives for each lesson.
5. Include an orientation page that identifies which Unit Process is involved and where in the plant the equipment is located; use plan layout from O&M Manual.
6. Format: 3-ring binders; table of contents; lesson pages with white space for taking notes.
7. Number of Workbooks: Provide one workbook for each attendee to keep, plus two extra hard copies and electronic copy as project record document.

G. Audio-Visuals: Provide one electronic project record copy of slides, videos, and other audio-visual instructional materials.

H. Number of Sessions: A session is defined as a separately scheduled training of the number of training days and trainees indicated; if number of sessions is not indicated, only one session is required.

I. Training Hours: A training hour is defined as 55 minutes of instruction, conducted Monday through Friday, during the daytime shift and not during lunch time or breaks.

J. Location: Conduct training on-site, unless otherwise specified.

3.9 CLEANING AND PROTECTION

A. Clean equipment and unit process surfaces of dirt, dust, debris, and other foreign matter.

B. Protect equipment from damage by construction activities.

END OF SECTION

SECTION 460506 - WATER TREATMENT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Flanged ductile iron pipe and fittings.

B. Non-flanged ductile iron pipe and fittings.

C. Stainless steel pipe and fittings.

D. Stainless steel tube and fittings.

E. Plastic (PVC/CPVC) pipe and fittings.

F. HDPE pipe and fittings.

G. Pipe expansion joints.

1.2 RELATED REQUIREMENTS

A. See drawings for normal service conditions, pipe sizes, pressure ratings, nominal wall thicknesses, and insulation requirements.

B. Section 312316.13 - Trenching: Trenching for piping installation

C. Section 460106 - Operation and Maintenance Manual.

D. Section 460500 - Common Work Results For Water and Wastewater Equipment: Requirements applicable to all piping and equipment.

E. Section 460500 - Common Work Results For Water and Wastewater Equipment: Temporary water supply.

F. Section 460509 - Piping and Equipment Supports and Anchors: Anchors, racks, trapeze hangers, single rod hangers, clamps, brackets, guides, and thrust blocking.

G. Section 460513 - Piping Specialties: Sample ports, strainers, air release devices, vacuum breakers, valved drains, underground marking tape, heat tracing.

1.3 REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.

B. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard 2017.

C. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings 2018.

D. ASME B16.11 - Forged Fittings, Socket-welding and Threaded 2016 (Errata 2017).

E. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges 2016.

F. ASME B31.3 - Process Piping 2018.

G. ASME B36.19M - Stainless Steel Pipe 2018.

H. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).

I. ASTM A182/A182M - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service 2020.

J. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts 2014 (Reapproved 2020).

K. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications 2020.

L. ASTM A194/A194M - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both 2020a.

M. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications 2020a.

N. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2014, with Editorial Revision (2017).

O. ASTM A312/A312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes 2019.

P. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2018).

Q. ASTM A403/A403M - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings 2020.

R. ASTM A479/A479M - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels 2020.

S. ASTM A513/A513M - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing 2020a.

T. ASTM A536 - Standard Specification for Ductile Iron Castings 1984 (Reapproved 2014).

U. ASTM A632 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service 2019.

V. ASTM A815/A815M - Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings 2020.

W. ASTM B36/B36M - Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar 2018.

X. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds 2020.

Y. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter 2012a (Reapproved 2020).

Z. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness 2015, with Editorial Revision (2017).

AA. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2015.

BB. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2017.

CC. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2020.

DD. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems 2020.

EE. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings 2007 (Reapproved 2015).

FF. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping 2021.

GG. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.

HH. ASTM D3892 - Standard Practice for Packaging/Packing of Plastics 2015 (Reapproved 2020).

II. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings 2018.

JJ. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 2020.

KK. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings 2015.

LL. ASTM F1290 - Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings 2019.

MM. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.

NN. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings 2016.

OO. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 2012.

PP. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.

QQ. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges 2011.

RR. AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe 2014.

SS. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast 2017, with Errata (2018).

TT. AWWA C651 - Disinfecting Water Mains 2014.

UU. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Waterworks 2015.

VV. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.

WW. DIPRA TRD - Thrust Restraint Design for Ductile Iron Pipe 2016.

XX. ISO 228-1 - Pipe threads where pressure-tight joints are not made on the threads -- Part 1: Dimensions, tolerances and designation 2000.

YY. PPI (PE) - Handbook of Polyethylene Pipe 2008, Second Edition.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 for submittal procedures.

B. Product Data: Manufacturer's descriptive and technical literature for each material and component, showing compliance with requirements and installation instructions.

C. Shop Drawings:

1. List of piping systems, indicating application, material, size, and pressure rating.

2. Detailed drawings of piping systems, showing locations of valves, expansion joints, specialties, and instrument connections.

D. Waste Water Disposal: Before starting operations that require a temporary water supply submit the method proposed for disposal of waste water; for information; where regulatory permits are required, submit evidence that permits have been obtained.

E. Pipe Testing Plan.

F. Field Quality Control Reports:

G. Operation and Maintenance Data: See Section 460106.

H. Project Record Documents: Record actual locations of pipe anchors and guides and layout of piping systems relative to other parts of the work including clearances for maintenance and operation.

1.5 QUALITY ASSURANCE

A. Plastic Piping Manufacturer Qualifications: Submit documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

B. Welder Qualifications: Provide certified welders for welding pipe joints; see Section 460500 for additional requirements.

C. NSF 61 Compliance:

1. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

D. Repairs:

1. Do not use patched or repaired pipe or appurtenances unless each individual length or element has been approved and marked for repair by the Engineer at the manufacturing plant. Repairs, other than at the manufacturing plant, are not permitted.

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Section 460500 for additional requirements.

B. Plastic Pipe: Package, pack, and mark in accordance with ASTM D3892. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

C. Gaskets: Store rubber gaskets not to be installed immediately under cover, out of direct sunlight.

D. Protect flanges, fittings, and specialties from moisture and dirt.

E. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

1.7 FIELD CONDITIONS

A. Existing Conditions:

1. Verify existing piping and penetrations.

2. Prior to ordering materials, expose all existing pipes which are to be connected to new pipelines.

3. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipes.

4. Inspect size and location of structure penetrations to verify adequacy of wall sleeves and other openings before installing connecting pipes.

PART 2 PRODUCTS

2.1 PIPING APPLICATIONS

A. As indicated on drawings.

2.2 PERFORMANCE REQUIREMENTS

A. Provide piping systems suitable for the design conditions and applications intended, coordinated to function as a system, and considering the piping both with and without internal pressure, installation factors, and supports.

B. The pressure ratings and materials specified represent minimum acceptable performance; provide fittings, flanges, valves, and appurtenances with pressure ratings no less than that required for the system in which they are installed.

C. Provide all work and equipment required to accommodate expansion and contraction of piping under varying temperature conditions; verify that anchors, guides, and expansion joints provided, adequately protect the piping systems.

D. Provide flexible connections:

1. Between floor mounted equipment and suspended piping.

2. At building separations and seismic joints.

2.3 PIPE AND FITTINGS - GENERAL REQUIREMENTS

A. Piping and Fittings: New and unused material.

1. Pressure Ratings: As specified per material.

2. Nominal Sizes: As indicated on drawings.
3. Fittings: Same pressure rating as pipe, or greater, unless higher rating is specified; same material as pipe unless otherwise indicated.
4. Sizes: Use standardized nominal sizes for compatibility with future work.
5. Material Identification: Permanently mark each piece of pipe and fitting with its AWWA or ASTM designation and other markings required for that designation.

B. Joints: Completed joints are to have working pressure rating for liquids equal to pressure rating of the pipe.

C. Flanged Joints and Fittings (Metal and Plastic): Internal diameter bores of flanges and flanged fittings same as that of pipe.

1. Bolting: Hex head bolts of alloy-steel complying with ASTM A193/A193M Grade B5, hex head nuts of ASTM A194/A194M Grade 3, and washers of same material as bolts; except when mating with cast iron flanges use Grade B8 Class 1 bolts and Grade 8 heavy hex head nuts.
2. Provide with washers of same material as bolts.
3. Non-Metallic Gaskets: Chloroprene rubber, unless otherwise indicated; ASME B16.5 and ASME B16.21.
   a. Thickness: 1/8 inch (3 mm), maximum.
   b. Hardness: 80 Shore A durometer, in accordance with ASTM D2240.
   c. Tensile Strength: 1,500 psi (10.34 MPa), minimum.
   d. Elongation: 125 percent, minimum.
   e. For Raised Face Flanges: Flat ring type.
   f. For Flat Face Flanges: Full face type.
4. Metallic Gaskets: Ring joint gaskets, of material suitable for application; ASME B16.5.

D. Restrained Joints: Design for working pressure equal to connected pipe rating; provide thrust ties where indicated and where required to restrain force developed by 1.5 times maximum allowable operating pressures specified.

E. Bolts and Nuts:

1. Buried: Zinc-plated; on cast iron and ductile iron couplings high-strength, low-alloy steel complying with AWWA C111/A21.11.
2. Submerged: Stainless steel, 304.

F. Isolation Devices for Dissimilar Metals: Where dissimilar metallic piping, fittings, or valves must be connected, use isolation devices as indicated and as required to separate the different materials to avoid galvanic action.

1. For flanged connections use flange isolation gaskets; gas-tight where underground.
2. For threaded and welded connections, use dielectric fittings.
3. For mechanical joints, use joint devices that accomplish separation.

G. Pipe Closure Pieces: ASME B16.9 or ASME B16.11; provide wherever pipe runs end.

1. Piping with Restrained Joints: Use closures installed with same thrust tie-rod assemblies.

H. External Coatings: Unless otherwise indicated; finish fittings with same coating as pipe.

2.4 FLANGED DUCTILE IRON PIPE FOR PRESSURE SERVICE

A. Ductile-Iron Pipe: AWWA C115/A21.15, all pipe sizes, with ASME B16.1, Class 125 flanges.

1. External Coating: Coated on outside with manufacturer's standard asphaltic coating, approximately one mil (0.25 mm) thick.

2. Nominal Size: As indicated on drawings.
3. Pressure Rating: 250 psig (1700 kPa).
4. Joints: Comply with AWWA C110/A21.10.
    a. Provide gaskets, glands, bolts and nuts as required to completely assemble joints.
    b. Gaskets: Vulcanized synthetic rubber; reclaimed rubber is not acceptable.

B. Fittings: Ductile iron or gray iron, cement mortar lined same as pipe.
1. Pipe Diameters Up To 12 inches (300 mm) Inclusive: Use fittings rated 250 psig (1.7 MPa).
2. Bolts and Nuts: Carbon steel complying with ASTM A307, Grade B, with washers of same material.
3. Gaskets: Ring.

2.5 NON-FLANGED DUCTILE IRON PIPE FOR PRESSURE SERVICE

A. Ductile-Iron Pipe: AWWA C151/A21.51 and AWWA C150/A21.50, all pipe sizes.
1. Cement-Mortar-Lining: AWWA C104/A21.4 with tolerance of plus 1/8 inch (3 mm) permitted.
2. External Coating: Coated on outside with manufacturer's standard asphaltic coating, approximately one mil (0.25 mm) thick, for below grade locations.
3. External Coating - Exposed Pipe: Coating on outside will be High-Performace Coating, see Section 099600.
4. Pressure Rating: 250 psig.

B. Mechanical Gland and Gasket Joints: AWWA C110/A21.10 and AWWA C111/A21.11.
1. Glands: Ductile or gray iron with asphaltic coating.
2. Gaskets: Styrene butadiene rubber (SBR) or vulcanized SBR; reclaimed rubber is not acceptable.
3. Orient bolt holes straddling vertical centerline of valves and fittings.

C. Mechanical Coupling Joints: AWWA C110/A21.10 and AWWA C111/A21.11.
1. Housings: Malleable iron, ASTM A47/A47M or ductile iron, ASTM A536.
2. Gaskets: Styrene butadiene rubber (SBR).
3. Bolts and Nuts: Heat treated carbon steel, ASTM A183, minimum tensile strength of 110,000 psi (760 MPa).

D. Push-on Joints: Comply with AWWA C111/A21.11, with gaskets and lubricant.
1. Gaskets: Compatible with joint design and comprised of styrene butadiene rubber (SBR) or vulcanized SBR; reclaimed rubber is not acceptable.
2. Lubricant: Specifically formulated for use with push-on joints, and non-toxic, odorless, tasteless, and not supporting bacteria growth.

E. Grooved Joint: Comply with AWWA C606-15.
1. Housing: Malleable or ductile iron housing with asphaltic outside coating
2. Gaskets: Molded or extruded elastomeric gasket material recommended by manufacturer for actual service application shown.
3. Bolts and Nuts: Corrosion resistant steel alloy.

F. Restrained Joint: Factory fabricated joint restrain system to resist pressurized pipe thrust forces.
1. Push-On Joint: Use boltless system of rubber gasket embedded with equally spaced stainless steel segments to grip the pipe, with allowance for joint deflection, and rated

for 250 psi working pressure.

2. Mechanical Joint: Use assembly of ductile iron retainer gland and corrosion resistant alloy steel bolts and nuts having a minimum 250 psi working pressure rating and permitting joint deflection.
3. Provide restrained joints where indicated on the Drawings and, at Contractor option, for direct burial piping thrust restraint in lieu of concrete and metal tie rods and bands.

G. Fittings: Ductile iron or gray iron, cement mortar lined same as pipe.

1. Pipe Diameters Up To 12 inches (300 mm) Inclusive: Use fittings rated 250 psig (1.7 MPa).
2. 250 psi (1.72 MPa) Service: AWWA C110/A21.10.

2.6 STAINLESS STEEL PIPE/TUBE AND FITTINGS

A. Stainless Steel Pipe:

1. Material: ASTM A312/A312M, welded.
2. Grade: 316.
3. Nominal Size: As indicated on drawings.
4. Wall Thickness for pneumatic piping: Schedule 40S, with dimension complying with ASME B36.19M.
5. Wall Thickness for process piping: Schedule 10S, with dimensions complying with ASME B36.19M.
6. Joints for pneumatic piping under 4": Threaded.
7. Joints for pneumatic piping 4" and larger: Flanged. Flange-to-pipe connection can be either field welded or threaded flange.
8. Joints for process piping: Flanged. Flange-to-pipe connection to be field welded.
    a. Flanges are required for all valve-to-pipe and pipe-to-process-equipment connections.
    b. Field welded pipe assembly cannot consist of more than one direction change. A field welded pipe assembly shall not exceed more than 20 feet as measured along its alignment.

B. Stainless Steel Tube:

1. Material: ASTM A632, seamless, Grade TP316.
2. Nominal Size: As indicated on drawings.
3. Joints: Compression.

C. Threaded Fittings, Tees, Bends, Reducer Couplings, and Unions: Austenitic stainless steel, ASME B16.11.

1. Material: ASTM A182/A182M Grade 316.

D. Welding Fittings: Forged austenitic stainless steel.

1. Material: ASTM A403/A403M Grade 316.
2. Butt-Welding Fittings: ASME B16.9 Class CR.
3. Socket-Welding Fittings: ASME B16.11 Class WP-S.

E. Flanged Fittings: Faced and drilled to ASME B16.5, Class 150, welding neck type.

1. Material: Forged austenitic stainless steel, ASTM A182/A182M Grade TP316.
2. Flange Faces: Flat.

F. Compression Fittings for Tubing: Nuts, ferrules and bodies rated to [_____] psig (____ kPa), minimum.

1. Material: Stainless steel, ASTM A479/A479M, Grade TP316.

2. Threads: Straight, complying with ISO 228-1.

2.7 JOINING DEVICES FOR METAL PIPE

A. Dielectric Fittings: Material, shape, and design as required to prevent metal-to-metal contact of dissimilar metallic piping elements; suitable for required working pressure, temperature and corrosion environment.

B. Flange Isolation Gaskets: Dielectric isolation gasket, isolation washers and full length isolation sleeves for flange bolts; size and type to fit piping flanges.

1. Gaskets: Full faced with outside diameter equal to flange outside diameter.

2. Shape and design as required to prevent metal-to-metal contact of dissimilar metallic piping elements.

C. Couplings for Joining Plain End Pipe Sections: Sleeve-type, comprised of cylindrical sleeve, two end bolting rings, two gaskets, and connecting bolts; sized to match piping.

1. Pipe Sizes 1/2 through 1-1/2 inch (15 through 40 mm): End rings of ductile iron; sleeve of ASTM A513/A513M; standard weight pattern.

2. Pipe Sizes 2 inches (50 mm) and Larger: End rings of ASTM A395/A395M; sleeve of ASTM A513/A513M; standard weight pattern.

3. Steel Components: Fusion bonded epoxy-lined and coated.

4. Couplings Made with Steel Components: Pressure tested beyond yield point.

5. Bolting Dimensions: AWWA C111/A21.11.

6. Bolts: Elliptic-neck, track-head steel bolts designed to properly compress gaskets.

7. Gaskets: Wedge type; natural rubber.

8. Split sleeve-type couplings may be used in aboveground installations under special situations and when approved in advance by Engineer.

9. Transition couplings may be used to connect two pipes of same material that have small differences in outside diameter.

2.8 PLASTIC PIPE, FITTINGS, AND JOINING DEVICES

A. Plastic Pipe: Chlorinated polyvinyl chloride (CPVC).

B. CPVC Pipe: Schedule-based; ASTM D1784, minimum cell classification 23447.

1. Nominal Size: As indicated on drawings.

2. Wall Thickness: In accordance with ASTM F441/F441M.

a. Threaded: Schedule 80.

b. Not Threaded: Schedule 80.

C. Joints and Fittings: Fittings of same composition as pipe.

1. Joints Requiring Future Disassembly: Use back-welded threaded joints; such joints include but are not limited to unions, valves, and equipment.

2. Chemical Feed Piping: Flanged or threaded.

3. Other Joints: Socket-welded, flanged, or mechanical joints, unless a specific joint type is indicated.

D. Threaded Fittings: ASTM D2464 Schedule 80; thread lubricant not required.

E. Socket-Welding Fittings: ASTM D2467 for Schedule 80; ASTM D2466 for Schedule 40; joined with PVC solvent cement complying with ASTM D2564 and of manufacture and viscosity as recommended by pipe and fitting manufacturer; primed prior to assembly with ASTM F656 primer.

F. Flanged Fittings: One piece molded hub type, flat faced, with molded stub ends; dimensions as specified in ASME B16.1.

1. Pressure Rating: Class 125.
2. Backing Flanges: Stainless steel, ASTM A240/A240M Type 304 with ASME B16.1 drilling.
3. Gaskets: Non-metallic, full-faced.
4. Where mating flange has raised face, use flat ring gasket and a filler gasket between outer edge of raised face and flange outer edge.

G. Compression Coupling: Comprised of middle section of like material, two mechanical nuts, two elastomeric gaskets and two machined steel lock rings; sized to match piping.

1. Minimum Allowable Working Pressure: 150 psig (1030 kPa) at 120 degrees F (49 degrees C).
2. Gaskets: Wedge type; natural rubber.

2.9 PE PIPE

A. PE Pipe: ASTM D2239

1. DR No. 9 or 9.3; with PE compound number required to give pressure rating not less than 200 psig.

B. Furnish pipe with each section continuously and permanently marked with the following identifying data:

1. Nominal size and outside diameter.
2. Material code designation.
3. Dimension ratio number (SDR or DR).
4. Pressure class.
5. ASTM or AWWA specification designation.
6. Manufacturer’s name or trademark and production record code.
7. Green color stripes or print lines to designate non-potable water.

C. Fittings: AWWA C906

1. Molded or fabricated fittings manufactured from same material as pipe and fully rated for the same internal pressure as the mating pipe. DR number matching pipe and PE compound number required to give pressure rating not less than 200 psig.
2. Plain End Pipe: Thermal butt-fusion per ASTM D2657.
3. Saddle Branch Fitting: Thermal Saddle fusion.
4. Conduct thermal fusion by operators trained and qualified in the recommended procedures of the pipe and fusion equipment supplier.

2.10 ACCESSORIES

A. Pipe Detection Wire

1. Manufacturer: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
   a. Pro-Trace HDD-CCS PE45 by Pro-Line Safety Products.
   b. Substitutions: See See Section 016000 - Product Requirements.
2. Provide No. 12 AWG solid single conductor, hard-drawn copper clad steel (CSS) cable or solid copper wire insulated with a 45-mil high molecular weight polyethylene (HDPE) jacket conforming to ASTM D1248 for Type 1 Class C. Provide CCS or solid copper wire with a minimum tensile break load of 1,030 pounds and with not less than 21 percent conductivity.
3. For splices, use direct burial, water and corrosion proof, silicone-filled, pipe detection wire connector kits.

4. Install Pipe Detection Wire on all below grade nonmetallic pipe.

B. Gate Valve Type 11 (GV-11):

1. Bronze body with threaded ends, handwheel operator, 200 pound pressure class (400 PSIG cold W-O-G, non-shock working pressure), rising stem, solid disc, union bonnet and capable of being repacked under pressure with valve fully open.

C. Pressure Reducing Valves

1. Provide pressure-relief valves rated for the pressure experienced on the high-pressure side and sized for the full installed capacity of the pressure regulating station at the pressure experienced on the low-pressure side. Set the valve so that the pressure does not exceed the correct low-side pressure by greater than 20 percent. Rate and label the valve. Ensure that the seat material is suitable for the service.

2. Pressure Gages

a. Ensure that the pressure gages conform to ASME B40.100 and are Type I, Class 1, (pressure) for the pressures indicated. Provide a pressure gage size that is 3 1/2 inches. Ensure the cases are constructed of corrosion-resistant steel conforming to [the AISI 300 series] [ASTM A666] with an ASM No. 4 standard commercial polish or better.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that size and location of piping, sleeves, and appurtenances embedded in concrete are correct.

B. Before installing, examine piping having factory-applied linings for damage to linings; replace pipe with damaged lining.

3.2 TRENCHING

A. Perform trenching for piping installation in accordance with Section 312316.13.

B. Do not backfill until piping testing is complete.

3.3 PREPARATION

A. Keep Interior of Pipes Clean:

1. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material inside piping sections during fabrication.

2. Close pipe openings with caps or plugs before, during, and after installation.

3. Remove foreign objects and dirt prior to assembly and installation.

B. Protect pipe coatings from chemical and mechanical damage; do not install damaged products.

C. Repair damaged zinc, organic, and paint coatings with material equal to original coating, as specified in Section 460500.

D. Before field fabrication of pipe or fittings, notify Engineer at least 2 weeks prior to date of starting fabrication.

3.4 INSTALLATION - GENERAL

A. Install piping and appurtenances in compliance with ASME B31.3, reviewed shop drawings, if any, and manufacturer's instructions, with all joints tight and no undue marring of finishes.

1. Install piping to accurate lines and grades.

2. Run piping as straight as practical in alignment shown with minimum of joints.

3. Maintain required upstream and downstream clearances.

4. At flow measuring devices, provide straight runs of piping upstream and downstream in accordance with device manufacturer's recommendations.
5. Install piping without springing or forcing pipe to fit.
6. Pitch piping toward low points and provide a valved drain at each low point.
7. Provide a sufficient number of unions or flanges to allow for dismantling of pipe, valves, and equipment.
8. Where temporary supports are used, make them sufficiently rigid to prevent shifting or distortion of pipe.
9. Make installed piping, valves, and fittings free from strain and excessive stresses caused by weight or misalignment.

B. Provide isolation valves and miscellaneous devices as required for an operable installation.

C. Pipe Jointing: Clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after installation.

D. Thermal Expansion and Contraction: Install piping to allow for thermal expansion and contraction resulting from difference between temperature during installation and during operation.

1. Anchors: Locate as indicated on drawings and reviewed shop drawings, if any, to withstand expansion thrust loads and to direct and control thermal expansion.
2. Intermediate Pipe Alignment Guides:
    a. Install adjacent to pipe expansion joints and within four pipe diameters each side.
    b. At pipe mounted on metal channel framing, install intermediate pipe guide at each metal channel framing support not carrying an anchor or alignment guide.

E. Flexible Couplings and Expansion Joints: Install in accordance with manufacturer's instructions, at connections to equipment and where shown on drawings and reviewed shop drawings, if any.

F. Couplings, Adapters and Service Saddles: Install in accordance with manufacturer's instructions.

1. Gaskets: Thoroughly clean pipe ends of oil, scale, rust, and dirt to provide clean seat for gaskets.
    a. Wipe gaskets clean.
    b. Lubricate flexible couplings and flanged coupling adapter gaskets with soapy water or manufacturer's standard lubricant before installation.
2. Tighten bolts progressively, drawing up bolts on opposite sides a little at a time until all bolts have uniform tightness.
3. Use torque-limiting wrenches to tighten bolts.

G. Pipe Tap Connections: Taps direct to pipe barrels are prohibited; make taps as follows:

1. Ductile Iron Piping: Use service saddle or tapping boss of a fitting, valve body, or equipment casting.
2. Steel Piping: Use a welded threadolet connection.

H. Metallic Piping Embedded In Concrete: Coat piping with specified underground pipe coating to prevent direct metal-to-metal contact with reinforcement bars and wires.

I. Buried Pipe Installation:

1. Carry pipe to the trench; do not drag it.
2. Exercise care when lowering pipe into trench to prevent damage and twisting of pipe.
3. At valves and connections, excavate trench bottom to sufficient length, width, and depth to ensure clearance between undisturbed trench bottom and bottom of valves and connections.

J. Joints at Rigid Structures:

1. Provide flexible joints at face of rigid structures, whether or not shown on drawings.
2. Flexible jointing methods include, but are not limited to, rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints; welded joints are not considered flexible.
3. Joint Location: Flush with structure face or up to one (1) pipe diameter from face; maximum distance from face:
    a. Pipe Diameter Over 18 inches (450 mm): First joint within one (1) pipe diameter from face.
    b. Smaller Diameters: 18 inches (450 mm) from face.

K. Provide and install supports, hangers, and guides as specified in Section 460509.

L. Install concrete thrust restraints where indicated on drawings and as specified in Section 460509.

M. Identify exposed piping as specified in Section 460500.

3.5 METALLIC PIPE JOINTING

A. Connecting Dissimilar Metallic Pipe and Appurtenances: Use isolation devices as specified and as required to separate different materials to avoid galvanic action; install in accordance with manufacturer's instructions.

B. Restrained Joints:

1. Ductile Iron Pipe: Design and install in accordance with DIPRA TRD.

C. Welded Joints: Welded in accordance with AWS D1.1/D1.1M.

1. Perform welding in accordance with qualified procedures using performance qualified welders and operators.
2. Welding Electrodes: In accordance with Table 3.1 of AWS D1.1/D1.1M as required for applicable base metals and welding process.

D. Grooved-and-Shouldered Joints:

1. Prepare grooves and install couplings in accordance with manufacturer's instructions.
2. Measure and record groove width and dimension of groove from end of pipe.

E. Flanged Joints: Make flanged joints up tight, taking care to avoid undue strain on flanges.

1. Install flanged fittings true and perpendicular to axis of pipe.
2. Install so that adjoining flange faces are not out of parallel to such degree that joint cannot be made watertight without overstraining flanges.
3. Align bolt holes in both flanges; use full size bolts; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose is not permitted.
4. Where instrumentation device is indicated to be installed in the vertical centerline of pipe, install flanges with bolt holes straddling vertical centerline of pipe.
5. Tighten bolts uniformly to prevent overstressing flanges and misalignment.
6. Replace flanged pipe and fittings whose dimensions do not allow making flanged joint as specified.

F. Screwed Joints: Make tight with joint compound applied to the male threads only or with joint tape.

3.6 PLASTIC PIPE INSTALLATION

A. Cut, fabricate, and install plastic pipe in accordance with pipe manufacturer's instructions and recommendations.

B. Install pipe only when ambient temperature is above 40 degrees F (4.5 degrees C) and below 90 degrees F (32 degrees C) and not exposed to direct sunlight.

C. Thermoplastic Piping Systems: Install in accordance with ASTM D2774.

D. Plastic Pipe Jointing: Follow manufacturer's instructions.

1. Heat Jointing: Comply with ASTM D2657.
2. Electrofusion Jointing: Comply with ASTM F1290.
3. Solvent-Cemented Jointing: Comply with ASTM D2855.
4. Push-On Joints: Lubricate gaskets to prevent displacement; take care to ensure that gasket remains in proper position in bell or coupling.
5. Do not thread Schedule 40 pipe; where connecting pipe to threaded valves or fittings, use Schedule 80 threaded nipples.
6. Use strap wrenches for tightening threaded plastic joints, taking care not to over-tighten fittings.
7. Shield pipe ends from direct sunlight prior to and during installation.
8. Provide adequate ventilation when working with pipe joint solvent cement; comply with ASTM F402 for handling of solvent cements, primers and cleaners.

E. Use expansion joints and offset piping arrangements to accommodate thermal expansion and contraction.

1. Make offset loops from pipe centerline as recommended by manufacturer based on maximum temperature difference between pipe temperature at time of jointing and operating temperature.
2. For pipe exposed to outside air or in which the temperature variation of the contents is substantial, make provisions for movement due to thermal expansion and contraction in accordance with PPI (PE); Material Properties; Coefficient of Expansion/Contraction.

3.7 FIELD QUALITY CONTROL - GENERAL

A. Test all parts of piping systems using clean water and hydrostatic pressure and leakage tests, unless otherwise indicated.

B. Underground Piping: Test after partial completion of backfill but before full completion of backfill; leave joints exposed for examination.

1. Exception: Where concrete thrust blocking is provided, do not test that section of piping until at least 5 days after installation of concrete, unless otherwise approved by Owner.
2. This requirement for joints to remain exposed for hydrostatic testing may be waived by Engineer when one or more of following conditions are encountered; request waiver in writing with reasons and alternative procedure to accomplish equivalent testing.
    a. Wet or unstable soil conditions in the trench.
    b. Compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to ensure safe conditions.
    c. Maintaining trench in open condition would delay completion.

C. Above Ground Pressure Piping: Test after piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

D. Leakage Testing: Perform after pressure tests have been satisfactorily completed, unless otherwise approved by Owner.

E. Testing New to Existing Connections:

1. Isolate new work with pipe caps, spectacle blinds, blind flanges, or other effective methods.

2. Test the joint between new and existing work by methods that do not place entire existing system under test load.

F. Water: Provide clean test water of such quality to avoid corrosion of piping system materials.

3.8 FIELD QUALITY CONTROL - HYDROSTATIC PRESSURE TESTING

A. Perform hydrostatic testing in accordance with ASME B31.3 under normal service conditions.

B. Test Pressure:

1. Rigid Piping: Calculated according to ASME B31.3; not be less than 1.5 times design pressure and not exceeding yield strength of piping system.

2. Non-Rigid, Non-Metallic Piping and Metallic Piping with Non-Metallic Liner: Calculated according to ASME B31.3 but not exceeding 1.5 times maximum pressure rating of lowest rated component in piping system.

C. Maximum Velocity During Filling: 0.25 fps (0.075 m/s) applied over full area of pipe or as recommended by pipe manufacturer, whichever is lesser.

D. Venting Air While Filling: Purge all air in system; open air release vents to purge air pockets; venting may also be provided by loosening minimum of four bolts of flanges or by use of equipment vents.

E. Valves: Include each valve in at least one piping section tested; open and close valves several times during test.

F. Rigid Piping Test Procedure:

1. Maintain test pressure continuously for minimum of 30 minutes and during examinations for leakage.

2. Leave piping system full of water after leaks are repaired, unless otherwise directed by Owner.

G. Non-Rigid, Non-Metallic Piping and Metallic Piping With Non-Metallic Liner Test Procedure:

1. Raise pressure to 50 percent of normal service pressure.

2. Inspect pipe, fittings, joints and connections, and valves for visible leakage; correct leaks and continue test.

3. Raise pressure to test pressure and add small amounts of test liquid as required hourly for maximum of 3 hours as required to maintain test pressure.

4. After 4 hours, lower test pressure by 10.2 psi (70 kPa).

5. If pressure remains steady for one (1) hour, no leakage is indicated.

6. Before retesting, allow piping system to relax for 8 hours.

H. Inspect pipe, fittings, joints and connections, and valves for visible leakage; correct leaks and re-test until results are satisfactory.

3.9 FIELD QUALITY CONTROL - PIPE LEAKAGE TESTING

A. Test piping for leakage by filling with water, or other appropriate test liquid, applying specified test pressure, and measuring amount of additional liquid is necessary to maintain the specified pressure for the specified duration.

B. Duration of Leakage Test: At least 2 hours after piping has been filled and air has been expelled.

C. Test Pressure: 200 psig (1.38 MPa) plus/minus 5 psig (34.5 kPa).

D. Locate leaks, repair, and re-test until leakage is within specified limits.

3.10 FIELD QUALITY CONTROL - PNEUMATIC TESTING

A. Perform pneumatic testing in accordance with ASME B31.3.

1. Take care to minimize chance of brittle fracture or failure during test.
2. Only air or non-toxic, nonflammable, inert gases may be used.
3. Provide a pressure relief device for each piping section being tested; set pressure not higher than test pressure plus lesser of 10 percent of test pressure or 50.8 psi (350 kPa).

B. Test Procedure:

1. Test Pressure: 110 percent of design pressure.
2. Incrementally increase pressure until gauge pressure reaches lesser of 50 percent of test pressure or 25 psig (170 kPa).
3. Examine piping joints for leakage.
4. If no leakage is occurring, continue to increase pressure incrementally, while maintaining each incremental increase long enough to equalize pipe strains, until test pressure is reached.
5. Reduce pressure to design pressure and maintain for 10 minutes without additional energy expenditure.
6. If pressure remains steady, then no leakage is indicated.

C. Locate leaks, repair, and re-test until pressure remains steady.

3.11 CLEANING PIPING - PRIOR TO STARTUP

A. After testing, flush piping with water to remove accumulated construction debris and other foreign matter; continue flushing until no foreign matter exits the pipe.

B. Install cone strainers in connections of attached equipment and leave in place until flushing is completed. Remove accumulated debris through drains or by removing spools or valves.

C. Minimum Flushing Velocity: 2.5 feet per second (0.76 m/s).

D. For large diameter pipe impractical to flush at minimum flushing velocity, clean pipe in place from inside by brushing and sweeping, then flush at a lower velocity.

3.12 DISINFECTION - PRIOR TO STARTUP

A. After testing and cleaning, disinfect all piping.

B. Disinfect in accordance with AWWA C651.

1. Disinfecting Chemical: One of the following at dosage of not less than 50 ppm of free chlorine residual.
   a. Liquid chlorine.
   b. Calcium hypochlorite in water solution.
   c. Sodium hypochlorite in water solution.
2. Introduce disinfecting chemical into piping in a liquid solution; NEVER put dry, solid chemicals directly into piping.
3. Retain treated water in pipe long enough to destroy all non-spore-forming bacteria; not less than 24 hours unless otherwise approved.
4. Open and close valves on piping being disinfected several times during retention period.
5. Use enough disinfecting chemical to produce not less than 25 ppm of free chlorine residual throughout pipe at end of the retention period.

C. After disinfection, flush piping with clean water until residual chlorine is reduced to less than 1.0 ppm.

1. During flushing period, open and close each outlet several times.
2. After flushing to remove residual chlorine, fill piping with clean water and let stand for sampling.

D. Repeat disinfection and flushing until successful bacterial tests have been obtained for 2 consecutive days.

END OF SECTION

SECTION 460509 - PIPING AND EQUIPMENT SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Supports, hangers, and guides.

B. Anchors and fasteners to supporting structures.

C. Thrust blocking for buried piping.

1.2 RELATED REQUIREMENTS

A. Section 460500 - Common Work Results For Water and Wastewater Equipment: Definitions of corrosion-potential exposures; pipe sleeves.

1.3 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2014.

C. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).

D. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping 2014 (Reapproved 2020).

E. ASTM A194/A194M - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both 2020a.

F. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality 2017.

G. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs 2017.

H. ASTM F594 - Standard Specification for Stainless Steel Nuts 2009 (Reapproved 2020).

I. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2019, with Editorial Revision (2020).

J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 - Common Work Results For Water and Wastewater Equipment for submittal procedures.

B. Product Data: Manufacturer's published literature for each factory-fabricated item, showing size, materials of construction, and loading capacity.

C. Shop Drawings: Detailed fabrication and installation drawings showing how each item of equipment, enclosure, and piping is supported and anchored.

1. Identify item supported/anchored and loads on supports/anchors

2. For supports, show member sizes, components, and connections.

3. For anchors, show anchor and fastener type, size, quantity, diameter, depth of penetration, edge distance, and spacing.

4. Include the calculations and prescriptive design tables used for design, sizing, and selection.

D. Manufacturer's Qualification Statement.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section with not less than three years documented experience.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Drawings do not show all details of supports and anchors; design supports and anchors to resist all live and dead loads.

1. Design Loads: As specified in ASCE 7.
2. Comply with applicable requirements of authorities having jurisdiction.
3. Select and design supports for piping in accordance with MSS SP-58.
4. Design supports and anchors with factor of safety of 2 (two).

B. Anchor all equipment, enclosures, and piping, including fittings, valves, and other items attached to piping, to structure capable of supporting them, whether such anchorage is shown on drawings or not.

C. Provide support for all piping not indicated to be direct-buried, whether such support is shown on drawings or not; unless otherwise indicated, support piping from structure above.

D. Provide thrust blocking for direct-buried, non-restrained joint piping whether shown on drawings or not.

1. At minimum, provide thrust blocking at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
2. Do not use thrust blocking for any plastic piping.

E. Do Not:

1. Do not support piping connections to equipment by the equipment; provide separate pipe supports.
2. Do not support large or heavy valves, fittings, or equipment by the piping; provide separate supports.
3. Do not support pipes by other pipes.
4. Do not use existing supports to support additional new piping unless it is shown that existing supports are adequate for the additional loads; provide reinforcement if necessary.
5. Do not block equipment access areas or bridge crane runs with pipe supports.

F. Piping Support Types:

1. Single Horizontal Suspended Piping: Use adjustable swivel-ring or clevis style hangers.
2. Single Horizontal Wall Mounted Piping: Use wall brackets.
3. Multiple Horizontal Piping: Use racks for floor-supported piping and trapeze hangers for suspended piping.
4. Horizontal Pedestal Mounted Piping: Use saddle type supports.
5. Vertical Piping Adjacent to Walls: Use wall brackets as appropriate.
6. Insulated Piping: Provide oversized supports to fit insulation inserts, galvanized or stainless steel protection shields, and oversized rollers.
7. Attachments to Structural Steel: Use beam clamps attached to top flange.
8. Base Flanges Adjacent to Rotating Equipment: Provide pedestal type support under pipe.

9. Pipe Sizes 2.5 inch (6 mm) and Larger: Provide means of vertical adjustment after erection while supporting load.

G. Piping Support Locations:

1. Provide supports at spacings indicated by MSS SP-58.

2. Provide individual supports at piping changes in direction and changes in elevation, adjacent to flexible joints and couplings, and where otherwise indicated on drawings.

2.2 MATERIALS

A. Materials: Unless otherwise indicated, provide all support products made of one or more of the following:

1. Stainless steel, TP304, with No.1 finish.

2. Polyvinylchloride (PVC) or chlorinated polyvinylchloride (CPVC) plastic.

3. Ductile Iron.

B. Racks and Trapeze Hangers: Fabricate of structural steel channel shapes, designed to suit conditions at points of installation.

1. Use clamps or clips to secure pipes to racks, while allowing sliding or rolling movement due to thermal expansion.

2. At each support where an anchor is not provided, provide an intermediate pipe guide that allows movement but keeps pipe aligned.

C. Hanger Rods:

1. Material: Carbon steel, ASTM A576.

2. Rod Diameter: As indicated on the drawings.

D. Bracing: Structural steel angle or channel shapes, not rods or cables.

E. Brackets: Welded, pre-punched with minimum of two fastener holes.

2.3 PIPE SUPPORTS, GUIDES, AND ANCHORS

A. Manufacturers - Factory-Fabricated Supports:

1. Provide all support products from a single manufacturer.

B. Pipe Supports:

1. Liquid Temperatures Up To 122 degrees F (50 degrees C):

a. Overhead Support: MSS SP-58 Types 1, 3 through 12.

b. Support From Below: MSS SP-58 Types 35 through 38.

C. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

D. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.

E. Pipe Hangers: For a given pipe run use hangers of the same type and material.

1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.

2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

F. Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.

1. Pipe Diameter 6 inches (150 mm) and Smaller: Provide minimum clearance of 0.16 inch (4 mm).

2. Pipe Diameter 8 inches (200 mm): Provide U-bolts with double nuts providing minimum clearance of 0.28 inch (7 mm).
3. Pipe Diameter 10 inches (250 mm): 0.75 inch (19 mm) U-bolt.
4. Pipe Diameter 12 to 16 inches (300 to 400 mm): 0.875 inch (24 mm) U-bolt.
5. Pipe Diameter 18 to 30 inches (450 to 750 mm): 1 inch (25 mm) U-bolt.

G. Pipe Alignment Guides: Galvanized steel.
1. Pipe Diameter 8 inches (200 mm) and Smaller: Spider or sleeve type.
2. Pipe Diameter 10 inches (250 mm) and Larger: Roller type.

H. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

I. Non-Penetrating Rooftop Supports for Low-Slope Roofs:
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
3. Mounting Height: Provide minimum clearance of 6 inches (150 mm) under supported component to top of roofing.

2.4 ANCHORS AND FASTENERS

A. Anchor and Fastener Applications:
1. Submerged and Splash Zone Locations: Use stainless steel TP304L or TP316L.
2. Anchoring Steel To Concrete: Use Type 316 stainless steel.
3. Anchoring or Connecting Fiberglass Reinforced Plastic to Anything: Use stainless steel machine bolts.
4. Anchoring or Connecting Aluminum to Anything: Use stainless steel machine bolts.
5. Anchoring or Connecting Steel to Steel: Use either galvanized steel, stainless steel, or wrought iron, unless otherwise indicated for corrosion zone.

B. Anchors, Bolts, Nuts, and Washers:
1. Steel Bolts: ASTM F3125/F3125M, Type 1, maximum hardness of Rockwell C 32.
2. Stainless Steel: ASTM F593 bolts and ASTM F594 washers.
3. Bolt Sizes and Locations: As indicated on approved shop drawings, except as otherwise indicated.
4. Anchor Bolts: Furnish templates for accurate positioning.

C. Concrete Inserts: Dovetail or slot-and-twist type, with load rating not less than that of hangers or anchors they support.

D. Expansion Anchors for Hollow Concrete Masonry and Brick Masonry, Hollow and Solid: Expansion shield and expander nut contained inside shield, to be placed in pre-drilled hole; designed to accept both machine bolts and threaded rods.
1. Shield Body: Four legs; inside of each tapered toward shield bottom or nut end, with end of one leg elongated and turned across shield bottom; outer surface of body ribbed for grip-action.
2. Expander Nut: Square with sides tapered inward from bottom to top, designed to climb bolt or rod thread and simultaneously expand shield as soon as the threaded item, while being tightened, reaches, and bears against shield bottom.
3. Material: Zinc plated steel of 43,541 psi (300 MPa) minimum tensile strength.
4. Threaded Fasteners: Machine bolts; steel nuts and washers, ASTM A194/A194M.

5. Select type, length, diameter, and embedment depth based on manufacturer's published maximum allowable working loads and application limitations.

E. Expansion Anchors for Solid Concrete and Solid Concrete Masonry: UL listed; one-piece stud or bolt that has integral expansion wedges, nuts and washers, to be placed in pre-drilled hole.

1. Stud/Bolt: Stainless steel, TP304.
2. Nut and Washer: Stainless steel, TP304.
3. Select type, length, diameter, and embedment depth based on manufacturer's published maximum allowable working loads and application limitations.

F. Drilled-In Adhesive Anchors: Anchor rod assembly and anchor rod adhesive cartridge to be placed in pre-drilled hole.

1. Do not use to anchor overhead hung supports.
2. Anchor Rod Assembly: Chamfered and threaded stud rod of zinc plated steel, ASTM A36/A36M with nut and washer of ASTM A194/A194M alloy-steel.
3. Adhesive Cartridge: Sealed capsule containing premeasured amount of resin, quartz sand aggregate, and hardener contained in separate vial within capsule; activated by insertion procedure of anchor rod assembly.
4. Select type, length, diameter, and embedment depth based on manufacturer's published maximum allowable working loads and application limitations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine materials and components prior to starting installation for damage to protective finishes; repair coatings with material equal to original finish.

3.2 INSTALLATION

A. Install manufactured products in accordance with manufacturers' instructions.

B. Install supports, hangers, guides, anchors, and fasteners as specified, as indicated on drawings, in accordance with approved shop drawings and as specified.

C. Do not use any of the following anchor or fastener types:

1. Impact expansion hammer drive type.
2. Explosive charge drive type.
3. Lead shields.
4. Plastic or fiber inserts.
5. Drilled-in plastic sleeve and nail drive systems.

D. Do not use drilled-in adhesive anchors for overhead hung supports.

E. Do not make holes in structural steel for hanger supports.

3.3 THRUST BLOCKING FOR DIRECT-BURIED PIPING

A. Provide thrust blocks for non-restrained joint piping, whether or not shown on drawings.

1. Place blocking between solid ground and fitting, so that fitting is securely anchored but with fitting joints accessible for repair.
2. For vertical down bends, use steel rods and clamps, hot-dipped galvanized or coated with bituminous paint, to anchor into gravity thrust blocks.
3. Size the area of bearing as indicated or as directed.

B. Concrete for Thrust Blocks:

1. Mix: Not leaner than 1 part cement, 2.5 parts sand and 5 parts gravel.

2. Compressive Strength: 2000 psi (14 MPa) at 28 days.

C. Pour base and thrust bearing sides against undisturbed earth; sides of thrust blocks not subject to thrusts may be poured against forms.

END OF SECTION

SECTION 460513 - PIPING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Check valves.

B. Backflow preventers.

C. Pressure reducing valves.

D. Pressure relief valves.

E. Air release devices.

F. Vacuum breakers.

G. Sample ports.

H. Valved drains.

I. Chemical resistant floor drains

J. Piping and equipment insulation.

K. Electrical heat tracing tape.

1.2 RELATED REQUIREMENTS

A. Section 460106 - Operation and Maintenance Manual: Operating and Maintenance Data.

B. Section 460500 - Common Work Results For Water and Wastewater Equipment: Requirements applicable to all equipment.

C. Section 460506 - Water Treatment Piping: Requirements for connections to piping.

D. Section 460916 - Control Valves: Valves for process control.

1.3 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch) 2013 (Reaffirmed 2018).

B. ASME B1.20.2M - Pipe Threads, 60 Deg. General Purpose (Metric) 2006; R 2011.

C. ASME B31.3 - Process Piping 2018.

D. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers 2017.

E. ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies 2011.

F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation 2021.

G. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials 2020.

H. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS 2017.

I. AWWA C511 - Reduced-Pressure Principle Backflow Prevention Assembly 2017.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 for submittal procedures.

B. Product Data: Manufacturer's data sheets for each item of equipment and material provided, showing compliance with requirements; include materials, pressure ratings, seats and seals, clearances for operation and maintenance, and other characteristics.

C. Operating and Maintenance Data: See Section 460106.

D. Maintenance Materials:

1. For Each Type and Size of Valve:

a. Lubricator, lubricant of appropriate temperature rating, lubricator/isolating valve.

b. Gaskets; 2 each.

c. O-ring seals; 2 each.

d. Diaphragms (molded); 2 each.

e. All other parts made of elastomeric materials; 2 each.

f. Stem packing; 2 each.

g. Seat rings; 2 each and seat ring pulling tool.

2. One set of special tools necessary for adjustment, operation, maintenance and disassembly.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than one years documented experience.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Valve and Equipment Inlet, Outlet, and End Connections: To suit pipe jointing method specified for pipe in which item is to be installed.

2.2 CHECK VALVES

A. Check Valves - General Requirements: These requirements apply to all check valves unless otherwise indicated.

1. Function: Permit free flow forward and provide positive check against backflow.

2. Rating: 150 psig (1.03 MPa).

3. Body: In metallic pipelines, iron body; in thermoplastic pipelines, thermoplastic body of same material as pipe.

4. All valves equipped with outside lever and spring, unless otherwise noted.

5. Swing Check Valves: Bronze mounted; flanged ends.

6. Identification: Directly cast on body; manufacturer's name, initials, or trademark; size of valve, working pressure; direction of flow.

B. Ductile Iron Swing Check Valves (CV-1) - Sizes 2 inch (50 mm) through 36 inch (900 mm):

1. Manufacturers:

a. Henry Pratt Company: www.henrypratt.com.

b. Bray International: www.bray.com.

c. American Valve, Inc: www.americanvalve.com.

d. Clow Valve Company: www.clowvalve.com.

e. Substitutions: See Section 016000-Product Requirements.

2. Rating for Valves 2 inch (50 mm) through 12 inch (300 mm): 175 psig (1.2 MPa).

3. Rating for Valves 14 inch (350 mm) through 36 inch (900 mm): 150 psig (1.03 MPa).

4. Body: AWWA C508; cast iron body; increasing-pattern body valve may be used where increased outlet piping size is shown.

5. Disc: ASTM A-126, Class B Cast Iron, with mechanically secured bronze disc seat.

6. Hinge: ASTM A-536 Ductile Iron with stainless steel hinge pin.

7. Coating: Rubber lining or NSF approved epoxy coating on interior.

8. End Connections: As indicated on construction drawings and on valve schedule.

C. Thermoplastic Check Valves (CV-5) - Sizes 1/4 inch (8 mm) Through 16 inch (400 mm):
   1. Rating: 150 psig (1.03 MPa).
   2. Body: Y-check design, of chlorinated polyvinyl chloride (CPVC).
   3. Discs, Seals, and Seats: Fluoro-elastomeric O-ring, polyvinyl chloride (PVC) coil guide, hex design caps.

D. Thermoplastic Cone Check Valves - Sizes 1 inch (25 mm) and Larger:
   1. Manufacturers:
      a. George Fischer: www.gfps.com.
      b. Substitutions: See Section 016000-Product Requirements.
   2. Style: True Union Spring Cone Check Valve
   3. Rating: 150 psig.
   4. Body: Chlorinated polyvinyl chloride (CPVC), with cone of like material.
   5. Cone Seal: Ethylene propylene diene monomer (EPDM), or Flouro-elastomer seals.
   6. Suitable for vertical or horizontal flow.
   7. Ends: Threaded, as indicated in the construction drawings and valve schedule.

2.3 BACKFLOW PREVENTERS

A. Manufacturers:
   1. Conbraco Industries: www.apollovalves.com.
   2. Watts Water Technologies: www.watts.com.
   3. Zurn Industries, Inc: www.zurn.com.

B. Backflow Preventers: Same size as pipe, with total head loss through complete assembly not more than 10.1 psi (70 kPa) at rated flow.

C. Double Check Valve Backflow Preventer Assembly: Complying with ASSE 1015, consisting of two check valves, one gate isolation valve, one differential relief valve, and testing cocks.
   1. Assembly Rating: 150 psig (1.03 MPa) working pressure at 150 degrees F (65 degrees C).
   2. Check Valves Rating: 175 psig (1.25 MPa) service at 140 degrees F (60 degrees C).
   3. Ports: 1 inch (25 mm) ASME B1.20.1 (ASME B1.20.2M) threaded, female.

D. Backflow Preventer with Intermediate Vent: AWWA C511 body of two independent bronze check valves, with intermediate atmospheric vent, isolation gate valve, and full-ported ball valves as testing cocks.
   1. Assembly Rating: 150 psig (1.03 MPa).
   2. Check Valves Rating: 175 psig (1200 kPa) at 140 degrees F (60 degrees C).
   3. Ports: 1 inch (25 mm) ASME B1.20.1 (ASME B1.20.2M) threaded, female.

2.4 PRESSURE REDUCING VALVES

A. Manufacturers:
   1. Cla-Val Co.: www.cla-val.com
   2. Watts Water Technologies: www.watts.com.
   3. Substitutions: See Section 016000 - Product Requirements.

B. Pressure Reducing Valves - Sizes 1/2 inch (15 mm) and Larger:
   1. Function: Normally open to maintain constant downstream pressure regardless of fluctuations in flow or upstream pressure and prevent backflow; externally mounted strainers with cocks.

2. Operation: Direct operated, diaphragm actuated, pilot controlled
3. Body: Globe design; ductile iron.
4. Trim and Stem: Stainless steel.
5. Disc: Buta-N Rubber.
6. Diaphragm: Nylon Reinforced Buta-N Rubber.
7. See Valve schedule for pressure reduction requirements specific to each pressure reducing valve.
8. End Connections: As indicated on construction drawings and valve schedule.

2.5 PRESSURE RELIEF VALVES

A. Pressure Relief Valves: Comply with ASME B31.3.

B. Pressure Relief Valves - Sizes 2 inch (50 mm) and Smaller:

1. Function: Direct diaphragm, spring controlled type; valves opening when upstream pressure reaches maximum set point.
2. Body: Aluminum body and spring case.
3. Trim: Brass, with miscellaneous parts such as valve stems, nuts, and springs of steel construction.
4. Seats: Nitrile.
5. Diaphragms: Elastomeric, nylon reinforced butadiene acrylonitrile rubber.
6. See Valve schedule for pressure reduction requirements specific to each pressure reducing valve.
7. End Connections: Threaded, as indicated on construction drawings and valve schedule.

2.6 VENTING DEVICES

A. Manufacturers:

1. Crispin Valve Co.: www.crispinvalve.com
2. Cla-Val Co.: www.cla-val.com.
3. Val-Matic Valve & Manufacturing Corp.: www.valmatic.com
4. Substitutions: See Section 016000 - Product Requirements.

B. Air Release Valve: shall be suitable for raw water and clean water for pressures up to 700 psig. Combination valves shall be designed to exhaust large quantities of air during filling of a pipe system and close upon liquid entry. The valve shall release accumulated air from the pipe system during operations and under pressure. The valve shall also open during draining or if negative pressure occurs.

1. Comply with AWWA C512.
2. Rating: 150 psig working pressure.
3. Body: ASTM A126 Class B Cast iron standard elongated body and cover.
4. Trim and Float: Stainless Steel.
5. End Connections:
    a. Sizes 1/2 through 3 inches: Threaded inlet and outlet, ASME B1.20.1 (ASME B1.20.2.M) threading.
6. Provide blow off valve, quick disconnect couplings, and minimum 6 feet (1830 mm) of hose to permit back flushing after installation without dismantling valve.

C. Air Release Vents:

1. Locate and vent in manner that upon operation a hazardous atmosphere will not be created.
2. Provide air release vents at all piping high points and as indicated on drawings.

D. Vacuum Breakers:

1. For piping applications, comply with ASSE 1001.
2. Sizes 2 inches (50 mm) and Smaller: Angle type with all bronze body.
3. Locate at least 6 inches (150 mm) above flood line of associated equipment.
4. Provide vacuum breakers as indicated on Construction Drawings.

E. Air/Vacuum Valve: ASSE 1001; functioning to automatically exhaust air during filling of system while allowing air to re-enter during draining or when vacuum occurs.

1. Rating: 150 psig (1030 kPa) working pressure.
2. Body: Cast iron standard elongated body and cover.
3. Trim and Float: Stainless steel.
4. End Connections:
   a. Sizes 1/2 through 3 inches (15 through 80 mm): Threaded inlet and outlet, ASME B1.20.1 (ASME B1.20.2M) threading.
5. Provide blow off valve, quick disconnect couplings, and minimum 6 feet (2 m) of hose for back flushing after installation without dismantling valve.

F. Combination Air Valve: Combined air and vacuum valve and air release valve.

1. Function: Automatically exhaust air during filling of a piping system and allow air to re-enter during draining or when vacuum occurs; automatically exhaust entrained air that accumulates in piping system.
2. Rating: 150 psig (1.03 MPa) working pressure.
3. Body: Cast iron standard elongated body and cover.
4. Trim and Float: Stainless steel.
5. End Connections:
   a. Sizes 1/2 through 3 inches (15 through 80 mm): Threaded inlet and outlet, ASME B1.20.1 (ASME B1.20.2M) threading.
6. Provide blow off valve, quick disconnect couplings, and minimum 6 feet (1830 mm) of hose to permit back flushing after installation without dismantling valve.

2.7 SAMPLE PORTS

A. Manufacturers:

1. Nibco, Inc: www.nibco.com.
2. Substitutions: See Section 016000 - Product Requirements.

B. Sample Ports: Valves, pipe, and pipe fittings in configuration as indicated on drawings.

1. Provide sample ports as indicated; some may be shown only on process and instrumentation diagrams.
2. Pipe, Fittings, and Jointing: Same rating, material, and jointing as piping in which sample port is installed, unless otherwise indicated.

C. General Service Sample Ports: Ball or gate valves.

2.8 CHEMICAL RESISTANT FLOOR DRAINS

A. Manufacturers:

1. Orion Fittings: www.watts.com/our-story/brands/orion.
2. Zurn Engineered Water Solutions: www.zurn.com.

3. Substitutions: See Section 016000-Product Requirements.

B. Floor Drains:

1. Polyvinylidene fluoride (PVDF) body construction, in accordance with ASTM D3222.
2. Strainer:
   a. Circular, size as indicated on drawings to match size of drain piping system.
   b. Adjustable in height to facilitate flush installation with finished floor.
   c. PVDF or stainless steel construction.
3. Manufacturer to certify the use of the floor drain for compatibility with the chemicals stored at the facility which could come into contact with the drain in the event of a spill.

C. To be utilized in locations as indicated in Construction Drawings including the following:

1. Corrosion Inhibitor Bulk Tank Containment Area
2. Corrosion Inhibitor Day Tank Containment Area
3. Sodium Hypochlorite Bulk Tank Containment Area
4. Sodium Hypochlorite DayTank Containment Area
5. Hydroflurorosilicic Acid Containment Area
6. Process Tanks Containment Area
7. Hydrochloric Acid Containment Area
8. Sodium Bisulfite Containment Area
9. Sodium Hydroxide Containment Area
10. Citric Acid Containment Area
11. Future Aluminum Chlorohydrate Containment Area

2.9 SPECIALTIES

A. Valved Drains: Pipe tap with ball valve draining by gravity.

1. Pipe Sizes 2-1/2 inches (65 mm) and Larger: 3/4 inch (20 mm) diameter drain or as indicated on drawings.
2. Pipe Sizes 2 inches (50 mm) and Smaller: 1/2 inch (15 mm) diameter drain or as indicated on drawings.
3. Provide valved drains at all piping low points, except for buried and embedded piping, as indicated on process and instrumentation diagrams, and as indicated on drawings.

B. Pipe and Equipment Insulation: Cellular glass type, complying with ASTM C552, 1 inch (25.4 mm) thick, minimum, with rigid PVC weather sealed jacket.

1. Provide insulation on outdoor aboveground piping, valves, and equipment where indicated on drawings.

C. Threaded Branch Connections (Olets):

1. Utilize threaded branch connections as indicated on drawings sized for piping size to be attached.
2. Connections shall be welded in place per manufacturers instructions and construted of like material to the pipe. Welds shall be watertight and of a method appropriate for pressures encountered at the connection.
3. Manufacturers:
   a. Bonney Forge: www.bonneyforge.com
   b. Ritinox Overseas: www.ritinoxoverseas.com
   c. Marel Piping Products: www.marcelpiping.com

d. Substitutions: See Section 016000-Product Requirements.

D. Heat Tracing Tape: UL listed parallel conduction type heat tape, with adjustable thermostat and self-regulation to prevent overheating and burnouts even where tape overlaps itself.

1. Weather Resistance: Not affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere.

2. Construction: Flexible, parallel circuit construction consisting of continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed to be cut to length in field and for wrapping around valves and complex fittings.

3. Ends of Circuits: Provide end seals; do not tie wires at ends of circuits together.

4. Capacity - Unheated Liquid Contents: Provide sufficient tape, as recommended by manufacturer, to keep pipe surface at 34 degrees F (1 degrees C) minimum during winter outdoor design temperature indicated, but not less than following:

a. 4 watts per foot (13 watts per m) for pipe 3 inch (80 mm) and smaller with one inch (25 mm) thick insulation.

b. 8 watts per foot (26 watts per m) for pipe 4 inch (100 mm) and larger with 1-1/2 inch (38 mm) thick insulation.

5. Capacity - Heated Liquid Contents: Provide sufficient tape, as recommended by manufacturer, to maintain liquid temperature of 80 degrees F (27 degrees C) during winter outdoor design temperature indicated.

6. Heat tracing table shall be powered using 120 Volt connection.

7. Provide heat tracing tape for outdoor aboveground insulated piping and equipment as indicated on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Automatic Valve Systems: Provide the services of equipment manufacturer's technician to supervise installation, adjustment, start-up, demonstration, and testing.

C. Backflow Preventers: Install in accordance with applicable codes.

1. Install with nameplate and test cocks accessible from front of unit, and with a

2. Minimum Clearance Between Port and Grade: 12 inches (305 mm).

3. Avoid vertical installation.

D. Sample Ports: Locate where easily accessible; avoid potential stagnant points and other areas where sample taken might not be typical.

E. Insulation: Install insulation and jacketing weather tight and in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL - PRIOR TO STARTUP

A. Demonstrate proper operation of each equipment item.

B. Valves: Demonstration may occur while testing pipelines or as a separate step.

1. Exception: Demonstrate operation of air and vacuum relief valves as the pipe is being filled to verify venting and seating.

2. Show that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications.

3. Count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data.

C. Relief and Regulating Valves: Set, verify, and record pressure settings.

D. Self-Actuating Valves: Demonstrate at both maximum and minimum operating ranges and reset upon completion to design value.

3.3 OWNER PERSONNEL TRAINING

A. See Section 460500 for additional requirements.

B. Content: For identical equipment in multiple locations, identify all locations and any variations in function.

C. Operating Personnel Training:

1. Sessions: One.

2. Trainees: Two.

3. Training Hours: 1, minimum, per unique equipment item.

D. Maintenance Personnel Training:

1. Sessions: One.

2. Trainees: Two.

3. Training Hours: 1, minimum, per unique equipment item.

END OF SECTION

SECTION 460517 - SLEEVES AND SLEEVE SEALS FOR WATER AND WASTEWATER TREATMENT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe sleeves.

B. Manufactured sleeve-seal systems.

1.2 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

1.3 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

C. Product Information: Provide manufacturers cut sheet indicating type, size, and material of product selected.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

PART 2 PRODUCTS

2.1 PIPE SLEEVES

A. Manufacturers:

1. Advanced Products and Systems, Inc..
2. PSI - Century-Line.
3. US Pipe - A Forterra Company
4. Trumbull Manufacturing, Inc.

B. Vertical Piping:

1. Sleeve Length: 1 inch (25 mm) above finished floor.
2. Provide sealant for watertight joint.

C. Plastic: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

D. Pipes 4-inches and smaller passing through interior cast-in-place concrete walls can be core cut at the contractor's discretion. Contractor shall take precautions to avoid reinforcing steel. Contractor will apply a suitable rust inhibitor to all reinforcing steel cut during coring operations.

E. Pipe Passing Through Structure in contact with Water:

1. Cast Iron pipe sleeve or thrust collar with NSF approved coating for interior sufaces and suitable coating for contact with concrete for exterior surfaces.
2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

F. Pipe Passing Through Exterior Concrete Walls or Concrete Slab on-grade - not in contact with water:
1. High Density Polyethylene.
2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

G. Pipe Passing Through Exterior Concrete Masonary Walls (CMU) or CMU and Brick Walls:
1. Galvanized steel pipe or Steel pipe with fusion bonded coating.
2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

H. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:
1. Galvanized steel pipe or cast iron pipe with asphalt coating.
2. Connect sleeve with floor plate except in mechanical rooms.

I. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
1. Galvanized steel pipe or cast iron pipe with asphalt coating.
2. Connect sleeve with floor plate except in mechanical rooms.

J. Clearances:
1. Provide allowance for insulated piping.
2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch (25 mm) greater than external; pipe diameter, or as requied for installation of Modular/Mechanical Seal.
3. Fire-Resistance-Rated Openings: Caulked tight with firestopping material complying with ASTM E814, and in accordance with Section 078400, to prevent the spread of fire, smoke, and gases.

2.2 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. Flexicraft Industries; PipeSeal: www.flexicraft.com.
2. GPT Industries: www.gptindustries.com.
3. CCI Piping Systems: www.ccipiping.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. Modular/Mechanical Seal:
1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
2. Provide watertight seal between pipe and wall/casing opening.
3. Elastomer element size and material in accordance with manufacturer's recommendations.
4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.2 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Structural Considerations:

1. Do not penetrate building structural members unless indicated.

E. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

F. Manufactured Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.

2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.

3. Locate piping in center of sleeve or penetration.

4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.

5. Tighten bolting for a water-tight seal.

6. Install in accordance with manufacturer's recommendations.

G. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.3 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

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SECTION 460525 - WATER TREATMENT PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pump application schedule.

B. Pumps for raw water transfer, membrane feed, and high service.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for bases.

B. Section 460106 - Operation and Maintenance Manual: Operating and Maintenance Data.

C. Section 460500 - Common Work Results For Water and Wastewater Equipment: Requirements applicable to all equipment.

D. Section 019113 - General Commissioning Requirements.

E. Section 460916 - Control Valves.

F. Section 463300 - Liquid Chemical Feed Equipment: Chemical feed metering pumps.

1.3 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

D. ASTM A48/A48M - Standard Specification for Gray Iron Castings.

E. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

F. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

G. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings.

H. NEMA MG 1 - Motors and Generators.

I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. ANSI/AWWA E-101 - Vertical Turbine Pumps – Line Shaft and Submersible Types

K. ANSI/HI - Pump Standards

1.4 DEFINITIONS

A. Feed Flush Flow Rate: Pumping rate through one membrane train required by the membrane manufacturer as a component of a multi-step cleaning process.

1.5 JOB CONDITIONS

A. Equipment Suitability

1. Do not propose a vertical turbine pump or centrifugal pump where significant structural, piping, control or electrical design modifications would be required beyond the extent shown in the Contract Documents.

2. By furnishing pumps the manufacturer and supplier have satisfied themselves as to the suitability of the equipment to the application, and are recommending that the equipment is suitable for the Project and the operational conditions. Further, the Manufacturer and supplier guarantee the pumps proper function as a component within the system based on the Project conditions shown.

3. The Pump Supplier is responsible for furnishing a complete pumping system including Variable Frequency Drives specified in Division 26 Section “Variable Frequency Drives”, and all other related accessories and components, not otherwise specified, which are necessary for proper and dependable pumping system functioning.

4. Design and supplementary duty points shall fall within the proposed pumps specified preferred operating range. Supplementary duty points may fall within the acceptable operating range upon engineer review and acceptance of pump curves supplied during submittal process.

1.6 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 - Common Work Results For Water and Wastewater Equipment for submittal procedures.

B. Product Data: Manufacturer's descriptive and technical data on each item of equipment, including performance charts and curves, catalog cuts, and installation instructions.

1. Submit pump characteristic curves showing:

a. Capacity in gallons per minute and liters per second.

b. Net positive suction head (NPSH).

c. Efficiency.

d. Speed.

e. Pumping horsepower from zero to 110 percent (100 percent for positive displacement pumps) of design capacity.

f. Operating points.

g. Stable operating limits.

h. Shut off head.

i. Frequency Analysis.

C. Shop Drawings:

1. Include product dimensions and weight.

2. Show relationship to other parts of work including clearances for maintenance and operation.

3. Include complete wiring and schematic diagrams.

4. Include any other details necessary to demonstrate that system has been coordinated and will properly function as a unit.

5. Proposed layout and anchorage of equipment and appurtenances.

D. Field Quality Control Reports.

1. Test reports in booklet form showing all shop and field tests performed to adjust each component and all shop and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system.

E. Operating and Maintenance Data: See Section 460106.

F. Maintenance Materials:

1. Spare Parts: Furnish spare parts recommended by manufacturer to keep on hand.

2. One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum five years of documented experience.

B. Manufacturer Experience: Furnish pumps produced by firms generally recognized as engaged in the manufacture of equipment suitable for the applications of the Project, as determined by the Engineer and which have a minimum of five (5) years of experience in the production of equipment proposed for this Project.

C. Service Availability: A factory authorized maintenance and parts facility shall be located within a 200-mile radius of the installation. The facility shall have at least two factory-trained

mechanics and show evidence of parts inventory for routine maintenance items such as bearings, gaskets, shafts and sleeves. The manufacturer must also be able to supply listed parts within twenty-four (24) hours.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application

E. ANSI/NSF 61 Compliance: All material in contact with the potable water.

1.8 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

B. Vertical Turbine Pumps:

1. Peerless: www.peerlesspump.com.
2. Goulds Pumps, Inc: www.goulds.com.
3. National Pump Company: www.nationalpumpcompany.com
4. Substitutions: See Section 016000 - Product Requirements.

C. Vertically Oriented Horizontal Split Case Pumps:

1. Peerless: www.peerlesspump.com.
2. Grundfos: www.grundfos.com.
3. Substitutions: See Section 016000 - Product Requirements.

2.2 PUMP APPLICATIONS

A. Raw Water Pumps: Vertical Turbine Pump:

1. Pump Identification:
   a. RWP-1002
   b. RWP-1003
2. Pump Location: As indicated on construction drawings. Two (2) total pumps shall be furnished and installed as indicated.
3. Pump Service: Raw water transfer.
4. Operation Criteria:
   a. Duty points as indicated below shall be achievable with the use of a VFD.

	GPM	Total Dynamic Head
Design Duty Point @ 60 Hz	1,830	126 feet
Supplementary Design Duty Points	1,460	114 feet
	730	111 feet

5. Design Operating Point shall have a minimum 78 percent bowl efficiency.
6. Static Head: 90 feet.
7. Minimum Motor Horsepower: 100 Hp.
8. Operating Speed: Variable Speed Motor, maximum speed of 1800 rpm.
9. Discharge Head Pipe Size and Flange: 16 Inches.
10. Impeller Material Type: Stainless Steel

B. Membrane Feed Pumps: Centrifugal Pumps - Vertically Oriented Horizontal Split Case Pump:

1. Pump Identification:
   a. FP-2001
   b. FP-2002
   c. FP-2003
2. Pump Locations: As indicated on construction drawings. Three (3) total pumps shall be furnished and installed as indicated..
3. Pump Service: Membrane Feed Pumping.
4. Operation Criteria:
   a. Provide pump meeting the following Duty Point ranges at various pump operating speeds:

Plant Condition	Pump Condition (GPM)		Pump Operating Head Range	
			Maximum Acceptable Minimum Value at Minimum Speed	Minimum Acceptable Maximum Value at Higher Speed
2.5 MGD	Design Flow	609	15 feet	118 feet
	Maximum Flow	998	37 feet	123 feet
	Feed Flush	690	20 feet	119 feet
5.0 MGD	Design Flow	916	31 feet	124 feet
	Maximum Flow	1334	75 feet	132 feet
	Feed Flush	930	32 feet	124 feet

   b. Provide pump meeting the following criteria:

Pump Design Duty Point	1334 GPM at 132' TDH at full speed
Minimum Pump Efficiency at Duty Point	79 Percent
Minimum Pump Motor Horsepower	60 Horsepower
Minimum Operating TDH at Full Speed	94 Feet
Maximum Motor Speed	1800 RPM
Maximum Shutoff Head at Full Speed	181 Feet
Minimum Pump and Motor Operating Speed Turn Down Ratio	4:1

5. Utilize a pump control valve as indicated in Section 460916.2.13 Pump Control Valves to allow pump operation at specified duty points when low head conditions are present in the system. Pump control valve is to be selected by membrane feed pump vendor to ensure full system operation.
6. Impeller Type: Bronze, Double suction configuration.
7. Operating Speed: Variable speed motor, maximum operation of 1800 rpm.
8. NPSH Required: 16.0 feet.
9. Rotation Direction: Clockwise.
10. Discharge Diameter: Minimum 6 inches.
11. Suction Diameter: Minimum 8 inches.
12. Minimum Motor Size: 60 Hp
13. Electrical Characteristics: 460 volts AC, 3 phase, 60 Hz.

C. High Service Pumps: Vertical Turbine Pump:

1. Pump Identification:
    a. HSP-4001
    b. HSP-4002
2. Pump Location: As indicated on construction drawings. Two (2) total pumps shall be furnished and installed as indicated.
3. Pump Service: High service from water treatment plant to distribution system.
4. Operation Criteria:
    a. Duty points as indicated below shall be achievable with the use of a VFD.

	GPM	Total Dynamic Head
Design Duty Point @ 60 Hz	1,750	234 feet
Supplementary Design Duty Points	700	169 feet
	1,400	175 feet
	1,700	179 feet

5. Operating Point of 1,400 GPM shall have a minimum 76 percent bowl efficiency.
6. Operating Speed: Variable Speed Motor, maximum operation of 1800 rpm.
7. Minimum Motor Horsepower: 150 Hp.
8. Discharge Head Pipe Size and Flange: 12 Inches.
9. Impeller Material Type: Stainless Steel

2.3 PUMPS - GENERAL REQUIREMENTS

A. Pumps: Complete pumping systems, including motor and drive, manual operator, automatic actuators where indicated, piping, valves, conduit and wiring, supporting structures, electrical and process controls, overload protection, and alarms; capable of continuous operation without overheating and without excessive vibration, noise, or power consumption.
    1. Cast Iron Pump Casings: Constructed of cast iron of uniform quality and free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects.
    2. Finishes: Factory finish pumps and motors with manufacturer's standard primer and two coats of paint.
    3. Anchor bolts, nuts, and washers: type 316 stainless steel.
    4. Couplings, gears, projecting setscrews, keys, and other rotating parts: Located that any person who may come in close proximity shall be protected by equipment guards.

B. Supply all pumping units of each type specified under this section by one pump manufacturer.

C. Pumps must be standard units for which parts are readily available. All working parts of the pump and motor, such as bearings, wearing rings, etc., shall be of standard dimensions built to tolerances such that parts will be interchangeable between like units, and such that the Owner may, at any time in the future, obtain replacement parts. Impellers shall be untrimmed

D. Identification: In addition to the information required by Section 460500, for pumps show the pump capacity, pump head, speed of rotation, direction of rotation, and manufacturer's name, address, and phone number, type or style, model, and serial number, cast into the body of the pump or included on a 316L stainless steel plate.

E. Pressure Gauges:
    1. Provide standard pressure gauges with isolation valves and pressure snubbers on discharge side of pumps. Gauges shall comply with ASME B40.1. Gauge ranges shall be as appropriate for the particular installation.

F. Electric-Motor-Driven Equipment: Provide motors, motor starters, controls and wiring in accordance with Section 460500. Controls shall communicate with plant SCADA and PLC controls per Sections 460923.

G. All major components, which make up the pumping unit, shall be furnished with lifting lugs over eyebolts to facilitate handling. The lugs or bolts shall be designed or arranged to allow safe handling of the pump components singly or collectively as required during shipping, installation, and maintenance.

H. The pump shall not overload the motor for any point on the maximum pump performance characteristic curve to prevent surging, cavitation, and vibration throughout the pump operation. Service factors for the motor shall not be applied when sizing the motor.

I. All parts of each pumping unit shall be designed to withstand the stress that will be imposed upon them during their handling, shipping, erection and operation.

J. All units shall be constructed such that dismantling and repair can be accomplished without difficulty.

K. The completed units when assembled and operating shall be free of cavitation, vibration noise and oil or water leaks over the range of operation.

L. The pump supplier shall be responsible for proper operation of the complete pumping system, which includes pump and motor, and associated drive where applicable.

2.4 VERTICAL TURBINE PUMPS

A. The pump shall be designed for continuous operation once started, until shutoff by a control system. The number of pump starts for a 24-hour period shall not exceed that required by the manufacturer.

B. The pump shall have continuously rising head capacity curve from runout flow through shutoff conditions.

C. To ensure vibration-free operation, all rotating components of each pumping unit shall be statically and dynamically balanced. Provide equipment which operates within the vibration limits established in ANSI/HI2.1-2.5 “American National Standard for Vertical Pumps for Nomenclature, Definitions, Application and Operation”, latest edition. The mass of the unit and its distribution shall be such that resonance at normal operating speed is avoided. Excessive vibration shall be sufficient cause for rejection of pumping equipment.

D. Vertical turbine pump shall be of the open line shaft type for wet well installation, utilizing product water for shaft lubrication.

E. Pump Bowl

1. The bowl assembly shall consist of two sections; the discharge bowl, and the impeller housing/suction bell. Each section shall be flanged, registered, and bolted together.

2. Constructed of close grained cast iron conforming to ASTM A48/A48M Class 30, free from blow holes, sand holes and all other faults and shall be accurately machined to close tolerance.

3. Provide bowls capable of withstanding a hydrostatic pressure equal to twice the pressure at rated capacity or 1.5 times shut-off head, whichever is greater.

4. Water passageways shall be lined with fusion-bonded epoxy to provide smooth water flow and maximum pump efficiency. Provide a minimum lining thickness of 10 mils. The bowls shall be smooth and free of sharp projections. Bowls shall have register fits for alignment and be connected by flanged and bolted construction.

5. Coat the exterior of bowl units with minimum 8 mils of epoxy complying with NSF 61 in conformance to Section 099600 High Performance Coatings.

F. Column Assembly: Fabricate discharge column assembly in lengths no greater than 5 feet using not lighter than standard weight steel pipe with heavy cast iron flanged couplings

G. Impeller

1. Enclosed type, 316 Stainless Steel, and shall be a single casting carefully hand finished and dynamically balanced to ANSI S2.19-1975 (ASA 2-1975) G 6.3

standards.

2. Waterways through the impeller shall have open end smooth passages to secure efficient operation and to prevent air or sand locking.
3. Balance statically and dynamically within the operating range and to the first critical speed at 150 percent of the maximum operating speed.
4. Securely key impeller to the bowl shaft with taper lock whereby the impeller cannot be loosened by torque from either forward or reverse rotation.

H. Wearing Rings

1. Provide renewable wearing rings on bowl and impeller.
2. Wearing surfaces normal to the axis of rotation.
3. Construct wearing rings of unlike hardness hard faced stainless steel.
4. Design wearing rings for ease of maintenance and secure with stainless steel set screws to prevent rotation.

I. Suction Inlet

1. Each pump shall be equipped with a suction inlet bell constructed of cast iron conforming to ASTM A48-CL30.
2. Suction bell shall have bottom bearing and be veined to permit uniform entrance of fluid into impeller eye.
3. Suction bell shall be provided with clip-on type basket strainer constructed of 316 stainless steel designed to prevent the passage of solids greater than 1/2-inch diameter.

J. Line Shaft and Column

1. Line shaft shall be turned, ground and polished AISI 416 stainless steel, of ample size to operate the pump without distribution or vibration and shall be tested for straightness.
2. Column section and line shaft lengths shall not exceed 5 feet. The shaft shall be furnished in interchangeable sections. Column sections shall be flanged. Provide NSF 61 certified interior coating system on interior and exterior of the column.
3. To ensure accurate alignment of the shafts, the shaft shall be straight within 0.0005-inch per foot and 0.005-inch total indication reading for a 10 feet section, the butting faces shall be machined square to the axis of the shaft. The line shaft shall be coupled with AISI 410 stainless steel keyed split ring couplings. The line shaft shall be provided with a non-corrosive wearing surface at the location of each guide bearing.
4. The upper end of this shafting shall be provided with a flanged coupling with a threaded adjustable piece for raising or lowering the shaft and pump impeller to properly center the impeller in bowl.

K. Line Shaft Bearings

1. Line shaft bearings shall be lubricated by pumped fluid.
2. Line shaft bearings shall be bronze or fluted nitrile rubber type.
3. Space the bearings at intervals of not more than 5 feet.
4. A hardened stainless steel field replaceable, bearing journal shall be firmly secured to the line shaft at each bearing point. Bearing journals shall be equivalent to heat treated stainless steel with great wear resistance.

L. Discharge Head Assembly

1. Provide above or below base discharge head that will attach to the discharge piping as indicated in the Construction Drawings.
2. The pump base shall be of fabricated steel conforming to ASTM A36/A36M or cast iron conforming to ASTM A48/A48M Class 35 and shall be of sufficient thickness to

support the assembled weight of the pump and motor, and to safely withstand all stress imposed thereon by vibration, shock, seismic action, and all possible direct and eccentric loads. The head shall be smooth radius type consisting of at least five (5) welded sections or shall be a standard long radius elbow with no mitered joints. The base shall be of adequate horizontal dimension to provide footing contact area and anchorage.

3. Lifting lugs of sufficient strength to support the weight of the pumping unit exclusive of motor shall be provided.
4. Provide tapped drain in discharge head for packing leakage.
5. The discharge elbow pipe shall be epoxy-lined, fabricated steel conforming to ASTM A36/A36M or cast iron conforming to ASTM A48-Class 35. Piping connection shall be 150-1lb raised faced flange with bolt holes and spacing to ASME B16.1.
6. The discharge head assembly shall be provided with a shaft packing box and a renewable bronze bushing. The packing box shall be made of cast iron in conformance to ASTM A48, accurately machined, and bolted to the discharge head where the shaft passes through the head. The packing box shall be of the gland-type box, adequately packed to withstand the pressure imposed upon it under all operating conditions including two times the shut-off, and of sufficient depth to receive at least 6 rings of packing. Water leakage shall be piped to the reservoir. Lantern ring shall be grease lubricated with suitable fittings to prevent loss of grease or entrance of contaminants. Packing box bearings, gland, nuts and bolts shall be bronze conforming to ASTM B62.
7. Large openings shall be provided in discharge head assembly adjacent to packing box to facilitate adjustment and repacking.
8. Pump Baseplate: Mount pump head on a separate ASTM A36/A36M steel base plate designed to be fitted to the discharge head with a bolted joint to ensure a tight seal. Attach base plate as shown on the Drawings and grout permanently to concrete foundation.

M. Stuffing Box: The packing box shall be fitted with a 2" female NPT prelubrication connection that will allow water to flow down the line shaft and across line shaft bearings.

N. Non-Reverse Rachets: A non-reverse mechanism in the motor shall be provided to prevent the line shaft and motor from reverse rotation when the power is interrupted and water empties from the column.

2.5 VERTICALLY ORIENTED HORIZONTAL SPLIT CASE PUMPS

A. Centrifugal Pumps:

1. The pumps shall be of single stage, single suction, vertically oriented horizontal split case design; split on the horizontal axis. Suction and discharge connections shall be located on opposite sides of the lower casing.

B. Pump Casing: Cast iron, with smooth volute passages, and tapped and plugged holes for venting and draining pump.

1. Pumps depending only on hydraulic balance end thrust will not be acceptable.
2. Capable of withstanding pressures 50 percent greater than maximum operating pressure.
3. Impeller removable without disturbing suction and discharge connections.
4. Hand hole to permit inspection and cleaning of pump interior.
5. Lifting eyes.

C. Impeller: Cast iron, bronze, or brass impeller.

1. Statically, dynamically, and hydraulically balanced within operating range and to first critical speed at 150 percent of maximum operating speed.
2. Securely keyed to shaft with locking arrangement whereby impeller cannot be loosened by torque from either forward or reverse direction.

D. Wearing Rings: Steel, cast iron, or brass, renewable, on both impeller and casing, with wearing surfaces normal to axis of rotation.

1. Designed for ease of maintenance.
2. Secured to prevent rotation.
3. Replaceable steel wear plates fastened to casing may be used in lieu of wearing rings on casing and impeller.

E. Pump Shaft: 416 Stainless Steel or high grade alloy steel; adequate size and strength to transmit full driver horsepower with liberal safety factor.

1. Pump shaft sleeve of stainless steel, high grade alloy steel, or bronze.
2. Joint between shaft and sleeve sealed to prevent leakage.

F. Mechanical Shaft Seals: Single, with each seal interface held in contact by its own spring system, supplemented by external liquid pressure; constructed to be readily removable from shaft.

G. Bearings: Ball or roller type designed to handle all thrust loads in either direction.

1. Life Expectancy: L-10 life of 50,000 hours minimum, as specified in ABMA STD 9 or ABMA STD 11.
2. Vertical Shaft Pumps: Grease lubricated.
3. Oil Bath Lubricated Bearings: Provide oil reservoir with overflow opening to prevent overfilling and drain at lowest point.
4. Grease Lubricated Bearings: Provide grease fitting of type that prevents over lubrication and buildup of pressure injurious to bearings; if grease fitting is not easily accessible, provide grease tubing to a convenient location.

H. Drive Couplings: Heavy-duty flexible type, keyed or locked to shaft.

1. Capable of being disconnected without removing driver half or pump half of coupling from shaft.
2. Couplings for extended shaft vertical centrifugal pumps may be universal type.

I. Supports and Bases:

1. Vertical Shaft Centrifugal Pumps: Common base plate for pump and motor.

2.6 DRIVE

A. General Motor Requirements

1. Application: Furnish motors conforming to applicable NEMA, IEEE, and ANSI standards.
2. Motor manufacturer shall have experience in the design and manufacture of similar products for a minimum of 10 years.
3. Service Conditions:
   a. Suitable for service location of pump and motor unit.
   b. Ambient temperature not greater than 40 degrees C.
   c. Voltage variation of +/- 10%
   d. Frequency variation of +/- 5%
   e. Combination of 3.c. and 3.d. above, not to exceed 10%
   f. Minimum motor service factor of 1.15.
   g. NEMA enclosure type: ODP for Membrane Feed Pumps and High Service Pumps. TEFC for Raw Water Pumps. Provide supplementary ventiliation as needed for motor cooling at low motor operating speeds.
4. Temperature Rise: NEMA standard for insulation and enclosure employed.

5. Bearings: Bearings shall be rated for an L-10 bearing life of 100,000 hours at operating condition
    a. Bearings shall be anti-friction type, ball or roller as required.
6. Space Heaters: For motors mounted outdoors or in non-fan-ventilated spaces, provide heating elements capable of maintaining motor coils at least 5 C above ambient using l20V, l Ph., 60 Hz. power source. Include appropriate fused terminal block inside enclosure box located adjacent to motor lead box.

B. Motor Drive
1. Default motor characteristics are specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
2. Insulation: Class H (minimum).
    a. Magnet wire shall be copper.
    b. Varnish shall be 100% solids polyester. Water borne varnish is not acceptable.
3. Provide electric motor drive as recommended by pump manufacturer, and conforming in construction and performance with applicable NEMA standards. Select motor of the squirrel cage, vertical, solid shaft type with non-reverse ratchet.
4. Furnish motor having all characteristics necessary for proper pump operation, and such that the motor is not overloaded under any condition from shutoff to minimum specified operating head. Comply with the general motor requirements listed for each type and application of pump.
5. Maximum temperature rise at rated HP shall not exceed Class B limits (80 degrees C).
6. Maximum temperature rise at 1.15 Service Factor shall not exceed Class F limits (155 degrees C).
7. The driven machine shall not overload the motor rating at any operating point. Provide a heavy duty adjustable type shaft coupling with registered fit to allow for impeller adjustment.
8. Coupling halves shall fit tightly to shaft so as not to loosen during operation of any point.
9. Motors shall have permanent lifting eyes or lugs capable of a safety factor of five (5).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine actual locations of connections before pump installation.

3.2 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions.

B. Provide stainless steel anchor bolts, sleeves, washers and nuts as recommended by the manufacturer. Embed anchor bolts firmly through pump sole plate, level and grout with approved non-shrink grout. Anchor bolt length to provide 1/4 inch projection through nut after assembly.

C. Install pumps with access for periodic maintenance including removal of motors, couplings, and accessories.

D. Independently support pumps and piping so pumps do not support weight of piping and piping does not support weight of pumps.

E. Install vertical turbine pumps with motor and pump shafts vertical.

F. Prior to applying electrical power to any motor driven equipment, rotate drive train by hand to demonstrate free operation of all mechanical parts.

G. Provide the services of manufacturer's technical representative to supervise installation, adjustment, demonstration, testing, and startup.

H. Before final alignment/adjustment, disassemble discharge flange to verify that no distortion or strain exists in the piping. After alignment/adjustment, grout sole plate and completely fill all voids with an approved non-shrink grout and finish in a neat workmanlike manner.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 40 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

3.4 PAINTING

A. Paint ferrous surfaces not finished at the factory as specified in Section 09960, High Performance Coatings

B. Coat stainless steel bolts and nuts with non-seizing compound prior to assembly.

3.5 MANUFACTURER'S SERVICES

A. Provide services of a manufacturer's representative who is experienced in installation, adjustment, and operation of the equipment for not less than 8 hours on the site for each type of pump furnished. The representative shall supervise the installation, adjustment, and testing of equipment.

3.6 SHOP TESTING

A. General. Each pump shall be subjected to a complete witnessed shop test as specified herein. Certified test reports, in triplicate, shall be submitted to the Engineer. No equipment shall be shipped until receipt of the Owner's written approval. All costs for the shop tests shall be borne by the Contractor and shall be included in his bid price.

B. Pumps. Each pump shall be shop tested using a job motor to determine the following characteristics at the maximum speed at which the pumps are to be operated:

1. Head-Capacity Curve
2. Brake Horsepower Curve
3. Efficiency Curve
4. NPSH required

C. All tests shall be performed in accordance with the latest Hydraulic Institute Standards.

D. The Contractor shall notify the Owner not less than 10 days prior to the date on which the pump manufacturer will conduct the performance tests of the pumps, to provide sufficient time for the Owner to be represented. All costs for initial witnessing of the tests by the Owner will be borne by the Owner.

E. In the event any pump does not meet the specified requirements, it shall be modified by the manufacturer to meet the requirements of the Specifications and shall be retested in accordance with the provisions of the Specifications. All costs of retesting, including costs for additional witnessing, shall be borne by the Contractor.

F. Motors. Each motor shall be subjected to the manufacturer's recommended shop tests in accordance with the requirements of the applicable sections of the IEEE, ANSI, and NEMA test standards.

G. Guarantee proper operation of pump at low water level through model NPSH test or factory test. Field test pump at normal water level in accordance with Hydraulic Institute noise and vibration standards.

3.7 FIELD QUALITY CONTROL - PRIOR TO STARTUP

A. Demonstrate proper operation of each pump, motor driver, actuator (if any), and controls; that each is mechanically, electrically, and structurally sound; meets specified operating characteristics; and has no leaks in seals or piping.

B. Correct deficiencies and re-test.

C. Operational Test

1. Perform an operational test of pumps, drivers, and control systems to determine if the installed equipment meets specifications prior to acceptance. Testing shall meet below requirements as well as those general requirements set forth in Section 019113.
2. Demonstrate that the equipment is not defective; is in safe and satisfactory operating condition; and conforms to operating characteristics.
3. On motor driven equipment, rotate drive train by hand to demonstrate free operation of all mechanical parts prior to applying power.
4. Check for:
    a. Excessive vibration,
    b. Leaks in all piping and seals,
    c. Correct operation of control systems and equipment,
    d. Proper alignment,
    e. Excessive noise levels, and
5. Before leaving any equipment in service, comprehensively brief the Owner and Engineer regarding its operation and maintenance.

D. Retesting
1. Correct defects revealed during testing, and retest until all defects are corrected.
2. Modify or replace equipment which does not function dependably as intended.

E. Upon notification by the Owner that approximately 500 hours operating time has been accumulated on the pumping equipment listed above, promptly have the vendor's service technician perform an appropriate inspection of the designated pumping equipment and certify to the Owner in writing that continued operation is recommended.
1. Establish that all related safety devices are working properly before leaving any equipment in operation.
2. Before leaving any equipment in service, comprehensively brief the Owner and Engineer regarding its operation and maintenance.
3. Modify or replace equipment which does not function dependably as intended.

3.8 OWNER PERSONNEL TRAINING

A. See Section 460500 for additional requirements.

B. Instructor: Equipment manufacturer's technical representative.

C. Content: For each pump include control sequences, actuating sensors, and interconnections between pumps in sets.

D. Operating Personnel Training:
1. Sessions: One.
2. Trainees: Two.
3. Training Hours: 2, minimum, for each pump and pump set.

E. Maintenance Personnel Training:
1. Sessions: One.
2. Trainees: Two.
3. Training Hours: 4 for each pump and pump set.

3.9 FIELD QUALITY CONTROL - AFTER STARTUP

A. Demonstrate proper operation in conjunction with process control system demonstration.

END OF SECTION

SECTION 460913 - CONTROL GATES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Upward sliding gates, for opening and closing channels.

1.2 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for updward sliding gates and weir gates wall construction.

B. Section 055000 - Metal Fabrications.

C. Section 460106 - Operation and Maintenance Manual: Operating and Maintenance Data.

D. Section 460500 - Common Work Results For Water and Wastewater Equipment: Requirements applicable to all equipment.

1.3 REFERENCE STANDARDS

A. AWWA C560 - Cast-Iron Slide Gates

B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications 2020a.

C. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2017.

D. ASTM A564/A564M - Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes 2019a.

E. AWWA C561 - Fabricated Stainless-Steel Slide Gates 2014.

F. NSF 61 - Drinking Water System Components - Health Effects 2020.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 - Common Work Results For Water and Wastewater Equipment for submittal procedures.

B. Product Data: Manufacturer's data on products, showing composition, dimensions, accessories, and anchorage.

C. Shop Drawings: Detailed fabrication and installation drawings showing materials, fabrication, tolerances, connections, seals, and anchorages.

D. Operating and Maintenance Data: See Section 460106 - Operation and Maintenance Manual.

E. Field Quality Control Test Reports.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Rodney Hunt: www.rodneyhunt.com

B. Hydro Gate, a brand of Henry Pratt Company: www.hydrogate.com.

C. Waterman Industries, LLC: watermanusa.com.

D. Golden Harvest, Inc.: www.goldenharvestinc.com

E. Substitutions: See Section 016000 - Product Requirements.

2.2 GATES - GENERAL

A. Stainless Steel Gates: Comply with AWWA C561.

B. Gates shall be compliant with NSF 61.

C. Gate type, lift type, frame type, size, and bottom-closure type is indicated in the application schedule below.

D. Gate Leaf:

1. Completely assemble gate leaf, including the attachment of all components and accessories, prior to placing in frame.
2. Avoid distortion of the gate leaf and attached components during installation.
3. Fasten rubber seals securely to metal retainers.
4. Apply a suitable lubricant to the rubber seal rubbing plates to protect rubber seals before operating gate.

E. Metals:

1. Structural steel, monel, babbit, steel forgings, steel castings, stainless steel, bronze, aluminum bronze, brass and other metal materials used for fabrication: Comply with requirements as indicated on drawings and as specified herein and in Section 055000.

F. Stainless Steel Bars and Shapes

1. Stainless Steel Bars and Shapes: Comply with ASTM A276/A276M, UNS S 20910, Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS S 17400, Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

G. Stainless Steel Plate, Sheet, and Strip:

1. Stainless Steel Plate, Sheet, and Strip: Comply with ASTM A240/A240M, UNS S 41008.
2. Plate finish: Hot-rolled, annealed or heat-treated, and blast-cleaned or pickled.

H. Rubber Seals:

1. Rubber seals: EPDM or Neoprene in accordance with ASTM D-2000.

I. Leakage Rate:

1. Leakage: Not to exceed 0.05 U.S. gallon per minute per foot (0.60 L/min/m) of seal periphery under the design seating head and 0.1 U.S. gallon per minute per foot (1.25 L/min/m) of seal periphery for the unseating design head.

J. Slide Gate Leaf:

1. Single-component structural fabrication, shop fabricated and provided complete with gate stem, stem guides, leaf nut, leaf nut spanner wrench, bar seals, seal collars, lock assembly, and other appurtenant items as required for installation.
2. Surfaces of leaf framing elements for welding to skin plates: Not to vary from a true plane by more than 1/16 inch (2 mm) to provide uniform bearing.
3. The outside surfaces of skin plates welded to framing elements: Not to vary from a true plane by more than 1/16 inch (2 mm).
4. Accurately machine surfaces where bar seals attach to provide uniform bearing for the full contact dimensions.
5. Firmly butt top and side bar seals together at the corners.

K. Slide Gate Frame and Bonnet:

1. Shop fabricate slide gate frame and bonnet. Provide frame compatible with mounting on existing embedded wall thimble.
2. Machine finish guiding and seal surfaces of slide gate frame and bonnet to true vertical plane.
3. Machine bottom seat of gate leaf for tight fit with gate frame sill.
4. Stress-relieve gate frame and bonnet prior to the attachment of bar seals.
5. Accurately machine surfaces where bar seals attach to provide uniform bearing for the full contact dimensions.

6. Firmly butt top, side and invert bar seals together at the corners.
7. Perform final machining of bar seals after attachment to gate frame and bonnet.

L. Slide Gate Bonnet Cover, Pedestal and Base Plate:

1. Accurately machine flanges of the bonnet cover, pedestal and base plate for the supporting the operating machinery for the slide gate; drill to match mating flanges and provide required true alignment.
2. Base plate dimensions may be altered to fit the operating machinery furnished, provided the basic configuration, plate thickness, and number and sizes of fasteners are equal to that indicated on drawings and the altered dimensions are approved.
3. Operators:
   a. Size Operators to start moving gate under design maximum head pressure with a pull not to exceed 40 lbs (178 N).
   b. Provide manual hand wheel or crank compatible with lift. Indicate direction of operation clearly and permanently on lift: Provide arrow and the word "OPEN" cast in raised letters to indicate the direction of opening.
4. Provide new stainless steel epoxy adhesive bolts, nuts, and washers in new drilled openings for installing in existing concrete deck of size recommended by manufacturer (but not less than 1/2 inch diameter) to anchor new operator pedestal to existing concrete.

M. Operating Stem:

1. Rising, threaded stainless steel stem connecting operating mechanism to gate leaf with threaded portion engaging the operating nut in the manual operator.
2. Minimum outside diameter of 1.5 inches.
3. Join stems with more than one section with stainless steel or bronze couplings. Provide adjustable stop collars to prevent over closing of the leaf.

2.3 STAINLESS STEEL GATES MATERIALS OF CONSTRUCTION

A. The following components shall be constructed of Type 304 Stainless Steel per ASTM A240.

1. Frame Assembly & Retainers
2. Stem
3. Slide & Stiffeners
4. Fasteners, Buts, and Bolts
5. Stem Guides

B. Pedestals shall be constructed of Ductile Cast Iron (ASTM A536).

2.4 APPLICATION SCHEDULE

A. Raw Water Pump Station:

1. Number of Gates: Four.
2. Gate Type: Wall Mounted, Non Self Contained.
3. Gate Material: Stainless Steel as indicated in 2.3 STAINLESS STEEL GATES MATERIALS OF CONSTRUCTION.
4. Sizing: Minimum dimensions of opening of 18 inch x 18 inch.
5. Existing 18 inch x 18 inch wall thimbles shall remain to be re-used.
6. Operator: Manual, geared lift mechanism with floor stand.
7. Furnish and install stem guides at frequency recommended by manufacturer.

8. Provide extra thick mastic or rubber gasket or multiple gasket layers to seal between existing wall thimble and new gate frame.

PART 3 EXECUTION

3.1 INSTALLATION

A. Thoroughly clean bearing surfaces requiring lubrication; lubricate with an manufacturer's approved lubricant before assembly and installation.

B. Align field welded components to correct positions prior to commencing welding.

C. Attach new gate frame and leaf to existing embedded wall thimble to be reused.

1. Provide new stainless steel anchor bolts, nuts, and washers for attachment to wall thimble.

2. Use anchor bolt size recommended by gate manufacturer, but not less than 1/2 inch diameter

3. Existing stud bolts in wall thimble are not expected to be reusable. Remove any existing bolts and install new anchors by drilling out wall thimble anchor bolt openings. If reusing existing anchor bolt openings is not possible, drill new openings through existing wall thimble flange to attach new anchor bolt fasteners.

4. New anchor systems may be expansion anchors, epoxy adhesive anchors, or other type recommended by gate manufacturer for installation under submerged conditions.

D. Gate frame and leaf installation is expected to be under submerged conditions below lake water level.

E. Prime coat embedded metals with required paint on all surfaces prior to installation in concrete forms.

F. Gate Frame and Guides:

1. Test gate frame and guides for proper alignment and clearances prior to installation, by lowering and raising the gate leaf through the full operating range.

G. Fabricate, assemble and install gate assembly so the gate leaf forms a watertight barrier in compliance with the specified leakage rate when lowered to the seated position.

3.2 ACCEPTANCE TRIAL OPERATION AND TEST

A. After the gate assembly has been installed, including operating machinery, the Owner and Engineer will examine the complete system for final acceptance.

B. Operate the gate throughout its full operating range a sufficient number of times to demonstrate proper operation.

C. Conduct operation of the gate assembly in actual operating conditions.

END OF SECTION

SECTION 460916 - CONTROL VALVES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Flow control valves.

B. Pump control valves.

C. Automatic operators.

D. Valve accessories.

1.2 RELATED REQUIREMENTS

A. Section 460106 - Operation and Maintenance Manual: Operating and maintenance data.

B. Section 460500 - Common Work Results For Water and Wastewater Equipment: Valve finish colors.

C. Section 460500 - Common Work Results For Water and Wastewater Equipment: Owner personnel training.

1.3 REFERENCE STANDARDS

A. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard 2017.

B. ASME B16.11 - Forged Fittings, Socket-welding and Threaded 2016 (Errata 2017).

C. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds 2020.

D. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 2012.

E. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.

F. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates 2016.

G. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates 2016.

H. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.

I. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions 2018.

J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 for submittal procedures.

B. Product Data: Manufacturer's data sheets for each valve and accessory, showing compliance with requirements; include materials, pressure ratings, valve operators, seats and seals, clearances for operation and maintenance, and other characteristics.

1. Identify data sheets using the valve identification scheme used on drawings.

2. For electric actuators, show electrical characteristics.

3. For pneumatic actuators, show air supply pressure.

C. Shop Drawings: Custom-prepared piping diagrams showing location of each valve and drain, whether or not indicated in Contract Documents; this shop drawing may be combined with other piping shop drawings.

D. Valve Schedule: Custom-prepared schedule of valves, showing:

1. Valve identifying number; cross-reference to product data sheets and to process and instrumentation diagrams (P&ID).

2. Manufacturer and model name/number.
3. Valve type using specification terminology (e.g. gate, metal body, over 2 inch).
4. Application (direct-buried or exposed).
5. Piping Service (e.g. return activated sludge).
6. Installation orientation (horizontal or vertical pipe, stem vertical or horizontal).
7. Size and dimensions.
8. Flow coefficient Kv (Cv).
9. Pressure rating and pressure drop at specified flow rate.
10. Spring range.
11. Valve end type (e.g. flanged, threaded, socket-welded).
12. Manual operator type.
13. Automatic operator type, where applicable, and identifying number.
14. Accessories (e.g. extension stem, floor stand, extension bonnet).
15. Access and clearance requirements.

E. Automatic Operator Schedule: Custom-prepared schedule of automatic valve operators, showing:
1. Valve and operator identifying numbers.
2. Operator manufacturer and model number.
3. Positive positioner range.
4. Close-off pressure to torque.
5. Actuator type (electric or pneumatic).
6. Electric Actuators: Input and output contacts.
7. Pneumatic Actuators: Input air pressure.
8. Access and clearance requirements.

F. Automatic Valve Operator Calculations: For each remote-controlled valve, submit calculations supporting selection of actuator, including calculations of the force required to move and seal the valve.

G. Project Record Documents: Approved shop drawings and schedules modified to show actual as-constructed conditions.

H. Operating and Maintenance Data: See Section 460106.

I. Maintenance Materials:
1. For Each Type and Size of Valve:
a. Lubricator, lubricant of appropriate temperature rating, lubricator/isolating valve.
b. Gaskets; 2 each.
c. O-ring seals; 2 each.
d. Diaphragms (molded); 2 each.
e. All other parts made of elastomeric materials; 2 each.
f. Stem packing; 2 each.
g. Seat rings; 2 each and seat ring pulling tool.
2. T-Handle Valve Wrench: Galvanized; 48 inches (1220 mm) long.
a. Furnish one for each six buried valves.
3. Operating Key for Cross Handled Valves: Galvanized.

4. One set of any other special tools necessary for adjustment, operation, maintenance and disassembly, for each valve type and appurtenance.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

PART 2 PRODUCTS

2.1 VALVE APPLICATIONS

A. Valve Applications: Provide valves as follows in Subparagraphs B-E whether shown on drawings or not.

B. Do not direct-bury flanged valves; provide valve pit or manhole.

C. In-Line Electrical Devices: Provide a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

D. Compressed Air Piping: Provide safety isolation valve on compressed air supply lines, located to provide accessibility for control and maintenance.

E. Pump Control Valves: Provide on discharge side of pumps.

2.2 REQUIREMENTS APPLICABLE TO ALL VALVES

A. See drawings for valve sizes and operator types.

B. Provide valves suitable for the service indicated and coordinated to piping system.

1. Provide valves that will withstand working pressure indicated or working pressure of pipe to which valve is connected, whichever is greater.

2. Provide valves of sizes indicated or of port diameter/area equal to that of pipe to which valve is connected, whichever is larger.

3. Provide valves that open by turning counterclockwise, with direction of opening integrally marked on operating nut or operator.

4. Valve End Connections: As indicated; if not indicated, provide end connections of the same type as indicated for joints in pipe to which valve is connected.

5. Factory install operators and accessories.

C. Identification and Tagging: In addition to the information required by Section 460500, mark valves in accordance with MSS SP-25 using identification tags securely attached; on tags show the service, valve identification number from drawings, manufacturer's name and model number.

1. Identification Tags: 1.375 inches (35 mm) diameter, minimum; engraved laminated plastic with black lettering.

2. Attachment: No. 12 AWG copper wire.

2.3 REQUIREMENTS APPLICABLE TO METAL-BODY VALVES

A. Valve End Connections:

1. Flanged Ends: In accordance with ASME B16.5; Class 125 pound (56 kg) unless otherwise indicated.

2. Threaded Ends: In accordance with ASME B16.11.

3. Mechanical Joint Ends: Styrene butadiene rubber (SBR) or vulcanized SBR gasketed type, in accordance with AWWA C111/A21.11 and AWWA C110/A21.10.

4. Push-On Joint Ends: Styrene butadiene rubber (SBR) or vulcanized SBR gasketed type, in accordance with AWWA C110/A21.10 and AWWA C111/A21.11.

B. Valve Exterior Finish: Factory-applied epoxy coating complying with AWWA C550; either two-part liquid material or heat-activated material.

1. Where valve is indicated to have fusion bonded epoxy finish, provide only heat-activated material.
2. Coating Thickness: 7 mils (0.18 mm), minimum, dry film thickness.
3. Colors: As specified in Section 460500; use "safety yellow" for isolation valves and lockout valves with handles, hand wheels, or chain wheels.

C. Valve Lining: Where valves are indicated to be lined, provide factory-applied factory-applied lining; use epoxy lining unless other material is indicated.

1. Epoxy Lining: AWWA C550; either two-part liquid material or heat-activated material except provide only heat-activated material when lining is indicated as fusion bonded.
2. Epoxy Lining Thickness: 7 mils (0.18 mm), minimum, dry film thickness, except where thickness is limited by valve operating tolerances.

2.4 BALL VALVES - METAL-BODY

A. Manufacturers:

1. Apollo Valves: www.apollovalves.com
2. Hammond Valve: www.hammondvalve.com
3. Milwaukee Valve Company: www.milwaukeevalve.com
4. Substitutions: See Section 016000 - Product Requirements.

B. Ball Valves (BV-3) - Sizes 2 inch (50 mm) and Smaller: End entry one-piece body type.

1. Rating: 2000 psig (13.79 MPa) at 150 degrees F (66 degrees C).
2. Body: 316 Stainless Steel, with full bore ports.
3. Seat: Reinforced Polytetrafluoroethylene seats.
4. Seal: Polytetrafluoroethylene seal.
5. Ball: 316 Stainless steel.
6. End Connections: Threaded.
7. Manual Operator: Hand lever.

2.5 BALL VALVES - PLASTIC BODY

A. Manufacturers:

1. George Fischer Piping Systems: www.gfps.com
2. Asahi/America: www.asahi-america.com
3. Spears Manufacturing Company: www.spearsmfg.com
4. Substitutions: See Section 016000 - Product Requirements.

B. Ball Valves (BV-5): End entry, double-union design.

1. Rating: 150 psig (1.03 MPa) at 120 degrees F (49 degrees C).
2. Body: ASTM D1784 polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) or Polypropylene (PP) body, ball, and stem.
3. CPVC valve seat: Polytetrafluoroethylene (PTFE) seat, with Ethylene propylene diene monomer (EPDM) or fluoro-elastomer seals.
4. PVC, PP valve seat: Polytetrafluoroethylene (PTFE) seat, with Ethylene propylene diene monomer (EPDM) seals.
5. Rating: 150 psig minimum.
6. End Connections: As indicated on drawings.
7. Manual Operator: Hand lever.

2.6 BUTTERFLY VALVES - METAL BODY

A. Manufacturers:

1. Pratt: www.henrypratt.com
2. Bray International, Inc: www.bray.com
3. DeZurik: www.dezurik.com
4. Milwaukee Valve Company: www.milwaukeevalve.com
5. Substitutions: See Section 016000 - Product Requirements.

B. Cast Iron Butterfly Valves (BFV-1):

1. AWWA Class: 150 in accordance with AWWA C504.
2. Body: ASTM A126 cast iron.
3. Disc: ASTM A126, Class B cast iron with stainless steel edge.
4. Valve Shafts: Stainless steel with self-lubricating, corrosion-resistant sleeve type bearings.
5. Seats for Valves 24 inch (600 mm) and Smaller: Attached to either valve body or disc; Reinforced polytetrafluoroethylene (PTFE).
6. End Connections: Flanged, as indicated on drawings.
7. Manual Operator: Hand wheel.
8. Rating: 150 psig (1.03 MPa) minimum.

C. Stainless Steel Butterfly Valves (BFV-3):

1. AWWA Class: 125 in accordance with AWWA C504.
2. Body: 316 Stainless Steel
3. End Connections: Flanged, as indicated on drawings and valve list.
4. Manual Operator: Hand wheel.
5. Rating: 150 psig (1.03 MPa)

2.7 BUTTERFLY VALVES - PLASTIC BODY

A. Manufacturers:

1. Asahi/America: www.asahi-america.com/#sle.
2. Spears Manufacturing Company: www.spearsmfg.com
3. Substitutions: See Section 016000 - Product Requirements.

B. Butterfly Valves (BFV-5): Lugged style.

1. Rating: 150 psig (1.03 MPa) at 140 degrees F (60 degrees C).
2. Body: Chlorinated polyvinyl chloride (CPVC).
3. Disc: Same material as body.
4. Seats: Ethylene propylene diene monomer (EPDM).
5. Seals: Same material as seats.
6. End Connections: As indicated on drawings and valve schedule.
7. Manual Operator: Lever.

2.8 GATE VALVES - METAL BODY

A. Ductile Iron Gate Valves (GV-1) - Sizes 8 inches and Larger: Resilient Wedge type with clear waterway equal to full diameter of valve.

1. Manufacturers:

a. American Valve, Inc: www.americanvalve.com
b. Clow Valve Company: www.clowvalve.com
c. Kennedy Valve Company: www.kennedyvalve.com
d. Mueller Company: www.muellercompany.com
e. Substitutions: See Section 016000-Product Requirements.

2. Rating: 250 psig (1.70 MPa).
3. Body: AWWA C515, resilient-seated; Ni-resistant.
4. Trim: Ni-resistant stainless steel hardware.
5. Bonnet: OS&Y, bolted type.
6. Disc: Iron; with rising stems with backseats.
7. End Connections: As indicated on drawings and valve schedule.
8. Coating: Rubber lining or NSF approved epoxy coating on interior
9. Horizontal Pipe Installation: Where valve is installed in horizontal pipeline in horizontal position with stem horizontal, provide bronze track, roller, and scrapers to support weight of gate for its full length of travel.
10. Vertical Pipe Installation: Where valve is installed in vertical pipeline with stem horizontal, provide slides to assist travel of gate assembly.
11. Manual Operator: Hand wheel.
12. For each gate valve 16 inches and larger, provide a by-pass valve of same materials as main valve with valves complying with AWWA C509.

B. Stainless Steel Gate Valves (GV-3) - Sizes 8 inches and Larger: Resilient Wedge type with clear waterway equal to full diameter of valve.

1. Manufacturers:
a. Crane Co: www.cranecpe.com
b. Dezurik: www.dezurik.com/
c. Pratt: www.henrypratt.com/
d. Substitutions: See Section 016000-Product Requirements.
2. Rating: 250 psig (1.70 MPa).
3. Body: 316 Stainless steel
4. Trim: 316 stianless steel.
5. Seating Surface:316 stainless steel.
6. Disc: 316 stainless steel flexible wedge disc.
7. Manual Operator: Hand Wheel

2.9 SOLENOID VALVES

A. Manufacturers:
1. Burkert Fluid Control Systems: www.burkert.com/en
2. Substitutions: See Section016000-Product Requirements.

B. Style: True Union Spring Cone Check Valve

C. Rating: 150 psig (1.03 MPa).

D. Body: Brass or stainless steel body and inner valve components.

E. Seal: Fluoro-elastomeric.

F. Ends: Threaded, as indicated in the construction drawings and valve schedule.

2.10 PLUG VALVES

A. Manufacturers:

1. Henry Pratt Company: www.henrypratt.com.
2. Substitutions: See Section 016000 - Product Requirements.

B. Plug Valves (PV-1) - Sizes 3 inches (80 mm) through 54 inch (1350 mm): Eccentric type.

1. Rating: 150 psig.
2. Body: Nonlubricated type; cast iron.
3. Plugs: Ductile iron, with Buta N resilient seating surface.
4. Ports: Regular, with open area minimum 80 percent of connecting pipe area.
5. Valve Bearings: Self-lubricating stainless steel.
6. End Connections: Flanged, as indicated on Construction Drawings.
7. Manual Operator for Valves 8 inches and Larger; totally enclosed, geared, with handwheel, 2-inch nut, or chain wheel.

2.11 PUMP CONTROL VALVES

A. Manufacturers:

1. Dezurik: www.dezurik.com.
2. Bray: www.bray.com.
3. Henry Pratt: www.henrypratt.com
4. Substitutions: See Section 016000 - Product Requirements.

B. Pump Control Valves: High Performance Butterfly Valve (BFV-3)

1. Size: As indicated on Construction Drawings.
2. Body: Stainless Steel.
3. Seat: 316-Stainless Steel.
4. Disc: 316-Stainless Steel.
5. End Connections: As indicated on drawings.
6. Controls: Modulating Electric Actuator.
7. Maximum differential pressure across Pump Control Valve: 28 psi.
8. Shaft and Bearing Material: 316-Stainless Steel.
9. NSF 61 Certified.

C. Pump Control Valve Application:

1. Valve shall be selected and furnished by the vendor furnishing the membrane feed pump as indicated in Section 460525 to ensure system operation.
2. Valve shall have capacity to increase system pressure from system low pressures indicated in Section 460525.2.2.B to ensure proper operation of membrane feed pumps at the specified design operating points and the self cleaning automatic strainers at the required working pressures as indicated in Section 466173.

2.12 VALVE OPERATORS

A. Operator Types:

1. For each valve controlled by process control system, provide remote-controlled automatic operator, electric and pneumatic types as indicated in the valve schedule and construction drawings.
2. For each valve not controlled by process control system, provide a manual operator, except for self-actuated valves.

B. Operators: Sized to operate valve for full range of pressures and velocities and of the type specified for application:

1. Maximum Force to Operate: Not more than 39.3 pounds-force (175 N) under any operating condition including initial breakaway; provide gear reduction where necessary to reduce force to operate.
2. Locking: Self-locking or equipped with self-locking device; padlock eyes on valve handles; wheels lockable with chain and padlock.
3. Quarter Turn Valves: Provide position indicator.
4. Direct-Buried Quarter-Turn Valves: Operator designed to withstand input torque of 450 foot-pounds (610 N-m) at fully open or fully closed positions; grease packed and gasketed to withstand submersion in water to 10.2 psig (70 kPa).

C. Automatic Operators: Actuator, valve stem coupling, gearing if required, size and configuration to suit full range of valve operation, and additional requirements as indicated.

1. Totally enclosed valve actuating mechanism with adjustable travel stops and valve position indicator.
2. For Quarter Turn Valves: Reversing, bi-directional operation.
3. Provide manual override mechanism unless specifically indicated as "no manual override"; with lockable motor de-clutch mechanism.
4. On loss of control signal, maintain valve in last position, unless otherwise indicated.
5. Housing: NEMA 250 Type 4X enclosure.

D. Manual Operators:

1. Direct-Buried Valves Larger Than 2-1/2 inches (65 mm): 2 inch (50 mm) operating nut.
2. Direct-Buried Valves 2 inches (50 mm) and Smaller: Cross handle for operation by forked key.
3. Exposed Valves: Hand wheel type operator except where other type is permitted or required.
4. Hand Wheels: Galvanized and painted.
5. Lever handles are allowed on quarter-turn valves 8 inches (200 mm) and smaller.

2.13 ELECTRIC VALVE OPERATORS (MODULATING)

A. Modulating Electric Valve Operator Manufacturers:

1. Beck Electric Actuators: www.haroldbeck.com.
2. Substitutions: See Section 016000 - Product Requirements.

B. Application Criteria:

1. Ambient Temperature Rating: -30 to +185 degrees F.
2. Ambient Humidity: 100 percent.
3. Maximum Differential Pressures across Closed Valves: Refer to Schedule of Valves with Electric Actuators located in the Contract Drawings.
4. Maximum Flows Through Full Open Valves: Refer to Schedule of Valves with Electric Actuators located in the Contract Drawings.
5. Duty Cycle: Continuous (minimum 1,200 starts/stops per hour), unless otherwise specified.
6. Power Supply: 120 VAC, single-phase, 60 Hertz.
7. Control Voltage: 120 VAC, single-phase, 60 Hertz.
8. Torque: As recommended by valve manufacturer.

9. Accepts 4 to 20 mADC input to positioner.
10. A maximum of 70 seconds for valve full closure.

C. General:
1. Provide actuator operable with handwheel even after electric handswitch for local operation.
2. Provide continuous duty operation that does not require special deadband or deadtime accommodations in system tuning. Actuators shall be able to control to 0.1 degree steps and respond within 25-50 milliseconds of a setpoint change.
3. Coordinate sizing of each electric actuator with valve manufacturer who shall furnish valve and electric actuator as a unit.
4. Electric actuators shall be suitable for valve orientation shown.
5. All spare parts for electric actuators shall be ready for immediate shipment.
6. Factory support shall be available 7 days per week.

D. Electric Motor:
1. General:
a. Provide motors suitable for modulating service, of high torque characteristics and minimum 85 degrees C temperature rating.
b. No burnout, low speed motor design that provides precise and repeatable control without any fear of burning out a motor if the application calls for frequent movements or if the valve jams.
2. Motor Construction:
a. Classification: Special Purpose Motor (Permanent Magnet), Synchronous Single Phase, Permanent – Split Capacitor Motor
b. Enclosure: NEMA 4X.
c. Insulation: Class H.
d. Impedence Protected
e. Power Supply: 120 v
f. Fractional horsepower, low current, low speed (72-120 RPM), no duty-cycle limitations.
g. Bearings: Double-lipped, grease-sealed, weatherproof bearing.
h. Provide with integral, Self-Locking Mechanisms (SLM) to hold up to 200% of rated torque from backdriving.

E. Actuator Gearing:
1. Housing: Precision machined, aluminum alloy casting, NEMA 4X enclosure
2. Close-coupled to electric motor pinion.
3. Input Shaft Gearing: Spur gear.
4. Output Shaft Gearing: Partial spur gear with virtually no gear backlash preventing valve disc chatter or vibration.
5. Gearing shall be of an all spur gear construction made of heat-treated alloy steels and ductile iron.
6. Lubrication: Permanent with lithium based grease spread. No oil or grease baths.
7. Bearings: Double lipped, grease-sealed, weatherproof bearing.
8. Input Shaft: Heat treated alloy steel and ductile iron.
9. Provide fixed mechanical stops to prevent overall travel to 110 degrees.

10. Provide mechanical position indication.

F. Limit Switches:

1. Provide each actuator with “END OF TRAVEL” limit switches to allow control of desired end position for each direction of travel.
2. Provide “OPEN” and “CLOSE” limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually and whether or not actuator is electrically powered.
3. Limit switch gearing shall be appropriately lubricated.
4. Provide drive mechanism totally enclosed to prevent entrance of foreign matter or loss of lubricant.
5. Provide four auxiliary switches for end of travel indication. Two switches shall close and two contacts shall open at a desired end position for each direction of travel.
6. Switches shall be rated six amperes at 120 VAC.

G. Handwheel Operation:

1. Equip actuator with a spoke-free, easy-to-turn handwheel for operation. The handwheel shall rotate when the actuator is running but pose no safety threat.
2. Spoke-free handwheel shall be less than 7 inches in diameter and be operable with a single hand to produce full actuator torque.

H. Controls:

1. Provide following controls in a separate compartment integral with the actuator.
2. Enclosure: NEMA 4X.
3. Provide five position electric handswitch (CCW, STOP, CW, STOP, AUTO). In CCW or CW, actuator shall run to the corresponding internal limit switch, at which point it will turn off. In STOP, actuator shall be disabled from local and remote operation, but can be operated with manual handwheel. In “AUTO” position, “open/close/stop” control from remote shall be enabled.
4. Provide “OPEN/CLOSE” indicating lights and zero-to-100 percent position indication in liquid crystal display window.
5. Motor shall be de-energized when valve is jammed for more than 300 seconds or some shorter time. (Programmable via HART)
6. For monitoring of actuator, provide set of single-pole/single-throw (SPST) dry contacts. Monitor relay shall indicate that actuator is available for remote operation when contacts are closed.
7. Provide each actuator with position controller. Controller shall have the following features:
    a. Receive 4 to 20 mADC analog control signal and position valve in proportion to this signal.
    b. Adjustments for duty cycle, band width, span, and zero programmable via HART Communicator.
8. On loss of control signal valve shall stay in its last position.
9. Provide actuator with position transmitter capable of producing 4 to 20 mADC output signal. Positioning device shall be contactless without any wiping or contacting surfaces prone to wear and routine maintenance. Accuracy shall be less than plus-or-minus one percent of scale. Transmitter shall include integral temperature-compensated, constant-voltage source for the position sensor. The position sensing device shall be integral to the device.
10. Supply actuator with circuit boards for high temperature service, minimum 85 degrees C.

I. Remote-mounted Control Stations:

1. Provide remote-mounted control panels where indicated on Contract Drawings.
2. Enclosure: NEMA 4X, Type 316 stainless steel.
3. Provide “AUTO/MAN” selector switch. In “MAN” position actuator shall be operated by “OPEN/OFF/CLOSE” pushbuttons. In “AUTO” position, “open/close/stop” control from remote source shall be enabled Provide contact when switch is in “AUTO” position for remote indication.
4. Provide “OPEN/CLOSE”spring-loaded selector switch.
5. Provide “OPEN/CLOSE” indicating lights.

2.14 PNEUMATIC VALVE OPERATORS

A. Pneumatic Valve Operators:
1. Apollo Valves: www.apollovalves.com
2. Bray International, Inc: www.bray.com
3. DeZurik/Apco/Hilton: www.dezurik.com.
4. Emerson Process Management; Emerson Electric Co: www.emersonprocess.com/en-US.
5. Weir Power Industrial; The Weir Group PLC: www.weirpowerindustrial.com.
6. Substitutions: See Section 016000 - Product Requirements.

B. Pneumatic Operators: Cylinder and diaphragm actuators as indicated; pressure regulator, gearing, exhaust muffler, safety vented lockout isolation valve, and accessories.
1. Provide pressure gauges in piping as indicated, easily readable and accessible.
2. Air Supply Pressure: 60 psig.

C. Cylinder Actuators: Comply with AWWA C541 and AWWA C542.
1. Non Swivel Type: Totally enclosed; position indicator; factory lubricated and sealed, requiring no additional lubrication.
2. Double Acting Type: Nonmetallic, for operation on non lubricated air; manual override independent of cylinder.

D. Diaphragm Actuators: Spring return with steel or aluminum diaphragm case and spring barrel, steel spring and actuator stem, and fabric-reinforced chloroprene diaphragm; factory lubricated and sealed.

E. Limit Switches: Travel stop limit switches with cams, internal, independent, adjustable, and actuated by cams mounted on drive shaft.

F. Pressure Regulator: Adjustable reduced pressure range as required by valve actuator; gauge range 1.33 to 2 times maximum operating pressure; with internal relief, filter, outlet pressure gauge, aluminum body and hand wheel.

2.15 VALVE ACCESSORIES

A. Extension Bonnets: Provide as necessary, with stem and accessories applicable to specific valve and operator.

B. Side Operators: Provide worm gear side operators for valves as indicated on the Construction Drawings.

C. Direct-Buried Valves: Provide extension stem enclosed in cast iron, concrete, or polyethylene valve box housing to prevent contact with soil.
1. Length: Sufficient to bring operating nut to a point 6 inches (150 mm) or less below grade.
2. Concrete Valve Boxes: Standard product of a manufacturer of precast concrete equipment; cast iron cover and cover ring.

D. Manual Valves Below Operating Personnel Floor Level: Provide extension stem and floor stand as indicated on design drawings.

1. Floor Stands: Non rising, indicating type; with extension stem, coupling, hand wheel, and yoke attachment.
2. Stem Guide Brackets: Spaced such that stem L/R ratio does not exceed 200; provide anchors as required.
3. Size Operators to start moving gate under design maximum head pressure with a pull not to exceed 40 lbs (178 N).

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to installation, clean debris and foreign material out of valve openings and seats, check operating mechanisms for ease of operation and proper functioning, and check nuts and bolts for tightness.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. For automatic valve systems, provide the services of equipment manufacturer's technician to supervise installation, adjustment, demonstration, testing, and startup.

C. Install valves as nearly as possible in position indicated on drawings, located and oriented to provide easy access to valve operator and to avoid interference with other equipment.

D. Install valves without exerting distortion or strain on appurtenances.

E. Flanged Connections:

1. Install flanged valve bolt holes so as to straddle vertical centerline of pipe.
2. Clean flanged faces prior to inserting gasket and bolts.
3. Tighten nuts progressively and uniformly.

F. Threaded Connections: Clean threads by wire brushing or swabbing prior to installation.

G. Manual Valve Orientation in Horizontal Runs of Pipe:

1. Where pipe centerline elevation is 54 inches (1370 mm) or less above finished floor, install valve with operating stem of in vertical position, unless otherwise indicated.
2. Where pipe centerline elevation is between 54 inches (1370 mm) and 81 inches (2057 mm) above finish floor, install valve with stem in horizontal position, unless otherwise indicated.

H. Automatic Valves: Install in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL - PRIOR TO STARTUP

A. Demonstrate proper valve operation while testing pipelines or as a separate step.

1. Show that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications.
2. Count and record the number of turns required to open and close each valve, and account for any discrepancies from manufacturer's data.

B. Isolation Valve Leak Check:

1. With full pressure in the system, command valve closed.
2. Use an ultra-sonic flow meter to detect flow or leakage.

C. Actuator Range Check: Verify proper operation of actuators and positioners.

1. Verify that actuator extreme positions are correct.

2. Apply a signal to actuator through its controller.
3. Record the signal levels for the extreme positions.
4. Vary the signal over its full range and verify that actuators travel in the correct direction and from one extreme position to the other.

D. Valve Stroke Setup and Check:

1. Verify the actual positions against the control system readout.
2. Set pump to normal operating mode.
3. Command valve closed; visually verify that valve is closed and adjust output zero signal as required.
4. Command valve to open; verify position is full open and adjust output signal as required.
5. Command valve to a few intermediate positions.
6. If actual valve position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

3.4 OWNER PERSONNEL TRAINING

A. See Section 460500 for additional requirements.

B. Content: For each valve include actuator and transmitter, cover control sequences, actuating sensors, manual operation, maintenance, and testing.

C. Operating Personnel Training:

1. Sessions: One.
2. Trainees: Two.
3. Training Hours: 2, minimum.

D. Maintenance Personnel Training:

1. Sessions: One.
2. Trainees: Two.
3. Training Hours: 2, minimum, per unique equipment item.

END OF SECTION

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SECTION 460923 - MONITORING AND CONTROL INSTRUMENTATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sensors, analyzers, transmitters, and accessory components.

B. Instrumentation enclosures.

C. Level indicators and transmitters.

D. TOC analyzers.

E. Fluoride analyzers.

F. Turbidity analyzers.

G. pH probes and analyzers

H. Coordinate and assume responsibility for compatibility of control functions with vendors of related equipment and devices actuated by or connected to the system.

I. Neither Drawings nor Specifications are represented as identifying all features, functions, elements or components which might be required for a properly performing installation. The vendor represents, however, that he understands the intent of the Contract Documents, and that he/she possesses sufficient knowledge to, and will in fact, translate such intent into the furnishing of a complete and satisfactory installation.

1.2 RELATED REQUIREMENTS

A. Section 011000 - Summary: Work Under Owner's Separate Contracts.

B. Section 460106 - Operation and Maintenance Manual.

C. Section 460500 - Common Work Results For Water and Wastewater Equipment: Device numbering scheme.

D. Section 460513 - Piping Specialties: Sample ports.

E. Section 460916 - Control Valves.

F. Section 463300 - Liquid Chemical Feed Equipment.

1.3 REFERENCE STANDARDS

A. 40 CFR 60 - Standards of Performance for New Stationary Sources Current Edition.

B. ANSI C12.1 - Electric Meters - Code for Electricity Metering 2016.

C. ASME B1.20.1 - Pipe Threads, General Purpose (Inch) 2013 (Reaffirmed 2018).

D. ASME B1.20.2M - Pipe Threads, 60 Deg. General Purpose (Metric) 2006; R 2011.

E. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard 2017.

F. ASME B31.8 - Gas Transmission and Distribution Piping Systems 2018.

G. ASME B40.100 - Pressure Gauges and Gauge Attachments 2013.

H. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).

I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.

J. NEMA ICS 1 - Industrial Control and Systems General Requirements 2000 (Reaffirmed 2015).

K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 RESPONSIBILITIES

A. Due to the complexities associated with the interfacing of numerous control system devices, the Instrumentation Contractor or Subcontractor shall be responsible to the Contractor for

the coordination of the Instrumentation System with devices provided under other Sections and provided by others. This includes providing review and comment to other vendor equipment submittals provided by others.

B. The following is a list of equipment and functions to be performed under this Contract. This list may not be inclusive.

1. Install individual control panels furnished by others as specified and shown on the Contract Drawings.
2. Furnish all equipment and instruments for a complete and functional system.
3. Provide all application engineering, equipment, and calibrations for equipment provided in this specification section.

C. As a minimum, the Instrumentation Contractor or Subcontractor or vendor shall perform the following work:

1. Implementation of the Instrumentation System:
    a. Prepare shop drawing drawing submittals.
    b. Prepare the test plan, the training plan, and the spare parts submittals for the equipment provided in this specification section.
    c. Procure hardware.
    d. Perform bench calibration and verify calibration after installation for the equipment provided in this specification section.
    e. Oversee and certify installation of the equipment provided in this specification section.
    f. Coordinate and participate in certifying loop testing with Work done by others.
    g. Oversee, document, and certify system commissioning for the equipment provided in this specification section.
    h. Conduct the performance test for the equipment provided in this specification section.
    i. Prepare operations and maintenance manuals for the equipment provided in this specification section.
    j. Conduct training for the equipment provided in this specification section.
    k. Prepare record drawings for the equipment provided in this specification section.
    l. Prepare calibration sheets for the equipment provided in this specification section.
    m. Certify the installation of the Instrumentation System for the equipment provided in this specification section.
2. Coordinate the Instrumentation System with the overall plant SCADA system integration and programming provided by others. The Owner will execute a separate contract with others for the fabrication of control panels and completion of the overall SCADA system integration and programming.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 for submittal procedures.

B. Product Data: Manufacturer's data sheets on each item of equipment, showing compliance with specified requirements and detailed technical characteristics; where multiple components are shown on the same data sheet, mark the specific component referred to.

1. Include construction details, material descriptions, dimensions of individual components and profiles, connection details, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. Submit detailed instructions on installation requirements, including storage and handling procedures.

C. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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

D. Product Test Reports: For each meter and analyzer for tests performed by a qualified testing agency.

E. Field Quality Control Reports.

F. Operation and Maintenance Data: See Section 460106.

G. Data Sheets

1. Data sheets, specification sheets, and an instrument list shall be provided for all components provided under this section. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., part numbers, scales, ranges, service, materials of construction, component location, options, and the individual tag number) as noted in the Drawings and Specifications.

2. Include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. More than one tag numbered item may be included on a sheet.

H. Test Procedure Submittals:

1. Submit the proposed procedures to be followed during tests of the Instrumentation System and its components. As a minimum provide factory, field and operational test procedures.

2. Preliminary Submittal: Outlines of the specific proposed tests and examples of proposed forms and checklists.

3. Detailed Submittal: After approval of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. This submittal shall include a statement of test objectives with the test procedures.

4. Certify in writing that for each system checked out, and all discrepancies have been corrected.

I. Calibration Sheets: Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:

1. Project name

2. Tag number

3. Manufacturer

4. Model number

5. Serial number

6. Calibration range

7. Calibration data: Input, output, and error at 10, 50 and 90% of span Switch setting, contact action, and deadband for discrete elements

8. Space for comments

9. Space for sign-off by Instrumentation Supplier, Engineer and Owner and date

10. Test equipment used and associated serial numbers

1.6 QUALITY ASSURANCE

A. Installer Qualifications for Specialized Devices: For devices indicated, provide evidence that installers are capable of installing device correctly.

1. Evidence includes:

a. Evidence of training in manufacturer's published procedures for installation and training on specific applications required.

b. Certificates demonstrating installer's qualifications.

2. Devices Covered by This Requirement:

a. Flowmeters.

b. TOC analyzers.

c. Fluoride analyzers.

d. Turbidity analyzers.

e. Chlorine analyzers.

f. Level Indicators and Transmitters.

B. Furnish all work specified under this Section from a single vendor for having overall responsibility for all systems and components, including installation of panels furnished by others. Such vendor must demonstrate a minimum of five years successful experience in the design, manufacture and commissioning of instrumentation and control systems of comparable nature, size and complexity to the proposed project. Provide a single warranty or guarantee from vendor covering the systems and all components other than panels furnished by others.

1.7 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Venturi Flow Meter Warranty Period: Twenty-five (25) years from date of Substantial Completion.

C. Provide the Owner with a written agreement from the instrumentation and control vendor guaranteeing proper operation of all systems and components for a period of 36 months after Project Substantial Completion. Such guarantee must provide for the replacement, repair, and adjustment of systems and components which may become necessary due to defective materials or workmanship, or due to lack of reliability under actual operating conditions. Such guarantee must further provide that no charge of any nature will be made to the Owner for work performed under the guarantee by the vendor.

PART 2 PRODUCTS

2.1 INSTRUMENTATION - GENERAL

A. In addition to devices indicated, provide all transformers, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, signal transmission, data signal, and control and power wiring suitable for the application, as necessary to provide complete end-to-end process control loop accuracy from sensor to display and final control element.

B. Where necessary, provide devices that make engineering units conversions and have specific algorithms for applications.

C. Gauges: Comply with ASME B40.100, with gauge range appropriate for particular installation or as shown on Drawings.

D. Wetted parts comply with NSF 61.

E. Transmitters: Provide a transmitter for each sensor unless otherwise indicated; transmitter selected to match sensor, with following characteristics unless otherwise indicated:

1. Display: Four digit or analog visual display of measured parameter.

2. Output Signal: 4 to 20 mA DC, proportional to level of measured parameter, or ethernet. Output signal should be compatible with PLC connection.
3. Accuracy: Plus/minus 0.5 percent of full scale reading with output error not exceeding Plus/minus 0.25 percent of the calibrated measurement.
4. Mounting: Integral with sensor, pipe mounted, wall mounted or installed in control panel as indicated on Drawings.
5. Location, if Not Integral with Sensor: Where indicated; if not indicated, not more than the distance from the sensor recommended by manufacturer.
6. Wiring connections to be NEMA 4X.

2.2 FLOW INSTRUMENTATION

A. Manufacturers:
1. Seametrics: www.seametrics.com.
2. McCrometer: www.mccrometer.com.
3. Emerson: www.emerson.com.
4. Endress + Hauser: www.endress.com/en.
5. Krohne: www.krohne.com
6. Substitutions: See Section 016000-Product Requirements.

B. Flow Instrumentation - General:
1. Liquid Indication: In gallons per minute.
2. Mounting: Easily removed for periodic maintenance.
a. For Liquids: Mount sensors in horizontal piping, unless otherwise indicated or otherwise recommended by manufacturer.
3. Straight Run Piping Requirements: Minimum straight unobstructed piping upstream and downstream as indicated by manufacturer or as shown on Drawings, whichever is greater.
4. Wetted parts comply with NSF 61.
5. Power Requirement: 120 VAC

C. Flow Transmitters:
1. Readout: Digital readout of volumetric flow rate to 3 significant figures.
2. Signal: Proportional to volumetric flow rate and compensated for fluid temperature, unless otherwise indicated.
3. Accuracy: Plus/minus one percent of full flow.
4. Location: As indicated on drawings.
5. Signal Output: 4-20 mA

D. Venturi Tubes for Flow Sensing:
1. The Venturi meter shall have a cylindrical inlet section of the same inside diameter as the inlet piping and shall contain a minimum of two high pressure taps and one low pressure tap.
2. Materials:
a. Body: Cast iron per ASTM A126, Grade B.
b. Throat section and pressure tap bushings: 304 stainless steel. Lining thermal expansion characteristics same as that of throat casting material.
c. Flanges: AWWA Class D steel flanges.
d. Tappings: ½ in. NPT

3. Surface of throat lining machined to plus/minus 50 mils (1.25 micron) finish, including short curvature leading from converging entrance section into throat.
4. Rating: For continuous duty at minimum pressure of 150 psig.
5. Mounting: Aligned to direction of flow, rigidly mounted, and vibration free.
    a. In Horizontal Pipe Runs: Installed with top above pipeline.

E. Flowmeters, Magnetic: Non-intrusive type, measuring fluid flow through use of self-generated magnetic field; metering tube of type 316 stainless steel.

F. Materials:
1. Flanges: AWWA Class “D” steel
2. Electrodes: 316 stainless steel.
3. Grounding Rings: 316 stainless steel

G. Flow Velocity: Capable of measuring clean or dirty flow up to 15 feet per second.

H. Pressure Drop: 2 feet, across meter and appurtenances, at maximum flow rate.

I. Mounting in Vertical Piping: So that flow tube remains full of process fluid under all operating conditions.

J. The transmitter shall provide four separate fully programmable alarm outputs.

K. The transmitter shall periodically perform self-diagnostics and display and resulting error messages.

L. Calibration Requirements:
1. Volumetric Testing of all meters must be performed prior to shipment.
2. The complete meter assembly and transmitter must be wet accuracy tested.
3. Each meter shall be hydraulically calibrated in an ISO 9000-certified testing facility.
4. Each meter shall be provided with a calibration certificate indicating the measured error (percent deviation) at three different flows, respectively equivalent to 25%, 50% and 75% of the nominal flow rate for each size.

2.3 LEVEL INSTRUMENTATION

A. Manufacturers:
1. Rockwell Automation: www.rockwellautomation.com/en-us
2. Endress + Hauser: www.endress.com/en.
3. Ashcroft: www.ashcroft.com
4. Emerson: www.emerson.com/en-us
5. MJK: www.mjk.com.
6. WIKA: www.wika.us.

B. Level Instrumentation - General:
1. For measurement of hazardous contents, provide relays and housings that are intrinsically safe or explosion proof as defined by NFPA 70 hazard rating for type of contents.
2. Mounting: Easily removed for periodic maintenance.
3. Output Signal: The digital communication signal to be transmitted to the bus via a 2-wire connection. The bus also provides power.
4. Wetted parts comply with NSF 61.

C. Level Sensors, Hydrostatic Type: Continuous reading hydrostatic level senor and transmitter.

1. Sensor Range: Install level sensor to operate within the stated range of the manufacturer.
2. Material:
    a. Body: Stainless Steel.
    b. Flange: Stainless Steel.
3. Accuracy: within 0.2 percent.
4. Output Signal: 4 to 20 mA DC, proportional to level of measured parameter. Output signal should be compatible with PLC connection.
5. Display: Local LCD.
6. Power Supply: 32 VDC Max

D. Level Sensors, Ultrasonic Type: Microprocessor based, providing continuous, non-contact level measurement of liquids and solids utilizing microwave pulsed time of flight measurement method, operating in a frequency band approved for water treatment use; capable of distinguishing between real echoes, reflections and background noise; automatic compensation for temperature changes.

1. Sensor Range: Zero to 30 feet.
2. Accuracy: Plus/minus one percent of full scale.
3. Temperature Range: Minus 15 degrees F (26 degrees C) to 120 degrees F (50 degrees C).
4. Body Material: UV and weather resistant
5. Mounting: Installed vertically in top of tank; easily accessible for maintenance and calibration without entry to or draining of vessel measured.
    a. Size mounting to eliminate echoing.
    b. Position sensor to maximize return echo signal and minimize vessel obstructions in sensor line of sight.
    c. Maintain minimum recommended distance from tank fill opening and from side of tank.
    d. Inside Tank Mounting: Surface wall mounting bracket, with minimum recommended distance from tank fill opening.
6. Power Supply: 45 VDC maximum
7. Accessories
    a. Stilling Well - Construction and Installation per sensor Manufacturer instruction
        1) Material: stainless steel
        2) Size: Stilling well to be not larger than sensor antenna diameter per manufacturer recommendation
        3) Slot Width: Per sensor manufacturer recommendation

2.4 PRESSURE INSTRUMENTATION

A. Pressure Instrumentation - General:

1. Operating Pressure: As indicated.
2. Control pressures within plus/minus 5 percent of design pressures.
3. Select switch contact ratings and duty for suitability to application.
4. Verify pressure sensors and pressure transducers by calibration.
5. Provide appropriate snubbers on pressure taps.
6. For pressure sensors and switches, provide valves for isolation, venting, and taps for calibration.

7. For pressure switches and transducers installed on liquid or steam lines, provide drains.
8. For pressure transducers, differential pressure sensors and differential pressure switches, provide nulling valves.

B. Pressure and Vacuum Gauges:
1. Mounting: Stem mounted, unless otherwise indicated.
2. Case: Stainless steel cases, with safety pressure blowout back.
3. Dial: Dry; 4.5 inch (114 mm) diameter; slotted adjustable pointer.
4. Scale: From zero to approximately twice anticipated process operating or equipment pressure; readings in psig/inches of mercury and MPa/mm of mercury.
5. Accuracy: Comply with ASME B40.100 Grade A.
6. Sensors: Diaphragm actuated; phosphor bronze.
7. Connections: Threaded; TP316L stainless steel; 5/16 inch (8 mm) diameter, male.

C. Pressure Sensors: Capsule, diaphragm, bellows, Bourdon tube, or solid state as suitable for application.
1. Indication: In psig and kPa with output to nearest 0.145 psi (1.0 kPa).
2. Range: Plus/minus 10 percent of operating pressure.
3. Local Output: Display and printout.
4. Pressure Transducer: Rated for 300 percent of rated pressure, selected to put design range of measured pressure in middle third of transducer's range.
5. Transducer Accuracy: Plus/minus 1.0 percent of full scale.
6. Transmitter Output Error: Not more than 0.1 percent of calibrated span.

D. Pressure Sensors, Differential Type: Suitable for installation with low pressure connection removed.
1. Rating: Minimum of 300 percent of operating pressure.
2. Accuracy: Plus/minus 2 percent of full scale.

2.5 PROCESS INSTRUMENTATION

A. Power Supply: 120 VAC

B. Sampling Mechanisms: Where sensor is not immersed in medium to be sampled provide a separate sampling mechanism.
1. Probes: Easily removable without interrupting service.
2. Use sampling pumps where necessary or applicable to sensing device.
3. For sensors integral to electronic controller, sample may be drawn directly into sensor or may be drawn through a sample tube.
4. For sensors remotely located, sample may be drawn through a sample tube.
5. Sample tubing from sample point to analyzer to be provided and installed by Contractor per Manufacturer instruction.

C. Chlorine in Liquid Sensors: Continuously monitor chlorine residual; all parts that may come in contact with chlorine or chlorine-filled environment constructed of materials suitable for this application.
1. Type: Amperometric
2. Manufacturer:
a. Hach: https://www.hach.com/
b. Swan: https://www.swan-analytical-usa.com/

c. Substitutions: See Section016000-Product Requirements.

3. Range: 0 to 20 mg/L.
4. pH Range: 4-9
5. Accuracy: Plus/minus one percent of full scale reading.
6. Response Time: 90 percent in maximum of 100 seconds.
7. Sensor Mounting: Immersed in fluid monitored using assembly that allows removal of sensor from fluid.
8. Sensor Location: In an area of continuous flow or in areas of intermittent flow.
9. Controller Location: In control panel or other location as indicated on drawings.
10. Communications: RS485, Modbus, or Profibus.
11. Power Requirements: 100-240V AC, 50-60 Hz.
12. Output: 4-20mA
13. Accessories
    a. pH sensor.

D. Fluoride Analyzer: Continuously monitor fluoride level in permeate water.
1. Manufacturer:
    a. Hach: https://www.hach.com/
    b. Swan: https://www.swan-analytical-usa.com/
    c. ThermoFisher: https://www.thermofisher.com
    d. Substitutions: See Section016000-Product Requirements.
2. Type: Wall-mounted analyzer with test line.
3. Range: 10 ppb to 200 ppm
4. Accuracy: Plus/minus 10 percent of full scale reading.
5. Response Time: 90 percent in maximum of 120 seconds.
6. Sensor Mounting: Inside controller box.
7. Sensor Location: In an area of continuous flow on test line through controller box.
8. Controller Location: In control panel or other location as indicated on drawings.
9. Communications: RS485, Modbus, or Profibus.
10. Power Requirements: 100-240V AC, 50-60 Hz.
11. Output: 4-20mA

E. pH Sensor: Flow-through pipe-mounted type; PVC, CPVC, or epoxy body, Continuous Reading.
1. Manufacturer:
    a. Hach: https://www.hach.com/
    b. Swan: https://www.swan-analytical-usa.com/
    c. ThermoFisher: https://www.thermofisher.com
    d. Substitutions: See Section016000-Product Requirements.
2. Range: 1 to 14 pH units.
3. Accuracy: Plus/minus 0.1 pH unit.
4. Automatic compensation for temperature over the temperature range.

5. Pipe Mounted Type: Located in threaded tee or fitting to allow removal of sensor the pipe with 1" NPT threads.
6. Sensor Locations: In area of continuous flow.
7. Transmitter Location: Remote from sensor.
8. Transmitter Mounting: Mounted to allow readout to be easily viewed.
9. Sensor Material: PEEK
10. Controller/Analyzer:
    a. NEMA 4X enclosure for indoor use
    b. 4-20 mA output with 0.01 mA resolution.
    c. Power Supply: 120 VAC, 60 Hz
11. Accessories:
    a. Provide cabling of at least 50 feet for probe and controller connection.

F. Total Organic Carbon (TOC) Analyzer:
1. Manufacturer:
    a. Hach: www.hach.com
    b. Swan: www.swan-analytical-usa.com
    c. OI Analytical: www.oico.com
    d. Suez: www.suezwatertechnologies.com
    e. Substitutions: See Section016000-Product Requirements.
2. Range: 0-25 ppm
3. Accuracy: Plus/minus 3 percent.
4. Communications: RS485, Modbus, or Profibus.
5. Power Requirements: 100-240V AC, 50-60 Hz.
6. Output: 4-20mA

G. Water Turbidity Sensors: Indicating meter, sensing element, and transmitter; industrial grade sensing element of Type 316 stainless steel and glass, unaffected by color in fluid, pressure, temperature or rate of flow.
1. Type: Nephelometer.
2. Manufacturer:
    a. For standardization with the existing instruments, provide product manufactured by Swan Analytical, USA Inc.
3. Sensor Mounting: Allowing periodic removal for adjustment and cleaning without requiring shut down of process.
4. Range: 0-200 nephelometric turbidity units (NTU), field verified for application and adjusted as required.
5. Accuracy: Plus/minus 1 percent of full scale reading.
6. Automatic zeroing, requiring no normal maintenance or periodic recalibration.
7. Communications: RS485, Modbus, or Profibus.
8. Power Requirements: 100-240V AC, 50-60 Hz.
9. Output: 4-20mA

H. Particle Counter
1. Manufacturer:

a. Chemtrac: www.chemtrac.com

b. Hach: www.hach.com

c. Yokogawa: www.yokogawa.com/us

d. Substitutions: See Section016000-Product Requirements.

2. Sensor Mounting: Allowing periodic removal for adjustment and cleaning without requiring shut down of process.

3. Range: 2-750 microns, field verified for application and adjusted as required.

4. Accuracy: Plus/minus 1 percent of full scale reading.

5. Automatic zeroing, requiring no normal maintenance or periodic recalibration.

6. Communications: RS485, Modbus, or Profibus.

7. Power Requirements: 100-240V AC, 50-60 Hz.

8. Output: 4-20mA

2.6 INSTRUMENTATION ENCLOSURES

A. Enclosures: As specified for electrical enclosures in Section 460500 for environmental conditions.

B. Enclosures should be rated NEMA 4X.

C. Weather Shields and Shelters:

1. Provide for sensors located outdoors.

2. Prevent the sun from directly striking sensor.

3. Provide adequate ventilation so sensing element responds to ambient conditions.

4. Prevent rain from directly striking or dripping onto sensor; for sensors near outside air intake ducts allow for normal outside air flow.

5. Construction Materials: Fiberglass reinforced plastic, aluminum, or stainless steel.

6. Color/Finish: White, painted; or natural aluminum or stainless steel.

7. Locations as indicated on drawings and as required.

8. Ground-Mounted Shelters: Three sides and roof.

a. Mounting Height: 48 inches (1220 mm) above supporting surface to bottom of shelter.

b. Supports as required, anchored and reinforced to minimize vibrations due to wind.

c. Mount devices in the 3-dimensional center of the open space of the shelter.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and as indicated on drawings.

B. Provide the services of a qualified technician experienced in installation and operation of type of equipment provided, to supervise installation, calibration, start-up, demonstration, and testing.

C. Install devices with adequate clearance for maintenance.

D. Do not obstruct access to or clearances required for maintenance of other equipment and systems.

E. Devices Installed in Piping: Provide all necessary gaskets, flanges, thermal compounds, insulation, piping, and fittings.

1. Provide bypass piping and manual valves as indicated on drawings.

2. Where new devices are installed in existing piping, also provide bypass piping and two manual valves for shutoff.

F. Local Indicators: Install direct-reading indicator devices, thermometers, and pressure gauges so that they can be easily read from floor level and are readily accessible for maintenance and service.

G. Adjust or replace devices not complying with specified requirements; except factory sealed devices must be replaced, rather than adjusted.

H. Repair damaged galvanized surfaces.

3.2 FIELD QUALITY CONTROL - SENSOR CALIBRATION - PRIOR TO STARTUP

A. Calibrate monitoring and control instrumentation; devices with factory calibration certification need not be field calibrated.

B. Calibrate using methods described below; alternate methods may be used, if approved by Owner beforehand.

C. Make reports of calibrations performed, documenting methods, and initial, intermediate, and final results.

D. Calibration Accuracy and Tolerances: As indicated for each device.

1. Owner reserves the right to require more rigorous calibration accuracy or tolerances for selected devices.

E. Calibration Equipment: Provide equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum equipment calibration requirements apply:

1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F (0.3 degree C) and resolution of plus/minus 0.1 degree F (0.05 degree C).

2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.

3. Equipment Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.

F. All Sensors:

1. Verify that sensor location is appropriate and away from potential causes of erratic operation.

2. Verify that sensors with shielded cable are grounded only at one end.

3. For sensor pairs that are used to determine a temperature or pressure difference, for temperature make sure they are reading within 0.2 degree F (0.1 degree C) of each other, and for pressure, within tolerance equal to 2 percent of the reading, of each other.

4. Tolerances for critical applications may be tighter.

G. Sensors Without Transmitters:

1. Make a reading with a calibrated test instrument within 6 inches (150 mm) of the site sensor.

2. Verify that the sensor reading is within the specified tolerances of the instrument-measured value.

3. If not, install offset, calibrate or replace sensor.

H. Sensors With Transmitters:

1. Disconnect sensor.

2. Connect a signal generator in place of sensor to simulate desired characteristic.

3. Connect ammeter in series between transmitter and process control panel.
4. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter.
5. Repeat for the maximum characteristic matching 20 mA to the potentiometer span or maximum and verify at the process control system.
6. Record all values and recalibrate controller as necessary to comply with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction.
7. Reconnect sensor.
8. Make a reading with a calibrated test instrument within 6 inches (150 mm) of the site sensor.
9. Verify that the sensor reading, via the permanent local display or the process control system, is within the specified tolerances of the instrument-measured value.
10. If not, replace sensor and repeat.

I. After calibration, perform calibration accuracy check:

1. Conduct two-point accuracy check of calibration of each control system sensing element and transmitter by comparing value from test instrument to corresponding sensor/transmitter output variable.
2. Use digital indicating test instruments at least twice as accurate as specified sensor accuracy, with calibration traceable to National Institute of Standards and Technology standards.
3. Verify that sensing element-to-control system readout accuracies at two points are within specified product accuracy tolerances.
4. If not, recalibrate or replace device and repeat calibration check.

J. Following startup, verify sensors and calibrations are functioning properly.

3.3 OWNER PERSONNEL TRAINING

A. See Section 460500 for additional requirements.

B. Content: Include each type of sensor, meter, analyzer, and transmitter, covering calibration, operation, maintenance, and testing.

END OF SECTION

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SECTION 462156 - INTAKE SCREENS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Passive Intake Screens.

B. Air Burst System.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 013000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

C. Section 460506 - Water Treatment Piping

1.3 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: For each type of product.

1. Description of capacities, performance, operation, and applied forces to foundation.
2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Installation methods.
5. Manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each equipment unit complies with the requirements of the Specifications and is intended generally for the installation applications shown.
6. Calculation sheets (input and output if using modeling software) that shows compliance with capacity and flow distribution.

C. Shop Drawings showing general arrangement and installation details of each main equipment unit and each separately installed accessory, including the location and nature of each service and utility connection. Shop drawings will also include:

1. Include plans, elevations, sections, mounting, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Tag numbers of all equipment
4. Detail fabrication and assembly of passive intake screen.
5. Air burst system receiver size, piping size, valves, electrical schematic, compressor data, enclosure data, and assembly size and weight.

D. Manufacturer’s literature including standard plans, performance data, parts list, installation instructions, and operations and maintenance procedures.

1.4 QUALITY ASSURANCE

A. Furnish screens and air burst systems produced by firms generally recognized as engaged in the manufacture of equipment suitable for the applications of the Project, as determined by the Engineer and which have a minimum of five (5) years’ experience in the production of equipment proposed for this Project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver screens and air burst systems cartoned or crated where necessary to provide protection during transit and job storage.

B. Store equipment in location and manner which protects against dust, moisture, and physical damage.

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

E. Do not under any circumstances store equipment in contact with ground surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:

1. Johnson Screens: www.aqseptence.com/app/en/keybrands/johnson-screens/
2. E&I Corporation: www.eandicorp.com
3. Hendrick Screen Company: www.hendrickcorp.com
4. Concord Screen Company: www.concordscreens.com
5. Elgin Water Solutions: www.elginwatersolutions.com
6. Substitutions: See Section 016000 - Product Requirements.

2.2 GENERAL

A. Vendors furnishing screens and air burst systems are required to satisfy themselves as to the suitability of their equipment to function properly and dependably as an element in the specific system of which they are a part. The act of furnishing the equipment is interpreted to mean that the vendor recommends his equipment for the specific application, and guarantees its proper functioning as a system element.

B. Furnish complete screens and air burst systems including all related accessories and components, not otherwise specified, which are necessary for proper and dependable equipment functioning.

2.3 PASSIVE INTAKE SCREEN

A. General:

1. Provide passive intake screen and air burst system from a single manufacturer responsible for the entire integrated system.
2. Screens shall be fabricated by ASME Section IX Certified welders and the manufacturer shall provide evidence of experience in having supplied at least five assemblies of similar designs which have been in successful service for at least five years.

B. Capacity:

1. The intake assembly capacity shall be 5 MGD at a maximum through-slot velocity, as a result of water withdrawal, of 0.5 feet per second. Pressure drop through the entire intake assembly shall not exceed 0.9 psi at the rated flow.

C. Strength:

1. The screen shall be capable of functioning properly between water depths of 4.5 and 22.5 feet, which is equivalent to the range of water levels in the passive intake screen structure.
2. Design stress used for determining strength of the assembly shall be no more than 90 percent of the published yield strength of the material used.

D. Construction:

1. Provide tee fitting arrangement cylindrical screen with circumferential slots that widen toward the interior of the cylinder. The surface wire, support beam and stiffener

structure shall be an all-welded matrix designed to provide the specific strength with minimal interference with the through screen flow pattern.

2. Provide end plates and tee/drum body a minimum of 0.105 inches thick. All structural butt welds shall be full penetration fillet welds and shall be the thickness of the thinner component.

3. Equip screen interior with perforated air pipe along its length arranged to flush the screen surface of debris using a short burst of air through the screen. Furnish screen outlet pipe fitted with minimum 2 inch diameter air pipe flanged connection.

E. Slot Opening Size:

1. The screen slot size shall be a maximum of 0.25 inches. Provide minimum open area for slots of 63 percent.

2. Slot size shall be controlled and continuously monitored during manufacture.

F. Materials

1. The main outlet flange shall mate with a 16 inch flange with a flange pattern equal to AWWA C-207, Table 2, Class D.

2. Fabricate entire screen assembly of type 304 stainless steel.

2.4 AIR BURST SYSTEM

A. Provide a skid-mounted air burst backwash system consisting of compressor(s), receiver, valving, instrumentation and controls necessary to provide sufficient amount of air to backwash intake screen provided as specified herein and as shown on the drawings. The receiver may be separate depending upon size.

B. Products:

1. Compressor: Provide one compressor with sufficient capacity to recharge receiver vessel to operating pressure of 150 psig within 30 minutes. Provide compressor complete with starting unloader, low oil level switch, pressure switch, after cooler, check valve, manifold, v-belt drive, totally enclosed belt guard, and intake filter. Provide a two-year warranty on compressor parts. Drive the compressors with motors rated to operate at 460V, 3 Phase, 60 Hz. Provide compressor with a minimum capacity of 36 CFM free air at 175 psig at ambient inlet conditions. Supply compressor rated for continuous duty.

2. Receiver: Provide an ASME code 200 psi horizontal/vertical air receiver. Provide the receiver with pressure gauge, safety valve, and automatic drain assembly. Size the receiver to displace a minimum three screen volumes of air at the screen in 3 to 5 seconds during a backwash to remove debris. Provide an 120 gallon minimum capacity receiver, based on an airburst piping length to the screen of 75 ft. maximum. Provide a minimum 2 inch nominal diameter receiver outlet.

3. Valves: Provide automatic operated backwash valve for each screen air pipe. The valves shall be 3-piece full ported SS ball valves with fast acting, vane style pneumatic actuators with only one moving part. The valve assemblies shall have integral mounted limit switches and solenoids. An auxiliary receiver shall be provided for valve actuation. The auxiliary receiver shall have a check valve, pressure gauge, safety valve, filter regulator and mechanical drain.

4. Control Panel: A NEMA 4 control panel shall be provided. Panel shall be pre-wired. Control panel shall contain as a minimum, Step-down control transformer, Motor protection circuit breaker, starter and overload relay for the compressor, Control transformer, System ON OFF switch with lamp, TEST OFF AUTO switch for the compressor, MANUAL OFF AUTO switch for each valve, spring return to off for manual initiation for each valve, READY lamp, LOW OIL lamp with compressor shut down, GENERAL fault lamp with reset push button and a PLC or relay logic to perform the specified control functions. A display shall be supplied to adjust backwash cycle time, open time for each valve and delay time as well as monitoring all I/O status.

5. Operation: The system shall operate in MANUAL or AUTO mode. In manual mode the backwash for each valve shall be initiated by momentary MANUAL position, which will

open the valve after a 30 second delay, provided the system is powered and the system has adequate air pressure. In the AUTO mode the air burst cycle is initiated by the programmed timer or a momentary contact closure from a remote location. After a 30 second delay the first valve will open and remain opened for a programmed period of time. Once the receiver has recovered to full pressure the second valve will be opened after the 30 second delay and remain open for the programmed period of time. The system will cycle through all valves that are in the AUTO mode. The 30 second delay shall have a dry contact output for customer to provide an alarm or warning if needed.

6. Enclosure: Enclose skid mounted air burst system in a fiberglass, sound dampening, outdoor, weather-proof enclosure with ventilation openings. The enclosure shall be fixed to the concrete pad. The enclosure shall have a lockable, double door.
7. Piping, Valves and Fittings: Conform to applicable provisions of Section 460506 - Water Treatment Piping.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate delivery of anchoring devices to project site to avoid delaying progress.

3.2 INSTALLATION

A. Refer to contract Drawings and shop drawings, and coordinate and fit equipment accordingly. Place sleeves, bolts, and inserts as structure construction progresses.

B. Make equipment installations in accordance with manufacturer's written recommendations. Advise Engineer of any conflict between Contract Documents and recommendations of manufacturer, before commencing installation.

C. Provide all necessary accessories for proper installation and operation of mixers.

D. Effectively protect mixers from damage and accelerated wear or deterioration during Project construction and until final Project acceptance.

E. Protect equipment against damage from freezing.

3.3 INITIAL OPERATION

A. Thoroughly clean equipment and related systems as necessary before attempting initial operation. In addition, use temporary strainers or other means to initially protect equipment from damage resulting from foreign matter entering through connecting piping.

B. Place all equipment in service, and monitor operation until proper and reliable functioning is fully demonstrated.

C. Establish that all related safety devices, including but not limited to safety valves, limit switches, moving machinery guards and handrails, are in place and working properly before leaving any equipment in operation.

D. Before leaving any equipment in service, comprehensively brief the District and Engineer regarding its operation and maintenance.

E. In the event any equipment unit, system or component fails to meet specified requirements or proves to be unreliable in service, make all necessary changes required to correct such deficiencies. Should the equipment unit remain unable to reliably meet specified requirements, remove the unit and replace it with equipment that does reliably meet specified requirements.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Field testing shall be performed after installation of the equipment. The field testing shall demonstrate the following:

C. The equipment has been properly installed in accordance with manufacturer’s instructions and recommendations.

D. The equipment has been installed in the specified location and orientation or as shown on the Contract Drawings.

E. There are not physical defects in any of the parts.

END OF SECTION

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SECTION 463129 - CHEMICAL METERING AND TRANSFER PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Peristaltic pumps.
2. Hose pumps.
3. Electrical components for pump systems.

B. Related Requirements:

1. 055000 - Metal Fabrications
2. 099600 - High-Performance Coatings
3. 460506 - Water Treatment Piping
4. Division 26, Electric Specifications
5. 463300 - Liquid Chemical Feed Equipment

1.2 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the rating and nomenclature of the Hydraulic Institute Standards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include special shipping, storage and protection, and handling instructions as well as Manufacturer's printed installation instructions.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump.
4. Complete manufacturer's information on Controller.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

B. Shop Drawings:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Detailed mechanical and electrical drawings showing the equipment dimensions, size, location of connections, and weights of associated equipment.
3. Power and control wiring diagrams, including terminals and numbers.
4. Complete motor information, including nameplate data, enclosure, and special features.
5. Factory finish system.
6. Suggested spare parts list to maintain the equipment in service for a period of 1 year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. Certification that the pumps and tubing’s materials of construction are compatible with product being pumped.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

1. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.

1.5 CLOSEOUT SUBMITTAL

A. Operation and maintenance manual.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. One complete set of any special tools.
2. Two lubrication refills for each pump (for pumps requiring lubricant fluid).
3. Two complete drives of each type used (without panel) suitable for installation and control panel.
4. Two spare pump head assemblies for each type of metering pump.
5. Two spare length of tubing for each diameter specified.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Must have at least three domestic operation installations of the same size operating in the same service as specified for a period of not less than 2 years.
2. Credit to the Owner all unused service person-days specified below, at the manufacturer’s published field service rate.
3. Technician must be factory certified and specifically trained on the type of equipment specified. Technician must have a minimum of 3 years direct experience on the size and type of equipment specified. The services of a manufacturer’s sales representative will not be accepted to fulfill this requirement.

PART 2 PRODUCTS

2.1 PERFOMANCE REQUIREMENTS

A. Flow Rate: as indicated herein and within Section 463300.

B. Head Requirements: as indicated herein and within Section 463300.

C. Operating Temperature: 41F to 113F.

D. Voltage: 240V ac.

1. Manufacturer to provide power cable at least 10ft in length

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Watson-Marlow/Bredel Pumps
2. Verdeflex Pumps
3. ProMinent Pumps
4. Blue-White Industries
5. Cole Parmer

B. All peristaltic pumps including but not limited to pump head, pump drive units, and internal HMI systems shall be the product of one manufacturer.

2.3 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Pump manufacturer must provide pumps, gear reducers, motors, drives, pulsation accumulators and dampeners, leak detection systems, and other accessories as specified

herein, regardless of manufacturer, as a complete integrated package to ensure proper coordination and compatibility. Pumps and/or control panels will be rejected if not supplied by the pump manufacturer.

C. Must be compatible with chemicals as specified in pump schedule data sheet.

2.4 PERISTALTIC PUMP

A. Positive displacement, peristaltic metering pump.
   1. Capable of running dry without damage to pump or hose.
   2. Repeatability ±1 percent accurate.
   3. Valveless/glandless with no dynamic seals in contact with the pumped product.

B. Pump Housing:
   1. NEMA 4X rating.
   2. Mounting frame shall have provision for anchor bolts which shall be easily accessible from outer dimension of the supports. Frames with anchor bolt provisions located on the inner frame surface which are totally or partially hidden by the pump, base, or drive are not acceptable.

C. Tubing to Pump Connections:
   1. Manufacturer to provide inlet and outlet leads to connect tubing to pump.
   2. Manufacturer to provide pump internal tubing.
   3. Must be compatible with the chemical being serviced at the concentration stored.

D. Tubing:
   1. Tubing shall be of an elastomer compatible with the with the chemical serviced at the concentration stored.
   2. Tubing Size: 1/32” ID.
   3. Burst Pressure: 165 bar minimum .
   4. Tubing shall be replaceable without cover or pump removal.
   5. Fittings :
      a. 1/32” Barb tubing connection to 1/4” NPS connection .
      b. Pressure Rating: 50 bar minimum .
      c. Connection between tubing and ¼” NPS should allow no leaks .

E. Schedule:
   1. Clear Well Chlorine Analyzer Metering Pumps:
      a. Suction Head Requirement: 40 psi
      b. Discharge Head Requirement: 20 psi
      c. Flow: 2.65 gal/hr, minimum

2.5 HOSE PUMP

A. Positive displacement, hose pump.
   1. Capable of running dry without damage to pump or hose.
   2. Repeatability ±1 percent accurate.
   3. Valveless/glandless with no dynamic seals in contact with the pumped product.

B. Pump Drive System Housing: Cast Iron

C. Pump Rotor and Integral Shoes: Cast Iron

D. Mounting frame shall have provision for anchor bolts which shall be easily accessible from outer dimension of the supports. Frames with anchor bolt provisions located on the inner

frame surface which are totally or partially hidden by the pump, base, or drive are not acceptable.

E. Hosing material shall be certified by manufacturer as suitible for use with the chemical serviced at the concentration stored at the plant.

F. All hose pumps furnished for use shall be of same sizing, manufacturer, and model to allow for uniform maintenance and spare part requirements.

2.6 ELECTRICAL COMPONENTS AND ACCESSORIES

A. Chemical metering pumps shall comply with controls as indicated in Section 463300.

B. General:

1. Provide all necessary electrical components and wiring for a complete, functional system. Electrical components shall be provided in accordance with the requirements of Division 26.

C. Pump Interface:

1. Two integral IP66 rated five pole M12 connectors for input and output connection.

2. Manufacturer to supply each pump with optical input and output cables each 10 feet in length.

D. HMI System:

1. Internal Pump HMI system shall be compatible with Plant’s HMI system.

a. Flush Pushbuttons: Stop and Start.

b. Display flow rate, pump speed, Volume Counter, and Run Hours.

c. Operational Modes.

1) Manual.

2) 4-20mA.

3) Fluid Recovery Mode/Reverse Flow.

d. Alarms:

1) General Alarm: drive overload, hose fail, and high pressure.

2) Leak Detection.

3) Motor Stalled or ran in wrong speed.

4) Voltage error.

e. Key Pad Security.

2.7 LEAK DETECTION

A. Provide leak detection system that will indicate on the display screen and auto-stop pump when a leak is detected.

2.8 ACCESSORIES

A. Equipment Identification Plate:

1. 16-gauge stainless steel with two rows of 1/4 inch die-stamped numbers. The first row of numbers will be the equipment tag number as identified in the Contract Documents. The second number, located below the equipment tag number, will be a Computerized Maintenance Management System number assigned by the Owner .

2. The equipment identification plate shall be securely mounted in a readily visible location. If attached with wire, wire shall be stainless steel. Equipment tags shall not be attached to handwheels.

B. Anchor Bolts: Size by equipment manufacturer, and as specified in Section 05500 “Metal Fabrications and Castings”.

C. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Gage Scale-Range: 0 to 200 psi .
5. Pressure Connection: stainless steel, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Plastic.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
11. Gage Attachment
    a. Snubbers: ASME B40.100, 304 stainless steel; with NPS ¼, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

D. Gauge Connections: Tapped and plugged gauge connections on piping headers adjacent to pumps. See Section 463300 “Liquid Chemical Feed Equipment”.

2.9 FACTORY FINISHING

A. Prepare surface and prime coat in accordance with 099600 - High-Performance Coatings.

2.10 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test all equipment actually furnished.

B. Factory Test Report: Include test data sheets.

C. Functional Test: perform manufacturer's standard.

PART 3 APPLICATIONS

3.1 CHEMICAL FEED PUMPS

A. Provide peristaltic and hose pumps in duty and standby configuration on manufactured chemical feed skids as indicated in the Chemical Metering Skid Schedule in Section 463300.

3.2 BULK TRANSFER SERVICES

A. Furnish six (6) total hose pumps, arranged into three (3) service trains as indicated on construction drawings with one (1) duty and one (1) standby pump servicing the following chemical bulk transfers (one service train consisting of two pumps per chemical transfer):
    1. Hydrofluorosilicic Acid (H2SiF6)
    2. Sodium Hypochlorite (NaOCl)
    3. Aquamag

B. Schedule:
    1. Hydrofluorosilicic Acid (H2SiF6) Transfer Service:
        a. Pump #s: TP-5037, TP-5038
        b. Total dynamic head design duty points: 5 feet TDH.
        c. Suction static head design point: Minimum 0 feet, Maximum 8.5 feet.
        d. Flow range requirements: 4 gallons per minute.
    2. Sodium Hypochlorite (NaOCl) Transfer Service:

a. Pump #s: TP-5003, TP-5004
b. Total dynamic head design duty points: 7 feet TDH.
c. Suction static head design point: Minimum 0 feet, Maximum 8.5 feet.
d. Flow range requirements: 16 gallons per minute

3. Aquamag Transfer Service:
a. Pump #s: TP-5031, TP-5032
b. Total dynamic head design duty points: 5 feet TDH.
c. Suction static head design point: Minimum 0 feet, Maximum 8.75 feet.
d. Flow range requirements: 10 gallons per minute

C. Tubing and pump materials utilized for each service train shall be certified for use with the chemical and storage amounts stored as indicated below:
1. Hydrofluorosilicic Acid at a solution strength of 23%.
2. Sodium Hypochlorite stored at a solution strength of 12.5%.
3. AquaMag at a solution strength of 10.0%.

3.3 LAB SAMPLING SERVICE

A. Furnish two (2) total peristaltic pumps, arranged into one (1) service train as indicated on construction drawings with one (2) duty and one (1) shelf pump servicing the laboratory sampling of the raw and permeate water.

B. Pumps shall be mounted on a skid per requirements set forth in Section 463300.

PART 4 EXECUTION

4.1 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations and as shown on Drawings.

B. Lubricants: The installation includes oils and lubricants for initial operation for pumps requiring lubrication fluid.

C. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

D. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

4.2 FIELD QUALITY CONTROL

A. Functional Test: Prior to plant startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test.

B. Performance Test:
1. The Contractor shall perform field tests on complete pump assemblies to demonstrate their conformance to the Specifications to the satisfaction of the Engineer. A test log shall be presented to the Engineer upon completion of each test that records flow, as measured by graduated containers or storage volumes.
2. Units apparently failing to meet the Specifications to the satisfaction of the Engineer shall be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the Contractor shall furnish a unit that will perform as specified at the Contractor's sole expense

END OF SECTION

SECTION 463300 - LIQUID CHEMICAL FEED EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Chemical solution tanks.

B. Chemical Metering Pump Skids.

C. Piping specialties.

D. Chemical Storage.

E. Controls and instrumentation.

F. Supply of chemicals for initial operating period.

G. Chemical Unloader Stations and Accessories

1.2 RELATED REQUIREMENTS

A. Section 460106 - Operation and Maintenance Manual.

B. Section 460500 - Common Work Results For Water and Wastewater Equipment: Requirements applicable to all equipment.

C. Section 460506 - Water Treatment Piping

D. Section 460513 - Piping Specialties

1.3 REFERENCE STANDARDS

A. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

B. ANSI Z400.1/Z129.1 - Hazardous Industrial Chemicals - Material Safety Data Sheets - Preparation 2010.

C. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2015, with Editorial Revision (2018).

D. ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tanks 2015.

E. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 2020.

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 for submittal procedures.

B. Product Data: Manufacturer's technical data sheets on each item of equipment; for pumps include performance charts and pump curves.

C. Shop Drawings: Detailed drawings showing layout and anchorage of equipment; relationship to other parts of work; clearances for installation, maintenance and operation; schematic and flow diagrams; piping and wiring.

D. For Each Chemical Furnished: Submit Material Safety Data Sheet complying with ANSI Z400.1/Z129.1 and certification stating that product furnished complies with specified requirements.

E. Operation and Maintenance Data: Section 460106.

F. Field Quality Control Reports.

1.5 MAINTENANCE MATERIALS AND TOOLS

A. Provide the following spare parts to the Owner for each chemical metering skid upon delivery of the pump skid. Spare parts shall include all parts required for (2) years of normal maintenance of all components of the chemical metering system. All parts shall be in one box labeled with the Skid ID Information:

1. P/M kit for each pressure relief valve.

2. Spare valve of each size for each pump skid.
3. Parts list for all serviceable components.

B. Tanks and Tank Equipment:

1. For each individual tank, provide complete set of parts recommended by manufacturer to be replaced after one year of service.

C. Pulsation Dampeners: For each unit, provide spare diaphragm and air valve.

D. Maintenance Tools: Furnish list of manufacturer-recommended tools for each unit.

1. One set of special tools for each type of equipment including calibration devices, and instruments required for adjustment, calibration, disassembly, operation, and maintenance of the equipment.

E. Personal Protective Equipment: For each room or space in which chemicals are handled, provide two pairs of safety goggles and/or face shields, two chemical resistant aprons, and two pairs of chemical resistant gloves.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Minimum of three years experience manufacturing products of the type specified.

B. Installer Qualifications:

1. Minimum of three years experience in the installation of similar equipment.

1.7 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 CHEMICAL FEED SYSTEMS - GENERAL REQUIREMENTS

A. Provide independent feed systems for each different chemical, suitable for 24-hour full load service in ambient, non-freezing conditions.

B. Provide feed systems comprising of the following components:

1. Chemical supply storage tank(s) from which chemical solution is pumped through piping or tubing to point of application.
2. Pre assembled chemical metering skids including pumps, controls, and accessories.

C. Tanks included in the chemical feed systems shall meet the requirements set forth in Section 415219.01 and herein.

D. Pumps included in chemical feed systems shall meet requiredements for pumps as specified in Section 463129 - Chemical Metering and Transfer Pumps.

E. Provide pump redundancy for each chemical feed service as indicated herein to include one duty and one standby pump.

F. Performance Requirements: As indicated, and:

1. Consistency: Same time to deliver a given quantity of chemical at a given stroke and speed setting at all pressures.
2. Positive Shutoff: Zero flow at zero stroke/speed setting.
3. Double diaphragm Systems: Fully synchronized.

G. Chemicals: Provide a supply of each chemical sufficient for operation during Startup Period, but not less than 3 months of operation at 1.5 MGD plant flow.

2.2 CHEMICAL METERING SKIDS

A. Acceptable Manufacturers:

1. A single manufacturer shall supply all chemical metering skids furnished.

2. Manufacturers:
    a. Tech Equipment, Canton GA
    b. Substitutions: See Section 016000-Product Requirements.

B. General:

1. Chemical metering skid shall be constructed from HDPE sheet or Co Polymer Polypropylene sheet stock with a minimum thickness of 1/2 inch. The design of the skid shall include gussets and supports as required for all components and shall be self-supporting. The skid shall be designed with a minimum of a 2-1/2" containment lip to contain spills. All components of the chemical metering system shall be contained within the skid. The skid shall be manufactured using continuous welding technology; bolted construction is not acceptable. Pump stands shall be provided to elevate the metering pumps above the skid base.
2. The pre piped skid mounted system shall include pressure relief valves; diaphragm protected pressure gauges, calibration columns, pulsation dampeners, and all required piping, isolation valves and supports as required to serve the pumps shall be pre piped on the skid. The pumps shall be piped to provide service to the main chemical feed point.
3. Piping shall include isolation valves and unions for all serviceable components. The chemical supply piping shall feature a calibration column designed for independent use with any of the metering pumps while other pump(s) remain in active service. The pump connections shall be designed with replaceable pipe sections on the suction and discharge via union or flange so that pump replacement or upgrade can be accomplished without cutting into skid piping. Provide flexible tubing connections and quick connects between fixed piping and suction and discharge of the pumps.
4. The piping shall be attached to the chemical metering skid with a non-metallic corrosion resistant support system. All support extensions shall be factory attached to the skid. The straps shall be removable and reusable to allow for servicing of the system. All inlet/outlet connections, valves and pump accessories shall be clearly labeled on the skid for easy identification.
5. The chemical feed skid manufacturer shall be responsible for providing a Nema 4x interface box with labeled terminal strips per pump for input and output control wires. The chemical feed skid manufacturer is also responsible for installing all control wiring from the pumps to the Nema 4x interface box. The electrical contractor is responsible for running conduit into the Nema 4X interface Box and installing input and output control wires on the terminal strips.
6. The chemical feed skid manufacturer shall be responsible for providing a prewired and piped 120V receptacle with weatherproof cover for each skid mounted pump completely independent from the control wiring. Each skid will have an electrical junction box that has been prewired from the 120V receptacle for the electrical contractor to tie into. The electrical contractor is responsible for running conduit and tying into skid mounted electrical junction box and installing 120V supply power to the skid.
7. The chemical metering skids shall be completely assembled and tested by the manufacturer prior to delivery to the job site.
8. The design and fabrication of the chemical metering skids shall comply with the following criteria:
    a. All piping shall be fabricated to production drawings that detail all pipe nipples, fittings, valves, metering accessories, supports, etc.
    b. The manufacturer prior to delivery shall hydraulically and electrically test each system. Testing shall be documented and include verification of pump performance and response to remote systems using simulation equipment as required.
    c. The manufacturer shall be responsible for ensuring the skids are sized properly so that all required pumps per chemical are able to fit over the specific chemical's

containment grating.

d. Each skid will be supplied with clips to allow the skid to sit atop the chemical containment grating. The clips shall be designed to withstand proper vibration requirements.

e. Each skid shall be supported by integral legs with a height of 36 inches to raise the chemical dosing pumps. Each raised skid will also contain a drawer large enough to contain chemical dosing pump heads.

2.3 CHEMICAL METERING SKID PIPING

A. Piping General:

1. Pipe and fittings shall be manufactured of materials as indicated in the Chemical Metering Skid Schedule. Fittings shall be heavy-duty Schedule 80 molded fittings.

2. All pipe and fittings shall bear the company's name or trademark, material designation, size, applicable IPS schedule, and the NSF mark as indicative of compliance with this specification.

3. Workmanship shall be in accordance with good commercial practice. Fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The fittings shall be commercially uniform in color, opacity, density and other physical properties.

4. All molded threads, internal or external, shall be "blunt start" threads. All threads shall conform to thread standard ANSI/ASME B1 .20.1 for tapered pipe threads. Threads shall measure not more than 11/2 threads large or small when checked with a plug gauge or ring gauge.

5. Dimensions and tolerances of sockets shall conform to IPS Schedule 80 Socket Dimensions. All reducer bushings shall be designed so as to provide for a positive and sufficient grip for cementing bushings in place.

6. Waterways shall be smooth and commercially free of flash and irregularities. On tees and 90° elbows, bond lines shall not coincide with the maximum stress area (crotch).

7. Assembly shall be performed in a controlled shop environment by the skid manufacturer. All pipe shall be squarely cut on precision equipment with the ends chamfered and deburred. All socket welded connections shall follow the guidelines set by the pipe/fitting manufacturer for proper cleaning, priming and gluing procedures. A heavy bodied solvent suitable for use with Sodium Hydroxide shall be used. All threaded connections will utilize Teflon tape, a suitable thread sealant or a combination of both. Threaded connections shall utilize stainless steel reinforcement rings where applicable to reduce the risk of cracking.

B. Isolation Ball Valves

1. Sizes 1/2" to 4" as applicable with manufactured skids.

2. True union design with two-way blocking capability.

3. O-rings shall be EPDM or FPM based on chemical being pumped.

4. Seats shall have elastomeric backing cushion of the same material as the valve seals. Stem shall have double O-rings and be of blowout-proof design.

5. Pressure rating of 230 psi for sizes 1/2" to 3" and 150 psi for 4" at 70 º F

2.4 CHEMICAL METERING SKID SCHEDULE

A. Hydrochloric Acid

Service	**Clean in Place Service**
Pump #s	DP-5017, DP-5018
Solution Strength	32.0%
Feed/Flow Rate	Minimum design duty point of 36 gallons per hour; maximum design duty point of 43 gallons per hour.
Head Conditions	Required Pump Head of 108.5' (47 psi).

Piping and Fittings	CPVC Construction
Accessories	10,000 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
	CPVC Pusation Dampener
Pumps	One duty and one standby pump per Section 463129

B. Sodium Hydroxide

Service	**Post Filtration Injection**
Pump #s	DP-5020, DP-5021
Solution Strength	40.0%
Feed/Flow Rate	Minimum design duty point of 0.07 gallons per hour, maximum design duty point of 0.37 gallons per hour.
Head Conditions	Required Pump Head of 49.7' (21.5 psi).
Piping and Fittings	CPVC Construction
Accessories	500 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
Pumps	One duty and one standby pump per Section 463129
Service	**Clean in Place Service/Neutralization Service**
Pump #s	DP-5022, DP-5023
Solution Strength	40.0%
CIP Feed/Flow Rate	Minimum design duty point of 21 gallons per hour, maximum design duty point of 25 gallons per hour.
Neut. Feed/Flow Rate	Minimum design duty point of 43 gallons per hour, maximum design duty point of 51 gallons per hour.
Head Conditions	Required Pump Head of 108.5' (47 psi).
Piping and Fittings	CPVC Construction
Accessories	10,000 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
	CPVC Pulsation Dampener
Pumps	One duty and one standby pump per Section 463129

C. Sodium Hypochlorite

Service	**Passive Intake Screen Service**
Pump #s	DP-5013, DP-5014
Solution Strength	12.5%
Feed/Flow Rate	Minimum 0.10 design duty point of gallons per hour, maximum design duty point of 0.49 gallons per hour.
Head Conditions	Required Pump Head of 44.0' (19 psi).
Piping and Fittings	CPVC Construction
Accessories	250 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
Pumps	One duty and one standby pump per Section 463129
Service	**Static Mixing Injection**
Pump #s	DP-5005, DP-5006
Solution Strength	12.5%
Feed/Flow Rate	Minimum design duty point of 0.10 gallons per hour, maximum design duty point of 0.49 gallons per hour.
Head Conditions	Required Pump Head of 126.7' (54.8 psi).

Piping and Fittings	CPVC Construction
Accessories	250 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
Pumps	One duty and one standby pump per Section 463129
Service	**Maintenance Wash/Clean in Place Service**
Pump #s	DP-5007, DP-5008
Solution Strength	12.5%
MW Feed/Flow Rate	Minimum design duty point of 18 gallons per hour, maximum design duty point of 21 gallons per hour.
CIP Feed/Flow Rate	Minimum design duty point of 35 gallons per hour, maximum design duty point of 42 gallons per hour.
Head Conditions	Required Pump Head of 108.5' (47 psi).
Piping and Fittings	CPVC Construction
Accessories	10,000 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
	CPVC Pulsation Dampener
Pumps	One duty and one standby pump per Section 463129
Service	**Post Filtration Primary Disinfection**
Pump #s	DP-5009, DP-5010
Solution Strength	12.5%
Feed/Flow Rate	Minimum design duty point of 0.44 gallons per hour, maximum design duty point of 2.23 gallons per hour.
Head Conditions	Required Pump Head of 49.7' (21.5 psi).
Piping and Fittings	CPVC Construction
Accessories	10,000 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
	CPVC Pulsation Dampener
Pumps	One duty and one standby pump per Section 463129
Service	**Post Filtration Secondary & Tertiary Disinfection**
Pump #	DP-5011, DP-5012
Solution Strength	12.5%
Feed/Flow Rate	Minimum design duty point of 0.44 gallons per hour, maximum design duty point of 2.23 gallons per hour.
Head Conditions	Required Pump Head of 49.7' (21.5 psi).
Accessories	10,000 ml Calibration Column
	2.5" Pressure Guage
	CPVC Pressure Relief Valve
	CPVC Pulsation Dampener
Pumps	Two Duty

D. Hydrofluorosilicic Acid

Service	**Post Filtration Injection**
Pump #s	DP-5040, DP-5041
Solution Strength	23%
Feed/Flow Rate	Minimum design duty point of 0.54 gallons per hour, maximum design duty point of 2.70 gallons per hour
Head Conditions	Required Pump Head of 49.7' (21.5 psi).
Piping and Fittings	CPVC Construction

Accessories	500 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
Pumps	One duty and one standby pump per Section 463129

E. Citric Acid

Service	**Clean in Place Service**
Pump #s	DP-5025, DP-5026
Solution Strength	50.0%
Feed/Flow Rate	Minimum design duty point of 51 gallons per hour, maximum design duty point of 61 gallons per hour
Head Conditions	Required Pump Head of 108.5' (47 psi).
Piping and Fittings	PVDF Construction
Accessories	10,000 ml Calibration Column
	2.5" Pressure Gague
	PVDF Pressure Relief Valve
	PVDF Pulsation Dampener
Pumps	One duty and one standby pump per Section 463129

F. Sodium Bisulfite

Service	**Neutralization Service**
Pump #s	DP-5028, DP-5029
Solution Strength	38%
Feed/Flow Rate	Minimum design duty point of 15.31gallons per hour, maximum design duty point of 18.19 gallons per hour
Head Conditions	Required Pump Head of 108.5' (47 psi).
Piping and Fittings	CPVC Construction
Accessories	10,000 ml Calibration Column
	2.5" Pressure Gague
	CPVC Pressure Relief Valve
	CPVC Pulsation Dampener
Pumps	One duty and one standby pump per Section 463129

G. Corrosion Inhibitor

Service	**Post Filtration Injection**
Pump #s	DP-5034, DP-5035
Solution Strength	10%
Feed/Flow Rate	Minimum design duty point of 0.71 gallons per hour, maximum design duty point of 3.55 gallons per hour
Head Conditions	Required Pump Head of 49.7' (21.5 psi).
Piping and Fittings	Polyethylene (PE) Construction
Accessories	500 ml Calibration Column
	2.5" Pressure Gague
	PE Pressure Relief Valve
Pumps	One duty and one standby pump per Section 463129

H. Sample Pumps

Service	**Sample Pumps**
Pump #s	SP-1020, SP-1030
Solution	Raw Water, Permeate Water
Feed/Flow Rate	3 gpm
Head Conditions	Required Pump Head of 35' (15.15 psi).

Piping and Fittings	Polyethylene (PE) Construction
Accessories	500 ml Calibration Column
	2.5" Pressure Gague
	PE Pressure Relief Valve
Pumps	Two Duty, One shelf pump

2.5 SOLUTION TANKS

A. Manufacturers:

1. Polyprocessing: www.polyprocessing.com
2. Substitutions: See Section 016000 - Product Requirements.

B. Provide chemical solution tanks per requirements set forth in Section 415219.01 and herein.

C. Chemical Tanks: Fully resistant to effects of full-strength and fully diluted solution concentrations to be contained; equipped with fill nozzle, vent, discharge, level instrument, drain, and two spare connections. Tank shall be semi-transparent.

1. Pressure rated for 1.5 times weight of solution at full capacity.
2. Capacity: As indicated.
3. Reinforced to withstand all forces when full of solution.
4. Shop fabricated with no field assembly permitted.
5. Drain connections providing complete drainage of tank.
6. Gaskets: Fluorocarbon elastomer.
7. Nuts and Bolts: TP316 stainless steel.
8. Steel Supports: Stainless steel or epoxy coated.
9. Provide removable lids on tanks smaller than 36 inches (900 mm) in diameter.
10. Provide manway access on tanks as indicated on Tank Datasheets.
11. Vented openings shall utilize a screen of suitable material for contact with chemical vapors at the vent termination point.
12. Provide level monitoring device on each tank in accordance with Section 460923 - Monitoring and Control Instrumentation.

D. Polyethylene Tanks: Comply with ASTM D1998.

1. All fittings on the 1/3 lower sidewall of tanks with capacities greater than 1000 gallons shall have 100% virgin PTFE expansion joint. Expansion joint to have a minimum of 3 convolutions, stainless steel limit cables and FRP composite flanges. Galvanized parts will not be accepted.
    a. Expansion joint to meet the following minimum performance requirements:
        1) Axial Compression ≥ 0.67”
        2) Axial Extension ≥ 0.67”
        3) Lateral Deflection ≥ 0.51”
        4) Angular Deflection ≥ 14º
        5) Torsional Rotation ≥ 4º

E. Tank Access Ladders

1. Provide access ladders as indicated in section 415219.01.
2. General:
    a. Ladder construction shall comply with all applicable OSHA and local safety standards.

b. Ladders shall be of steel construction, with manufacturers standard coating.

c. Ladder mounting brackets and anchors shall be furnished by ladder and tank manufacturer.

d. Returns shall be constructed of like material to the ladder and installed to provide a minimum of a 38" vertical extension from the top of the ladder.

2.6 PIPING SPECIALTIES

A. Calibration Columns:

1. A clear calibration column made of materials compatible with pumped fluid shall be provided in the chemical supply piping. Calibration column shall be direct reading in both ml/minute and Gallons/Hour and sized to allow at least a 30-second drawdown.

B. Pressure Relief Valves:

1. Pressure relief valves shall be provided in the discharge piping of each metering pump, prior to any valves, to eliminate the buildup of excess pressure in the system. The pressure relief valves shall be fully adjustable from 10 – 150 psi with bodies compatible with the pumped fluid. Spring loaded valve shall have a Teflon diaphragm and no metal parts in contact with the chemical. Output of the pressure relief valves shall be field piped to return to the day tanks.

C. Backflow Preventers: See Section 460513; provide backflow prevention devices or air gaps on tank fill lines.

D. Pressure Gauges: Diaphragm type with Bourdon tube and diaphragm compartments filled completely with oil, made of materials suitable for application.

1. Diaphragm Seals: At each gauge connection to isolate gauges from corrosion, sludge or other hazards of process fluid; seal material compatible with oil in gauge and process fluid.

2. A fabricated PVC bracket shall be provided for each pressure gauge to secure the isolator and prevent lateral movement of the pressure gauge. Gauge face shall be 2-1/2" inches diameter.

E. Pulsation Dampeners:

1. Accumulator/Dampeners shall be provided for installation on the discharge piping and shall be chargeable, the appendage type, and consist of a PVC housing, and a remote one-way air inlet valve to prevent product backflow with air tubing and a pressure gauge.

2. Housing shall be rated for 150 psi and made of PVC. Bladder shall be Viton and compatible with the pumping system and service.

F. Injectors for Chemical Solutions: Injection nozzle body material shall be of PVC, PVDF, or 316 Stainless Steel as recomended by the manufacturer for the specific chemical application, or suitable diffuser tube inserted into pipeline through a corporation cock; constructed so that accidental breakage of discharge hose or tubing will not cause water to escape from pipeline and will allow disassembling of unit without leakage. Locations of chemical injections as indicated in construction drawings.

1. All quills shall be sourced from same manufacturer. Materials of construction may vary based on manufacturers reccomendation of material use per chemical application.

2. Seal material shall be certified by manufacturer to be compatible

3. Manufacturers:

a. Koflo Corporation: www.koflo.com

b. Cormon LTD: www.corrscience.com

c. Flowmotion Systems Inc: www.flowmotioninc.com

d. Hayward Industries, Inc: www.haywardflowcontrol.com

e. Substitutions: See Section016000-Product Requirements.

G.

2.7 CHEMICAL METERING PUMP CONTROLS

A. Provide controls required for specified sequence of operation.

1. Provide automatic controls unless specifically not permitted.
2. Provide manual controls for all systems.
3. Provide remote controls for all manual and automatic controls.
4. Coordinate controls with process control system and monitoring and control instrumentation.
5. If pumps selected for use on the skid systems are classified as Hose Pumps, provide controls as indicated below in B. Hose Pump Controls. If pumps selected for use on the skid systems are classified as peristaltic pumps, provide controls as indicated below in C.

B. Hose Pump Controls:

1. Each metering pump shall be provided with a back panel mounted controller (VFD) with integral LCD display.
2. The controller shall contain all required components and appurtenances for complete control and monitoring of the equipment over the entire pump range.
3. The controller interface shall include a security locking function using a PIN code.
4. Each controller shall be equipped with Local/Off/Remote (LOR) control selector on the face of the controller HMI.
    a. Local: In local mode, the speed of the pump shall be adjustable at the pump controller HMI.
    b. Stop: Motor off.
    c. Remote: The motor speed of the selected pump shall be controlled by a remote start/stop contact and a 4-20 mA pump speed signal.
        1) In Remote, the pumps are started and stopped based on the start/stop contact from the remote PLC.
        2) A 4-20 mA signal shall be provided to each pump controller to set the desired speed of the pump.
        3) A 20 mA signal will cause the motor to operate at 100% speed.
        4) A 4 mA signal cause the motor to stop (0% speed). The pump will not de-energize or turn off due to a 4 mA signal.
5. Pump settings and mode of operation shall not be affected by loss of power.
6. As a minimum the following statuses shall be indicated on the face of the control panel.
    a. Run indication.
    b. Power On indication.
    c. Forward or reverse
    d. Equipment failure indication.
7. The following outputs shall be provided from each metering pump VFD to the PLC.
    a. Running status - N.O. dry contact, closed on run.
    b. Fail status - N.O. dry contact, closed on fail (common alarm).
    c. In-remote/auto Mode – Digital output
8. The following analog signals shall be provided to each metering pump VFD from the PLC.

a. Metering Pump Speed Adjustment (4-20mA).

9. The metering pump shall provide a 4-20mA output signal for actual flow rate for remote monitoring.

10. Additional Functions, Current limit 5-150%, Timed Overload, Fault detection, high level switch input and RS485 (Modbus) communications

C. Peristaltic Pump Controls:

1. Manual Control Interface:

a. Display: Backlit graphical TFT Display capable of up to 8 lines of text with up to 26 characters per line to display pump tag number, flow rate, and programming instructions. Display shall also provide visual indication of running status via screen color: Blue = Running, White = Stopped and Red = Warning.

b. Keypad: Keypad for start, stop, speed increment, speed decrement, rapid prime, and programming.

c. Flow units: Programmable in either ml/min or gallons/hour.

d. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.

e. Auto Restart: feature to resume pump status in the event of power outage interruption.

f. Multilingual menu: include programming menus in nine languages, including at a minimum English, Spanish, and French.

g. Fluid level monitor: Programmable flow totalization to advise operator when their supply tank is low.

2. Remote Control I/O

a. Supply auto control features to meet the minimum functionality requirements for the use with Scada System. Pumps not meeting this minimum functionality will not be accepted

b. Speed Control Input: Analog 4-20mA speed input with 1,600:1 turndown with incremental steps of 10 microamps.

c. Run/Stop Input: Either 5-24V industrial logic, dry contact or powered 110 VAC contacts as shown per the process and instrumentation drawings.

d. HMI, analog connections, and mains power shall be accessible from the front or side of the enclosure.

2.8 INSTRUMENTATION

A. For each group of automatically operating equipment provide one control panel.

B. Control Panel: Mount instrumentation and control devices in enclosure as specified in Section 460500, mounted near equipment. Provide the following, at minimum, mounted on or in panel door:

1. On-Off-Alarm indication.

2. Cycle setting device.

2.9 CHEMICAL TANK SCALES

A. Manufacturers:

1. Force Flow Scales

2. Scaletron Industries, LTD

3. Engineer Approved Substitutions: See Section 016000-Product Requirements.

B. Provide tank scales for following chemical solution tanks. Scales shall be sized appropriately to accept the tanks.

1. Hydrofluorosilicic Acid Day Tank.

C. Scale shall be of the single load cell design with minimum measurement accuracy to 0.5% of load.

D. Four (4) adjustable hold down lugs shall be furnished on the platform to allow securing the vessel to the platform

E. Platform scale coating system shall be a minimum dry thickness of 80 mils and be resistant to moisture, chemicals, abrasion, impact and UV light.

F. Scale shall carry a Full Five (5) Year Factory Warranty.

G. Instrumentation and Controls

1. Housing shall be a NEMA 4X, UL approved enclosure.

2. Indicator shall display an alarm in any of the following conditions: Low level, high level, low feed rate, high feed rate, max daily use, min daily use, supply exhausted and load cell failure.

3. A data log shall store the daily usage amounts for each of the previous 31 days.

4. Display interface shall give operator the ability to monitor chemical by weight, volume or percent full.

2.10 CHEMICAL UNLOADER STATIONS AND ACCESSORIES

A. Manufacturers:

1. Tech Equipment

2. Engineer Approved Substitutions: See Section 016000-Product Requirements.

B. General:

1. The chemical unloading stations shall be completely self-contained and designed to safely unload chemicals as listed under Service Conditions. Each chemical unloader station shall include integral chemical unloading stand, upper housing with front door, stainless steel accessories, stainless steel hardware, and containment carboy as indicated in this specification and the contract drawings.

C. Chemical unloading stations shall be constructed from HDPE sheet or Co Polymer Polypropylene sheet stock with a minimum thickness of ½ inch. The design of the unloading station shall include gussets and supports as required for all components and shall be self-supporting. The unloading station shall be designed with a minimum of a 1" containment lip to contain spills. The chemical unloader station shall be manufactured using continuous welding technology; bolted construction is not acceptable.

D. The size & piping used for unloading the chemicals is to be provided and installed by the contractor inside the upper housing of the chemical unloader station. Piping sizing as indicated in Construction Drawings.

E. The chemical unloader station manufacturer shall be responsible for providing a 15 liter carboy that is plumbed from the drain in the bottom of the upper housing to the inlet of the carboy with the use of PVDF fittings, PTFE piping and stainless steel clamps.

F. The contractor shall be responsible for providing the hose connection fitting.

1. Hose connection fitting shall be made of a meterial compatible with all bulk stored chemicals: Sodium Hypochlorite, Aquamag, and Hydrofluorosilicic Acid.

2. Hose connection fitting shall be a 2" NPT female dry disconnect cam lock coupler with internal check system to prevent flow in the direction from the tanks out to the yard.

a. Basis of Design: Dixon Stainless Steel Dry Disconnect 2.5 inch Coupler x 2 inch Female NPT.

b. Contractor to coordinate with chemical delivery company to ensure hose connection fitting is compatible with chemical delivery hose.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and recommendations.

B. Chemical Feed Piping: Install so that piping can be conveniently and safely bled of trapped air and to minimize infiltration of air bubbles.

3.2 FIELD QUALITY CONTROL - PRIOR TO STARTUP

A. Tanks: Test for leaks using hydrostatic water pressure first, then with specified chemical.

1. Clean interior of tanks and dry prior to testing.
2. Hydrostatically test to 1.5 times system operating pressure, whichever is greater.
3. Test with relevant chemical solution for 24 hours.
4. Repair or replace damaged or leaking tanks.

B. Feed Systems: Demonstrate proper operation, without vibration or leakage, and required performance, using clean water for solution delivery systems and actual chemicals for slurry delivery systems.

1. Simulate chemical delivery without actual injection; provide temporary equipment as required for recirculation and/or capture of test liquids.
2. Operate in all control and operational modes, with pumps operated singly and in unison.
3. Operate at specified back pressure and test at maximum design flow rate and at half design flow rate.
4. Test at maximum design flow rate and at half design flow rate; record time, flow, and pumping pressure.
5. Use permanent calibration standpipes.

C. If demonstration or test results are unsatisfactory, adjust, modify, repair, or replace, and retest.

1. When new units are installed, restart testing from beginning.
2. Owner reserves the right to reject the furnished equipment if performance appears to be unachievable with furnished equipment.
3. Prior to retesting, obtain Owner's approval of retesting schedule.

D. Chemicals Used During Testing: If possible, store chemicals and release after Startup into processes without causing upset.

1. Otherwise, neutralize and/or reduce concentration sufficiently to allow safe disposal into sanitary sewer; obtain approval of regulatory authorities.
2. Acids and Bases: Neutralize to pH value between 6.5 and 9.5.
3. Chlorine: Concentration of not more than 1 percent (10,000 mg/L).

3.3 OWNER PERSONNEL TRAINING

A. See Section 460500 for additional requirements.

B. Operating Personnel Training:

1. Sessions: One.
2. Trainees: Two.
3. Training Hours: 1, minimum, for each different chemical feed system.

C. Maintenance Personnel Training:

1. Sessions: One.

2. Trainees: Two.
3. Training Hours: 1, minimum, for each different chemical feed system.

3.4 FIELD QUALITY CONTROL - AFTER STARTUP

A. In conjunction with testing of process control system, adjust feed controls to produce desired result; record sampling locations, measured characteristics, and control settings in Operation and Maintenance Manual.

B. Owner reserves the right to reject installed equipment if performance appears to be unachievable with installed equipment.

END OF SECTION

SECTION 464100 - MIXING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. In-line static mixers.

1.2 RELATED REQUIREMENTS

A. Section 460106 - Operation and Maintenance Manual.

B. Section 460500 - Common Work Results For Water and Wastewater Equipment: Requirements applicable to all equipment.

1.3 REFERENCE STANDARDS

1.4 SUBMITTALS

A. See Section 013000 - Administrative Requirements, and Section 460500 for submittal procedures.

B. Product Data: Manufacturer's technical literature, performance charts and curves, catalog cuts, weight, description of capacities, and installation instructions.

C. Shop Drawings - Static Mixers: Custom prepared drawings showing installation and anchorage details.

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Tag numbers of all equipment.

D. Manufacturer Qualification Statement.

E. Installer Qualification Statement.

F. Field Quality Control Reports.

G. Operation and Maintenance Data: See Section 460106.

H. Manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each equipment unit complies with the requirements of the Specifications and is intended generally for the installation applications shown.

I. Calculation sheets (input and output if using modeling software) that shows compliance with minimum velocity gradient under full range of operating conditions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Minimum of three years experience manufacturing products of the type specified.

2. Minimum of three similar systems installed, with documented evidence of satisfactory operation for each installation.

B. Installer Qualifications:

1. Minimum of three years experience in the installation of similar equipment.

2. Minimum of three similar systems installed, with documented evidence of satisfactory operation for each installation.

1.6 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 IN-LINE STATIC MIXERS

A. Manufacturers:

1. Koflo Corporation, www.koflo.com.
2. Volcrest - Flusion Fluid Equipment LLC, www.volcrest.com.
3. Komax Systems Inc., www.komax.com.
4. Substitutions: See Section 016000 - Product Requirements.

B. In-Line Static Mixers: Select mixer design and size to disperse added chemicals with a complete mix at all specified flow conditions, by utilizing flow division and radial mixing action.

1. The static mixer shall produce a uniform residence time distribution, such that all process fluids are exposed to the same mixing time. All effects of back mixing must be minimized to approach plug flow conditions. Static mixers utilizing baffles or tabs and back mixing are unacceptable. Stagnant flow pockets must not be present.
2. End Connections: Flanged ends compliant with ANSI B16.5 sized and oriented as required for piping in which installed.
3. The static mixer shall incorporate mixing elements that are solid, welded, one-piece construction. Internal fasteners, retaining bars, or pins will not be permitted. The mixing elements shall be retained within the mixer housing by welds at each end of the element assembly to minimize vibration at high linear flow velocities.
4. Identification: As specified in Section 460500 for equipment, plus direction of flow.
5. NSF Compliance: NSF 61.

C. In-Line Static Mixers (SM-2009, SM-2010, SM-2011): For mixing raw water chemical addition.

1. Design Flow at 2.5 MGD Plant Capacity: 609 Gallons Per Minute.
2. Design Flow at 5.0 MGD Plant Capacity: 916 Gallons Per Minute.
3. Minimum Flow: 500 Gallons Per Minute.
4. Maximum Flow: 1334 Gallons Per Minute.
5. Material: All parts of Type 316 stainless steel.
6. Connecting Pipe Size to Mixer: 8 Inches.
7. Number of Mixing Elements: 3, minimum
8. Length: 80 Inches, maximum.
9. Homogeneity of Final Mix: Coefficient of variation less than or equal to 0.05 at outlet.
10. Open area shall be a minimum of 95%.
11. Pressure Drop From Inlet to Outlet: 15 ft water column, maximum at maximum flowrate specified.
12. Injection Ports: Three 3/4" female NPT 316L stainless steel injection ports located radially at 0^{o}, 90^{o}, 270^{o} from top of mixer.
13. Sample Ports: One 3/4" female NPT Sample port located at the top of mixer, at least 1 pipe diameter doenstream from end of mixing elements.
14. Minimum of injection ports with 3/4" female NPT connection.
15. The static mixers shall be rated for a maximum pressure of 150 psig or greater at 68^{o}F.
16. The minimum velocity gradient for the static mixer will be 750 per seconds for all flows.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that pre-installed anchor bolts are in correct position. Do not start installation until anchorages are correct.

3.2 PREPARATION

A. Touch-up damaged metal coatings per manufacturers guidance to original condition before installation. See Section 460500 for additional requirements.

3.3 INSTALLATION

A. Refer to contract Drawings and shop drawings to coordinate and fit equipment accordingly. Place sleeves, bolts, and inserts as structure construction progresses.

B. Install in accordance with manufacturer's written instructions. Advise Engineer of any conflicts with manufacturer's written instructions and the contract documents.

C. Provide all necessary accessories for proper installation and operation of mixers.

3.4 FIELD QUALITY CONTROL - PRIOR TO STARTUP

A. Prior to startup, throughoughly clean equpment as necesary before initial operation. Utilize temporary strainers or other means to initially protect equipment from damage as a result of foreign matter entering through connected piping.

B. Demonstrate proper operation, alignment, flow distribution, and controls using temporary water supply.

3.5 OWNER PERSONNEL TRAINING

A. See Section 460500 for additional requirements.

3.6 FIELD QUALITY CONTROL - AFTER STARTUP

A. In conjunction with liquid chemical feed equipment demonstrations, verify adequate mixing by sampling.

B. If demonstrations or inspections are unsatisfactory, adjust, modify, repair, or replace, and retest.

1. Owner and Engineer reserves the right to reject the furnished equipment if performance appears to be unachievable with furnished equipment.

2. Prior to retesting, obtain Owner's approval of retesting schedule.

END OF SECTION

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SECTION 466100 – FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Design and supply a water treatment system consisting of pressurized ultrafiltration membrane filtration system and related equipment properly assembled to greatest extent possible to minimize onsite assembly by Contractor and to optimize shipping. System shall be capable of full integration and operation in water treatment plant which provides clean, safe drinking water to the Public.

B. Supply the equipment and services as specified in this Section 466100. Work items are generally described as follows with details in this Specification Section:

1. Filtration system designed to produce the net filtrate capacity to performance requirements.
2. Compressed air system including redundant compressors and air receivers.
3. Blower system including redundancy, if applicable.
4. Backwash system components consisting of pumps, valves, and accessories, as required.
5. Clean in place (CIP) and maintenance wash system components consisting of CIP recirculation pumps, valves, and accessories.
6. Integrity testing system components and related accessories.
7. Instrumentation, Operator Interface Terminal (OIT)/Human Machine Interface(HMI), and PLC-based control system to control and monitor the filtration system and all related systems which ensure filter operation and compliance as required by regulatory agency including, but not limited to, backwash system, integrity testing system, maintenance wash system, CIP system, flow meters, pneumatic valve actuators, and air-supply system. The instrumentation and control system shall be compatible and work seamlessly with overall plant instrumentation and control system. Aid Owner's Integrator in integrating membrane system control system with Owner's plant-wide instrumentation and control system.
8. Provide design assistance.
9. Provide installation guidance, startup, commissioning, and staff training services. Assist Owner during acceptance testing.
10. Provide electrical equipment such as, but not limited to, motors and starters pre-wired.
11. Provide sound enclosures at an eight-hour time-weighted-average sound level (TWA) of 72 dB(A) or better.

C. General Contractor Responsibilities for Membrane Filtration System:

1. Administer the Membrane System Supplier's Contract after assignment by the City of Buford.
2. Unloading and temporary storage, if necessary, of delivered equipment at a mutually agreed location. The storage facility shall meet the Membrane System Supplier's storage requirements.

3. Installation of all equipment provided by the Membrane System Supplier according to Supplier's instructions. Provide all access structures (scaffolding) and mechanical lifting equipment (cranes, forklifts and scissor lifts) for installation of membrane system.
4. Corrective assistance during field testing of the Membrane System.
5. Integration of the Membrane System Supplier's control system with the plant-wide instrumentation and control system.
6. Laboratory services during equipment check-out, startup, and testing.
7. Flushing and disinfection of all piping and disposal of membrane system preservative.
8. Supply and installation of all required oil and lubrication for equipment start-up and initial operations as per the manufacturer's literature for the specific piece of equipment.
9. Supply and installation of equipment anchor bolts for membrane system.
10. Field alignment of all pumps and blowers provided by the Membrane System Supplier.
11. Supply Chemical, Backwash, MW/CIP, and Neutralization tanks.

1.2 RELATED DOCUMENTS

A. General Provisions, General and Supplementary Conditions, and Specification Sections apply to this Section.

1.3 SUMMARY

A. This section includes the design, supply, start-up services, and testing of the membrane filtration system. The system will include membrane modules, valve racks (including piping integral to the valve racks and conduit, wire, cable, tubing and fasteners integral to the valve racks); backwash, maintenance wash, and CIP systems; valves and valve actuators; blowers as required per manufacturer; compressed air equipment; instrumentation devices, PLC, panels, and control software; cleaning and neutralization chemical dosing systems; automatic on-line integrity testing equipment; as necessary for a complete, working system.)

B. All materials and assembly shall meet Potable Water Industry Standards including NSF/ANSI Standard 61.

C. Supplier shall assume modules will be located in an indoor facility climate controlled to operating requirements.

1.4 DEFINITIONS

A. CIP: Clean-In-Place

B. CPI: Bureau of Labor Statistics North American Consumer Price Index

C. EPA: Environmental Protection Division

D. HMI: Human Machine Interface

E. I/O: Input/Output

F. LRV: Log Removal Value

G. MCC: Motor Control Center

H. MCP: Master Control Panel

I. MCS: Major Control System

J. Membrane Train: one set of membranes on a single frame working as a unit for purposes of cleaning or maintenance.

K. MIT: Membrane Integrity Test

L. OIT: Operator Interface Terminal

M. P&ID: Process and Instrumentation Diagram

N. PLC: Programmable Logic Controller

O. Process Water: Water which with treatment will become potable water.

P. TWA: time-weighted-average

Q. UPS: Uninterruptible Power Supply

R. UV: Ultra-violet

S. WTP: Water Treatment Plant

1.5 REFERENCES

A. NSF International (NSF).

B. National Fire Protection Association (NFPA) 70.

C. National Electrical Code (NEC).

D. American National Standards Institute (ANSI).

E. American Society for Testing and Materials (ASTM).

F. American Water Works Association (AWWA).

G. National Electrical Manufacturers Association (NEMA).

H. UL LLC (UL).

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Manufacturer's descriptive data and technical literature, catalog cuts, performance curves, equipment description, chemical resistance data for membrane system components, specifications, furnished specialties, accessories, and installation instructions.
2. Manufacturer's literature clearly marked to identify the applicable model number and any optional features.
3. Provide illustrations, specifications, dimensions, materials of construction, performance data, weights, pump curves, motor parameters, electrical details, and engineering data as applicable for all equipment and tailored specifically to that provided for this project. Provide specifications (including quantities for initial startup and routine operation) for all required oil and lubrication for equipment.
4. Process design calculations including design calculation for all major pieces of equipment, including but not limited to pumps, compressors, blowers, membrane system, backwash tank, neutralization tank, chemical feed systems, filtration skids, reject water, and controls including input and output signals. Provide storage and unloading requirements for all shipped equipment.
5. Special tools information.
6. Evidence of NSF approval for all equipment supplied, where applicable.

B. Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation: Detail drawings consisting of a complete list of equipment and materials containing complete wiring and schematic diagrams and any other details required demonstrating that the system has been coordinated and will properly function as a unit. Include plans, elevations, sections, details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Submit these drawings prior to construction and again as final "as-builts" at the completion of the project. Include the following:

1. General Arrangement Drawings showing dimensions, sizes, and weight of associated equipment and locations of connections and anchoring points.
2. Detailed Process Flow Diagram.
3. P&IDs including pipe and equipment sizes, materials of construction, flowrates, and anticipated pressure readings.
4. Single Line Diagram showing the major control system components and their physical interconnections, motor horsepower, required starter, breaker and fuse size, and/or supply voltage and peak demand current as appropriate for each equipment element provided.
5. Unit arrangement drawings including plan and elevation view of the membrane units identifying termination points, dimensions, and sizes of connection points.
6. Dimensional drawings and data including but not limited to weight, material of construction, safety features, anchoring points, level measurement information, air release, pressure information, and connection locations for tanks oriented per Engineer.
7. A Bill of Material for all tagged devices and components including the original part number identifying each piece of equipment. The Bill shall include at the minimum the original part number, the tag number of the equipment, the P&ID sheet number, the functional name, size, materials, ranges and other pertinent information for each piece of equipment.
8. Control panel schematic diagrams.

C. Delegated-Design Submittal: For membrane filtration system indicated to comply with performance requirements and design criteria, include engineering analysis and calculations data signed and sealed by the qualified professional engineer responsible for their preparation including the following:

1. Process calculations for all tank volumes.
2. Process calculations for piping systems.
3. Process calculations for air flow requirements.
4. Process calculations for membranes.
5. Process calculations for tank heating system.
6. Process calculations for dosing.
7. Process calculations for electrical requirements

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency:

1. Certification of membrane module testing conducted at the membrane manufacturing facility. Acceptable wet test methods include pressure hold test, bubble point test, or diffusive air test per EPA Membrane Filtration Guidance Manual.
2. Test and inspection reports of the membrane piping rack/skids and membrane rack/skids performed at the manufacturing or assembly facility.

B. Qualification Data: For Installer, manufacturer, testing agency, and service.

C. Field quality-control reports.

D. Review and provide comments for Minutes of design and preinstallation conferences as recorded by Engineer.

1.8 CLOSEOUT SUBMITTALS

A. Operations and Maintenance Manuals.

B. Final “as commissioned” PLC program files shall be submitted electronically to the Engineer in format required by Engineer.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer shall be acceptable to both Membrane Supplier and Engineer.

B. Manufacturer's Representative: A representative of the filtration system manufacturer, who is familiar with the design and experienced in the installation, adjustment, and operation of the equipment specified shall be present at the jobsite during the installation, startup, commissioning, and testing of the filtration system as specified.

C. The complete membrane filtration system will be provided by one Supplier having complete responsibility for the design and startup and commissioning of the system, including all specified ancillary equipment, to provide a complete operating system.

D. Service Qualifications: Supplier shall provide qualified service personnel capable of performing services in a professional manner in accordance with applicable laws and industry standards.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Shipment of membrane system to be coordinated with Engineer and Contractor. Agreed date of shipment must be confirmed in writing by Engineer.

B. Supplier is responsible for shipment with insurance and all associated costs to project site on agreed date.

C. Contractor will unload and store products on site in a manner that prevents damage according to Supplier's recommendations. Protect delivered equipment from the weather, UV, excessive humidity, excessive temperature variation, and dirt, dust, or other contaminants per Supplier's recommendation.

D. Supplier will mark each box to show its net weight in addition to its contents.

E. Schedule delivery of equipment supplied in this Section no greater than six months prior to projected Substantial Completion. No payment will be authorized for stored materials if delivery is made prior to this deadline.

1.11 WARRANTY

A. Mechanical Warranty: Supplier agrees to repair or replace mechanical components of filtration system that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: One (1) year from date of Substantial Completion.

B. Membrane Module Warranty: Supplier agrees to repair or replace, at the Supplier's expense, membrane modules that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. If the membrane module fails the standard integrity test and cannot be repaired.
b. If 0.3% of fibers in a module require pin repair in any twelve (12) month period or more than 0.9% of fibers, per module, require repair over the entire Membrane Module Warranty Period, the membrane module may be repaired or replaced under the terms of membrane module warranty. A pin repair event is defined as each occasion where a module is removed from the array and where one or more fibers must be pinned.

2. Warranty Period: Ten (10) years from date of Substantial Completion.

a. First two (2) years: If a membrane module shall require replacement, a replacement will be supplied by the Supplier at no charge. Supplier shall pay all shipping costs to original point of destination.

b. Subsequent eight (8) years: If a membrane module shall require replacement, a replacement will be supplied by the Supplier and invoiced based upon a pro-rated value of a total of ninety-six (96) months.
c. For any membrane module found to be defective during the pro-rated warranty period, the cost for replacement will be determined as follows. The pro-rated replacement cost to the Owner will be equal to the number of whole months elapsed between the membrane module replacement date and the warranty start date multiplied by the membrane module replacement price divided by the total membrane warranty duration in months.
d. Membrane modules replaced under warranty shall assume the remainder of the warranty for the membrane modules being replaced, with such warranty to be not less than a two (2) year full-replacement warranty from the date of replacement with a new membrane module.

3. Supplier shall repair or replace membrane modules within three (3) days from Notification by Owner.
4. Supplier is committed to continuous development of its filters and filter processes. Should membrane technology improve, for example via changes in the permeability or operating flux rates of the membranes, Supplier reserves the right to offer a suitable number of alternative membrane replacements during the Warranty Period and beyond.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Feed Water Quality: The proposed filtration system feed water quality is as follows:

Parameter	Units	Average	Minimum	Maximum
Alkalinity	mg/L	15	9	20
Color	HU	12	5	20
Hardness	mg/L	4.3	2.9	7.1
Iron	mg/L	0.09	0	1.4
Manganese	mg/L	0.02	0	0.2
pH	S.U.	7.0	6.0	9.0
Total Dissolved Solids	mg/L	41	20	70
Temperature	°C	20	8	35
Total Organic Carbon	mg/L	1.6	1	3
Turbidity	NTU	2.6	0	50
Suspended Solids	mg/L	6	0	10

B. Performance Requirements: Meet the performance requirements as follows:

1. Minimum Net Design Capacity (Firm Filtrate Net Capacity) with one train out of service at minimum temperature listed above: 2.5 MGD
2. Not-To-Exceed Maximum Instantaneous Flux at minimum temperature listed above: 55 gfd
3. Minimum Spare Module Spaces per Membrane Train: 35%
4. Each membrane train shall be designed to allow for a future capacity of 1.67 MGD Firm Filtrate Net Capacity at minimum temperature listed above. The 35% comprises at least

33% for future expansion capacity; additional spare spaces shall be 2% or 2 modules, whichever is greater.

5. Maximum Frequency of Maintenance Cleans: 1 per train per day
6. Maximum Duration of Maintenance Clean: 60 minutes
7. Maximum Frequency of CIP: 1 per 40 days per train per chemical.
8. Maximum Duration of CIP: 6 hours per chemical.
9. Minimum Frequency of Membrane Integrity Test: 1 per day per train.
10. Minimum Number of Trains Furnished Under Contract: 2 trains in service plus 1 spare train.
11. Stub out connections and space for future additional trains: 1 train.
12. Minimum recovery (ratio of firm filtrate flow over total feed flow): 95%.
13. The firm filtrate net capacity shall be based on the plant being available for operation 100% of the time.

C. Filtrate Water Quality: Filtrate water from the membrane system will be guaranteed to meet the following requirements:

Parameter	Units	Limit
Turbidity	NTU	≤ 0.1 NTU 95% of the time ≤ 0.3 NTU 100% of the time
Giardia and Cryptosporidium		≥ 4.0 LRV
Color, Hardness, Iron, Manganese, Total Dissolved Solids, Total Organic Carbon, pH	These parameters shall not degrade by the membrane system filtration process.	

2.2 PRETREATMENT

A. Pre-treatment chemicals dosage parameters from Supplier at average Feed Water Quality per Section 2.1 A:

1. Chlorination: Supplier to provide chlorination parameters, if applicable:

    a. Dosage in mg/L as Cl_2
    b. Residual requirement prior to membrane entry, as Cl_2:

        i. Maximum allowable,
        ii. Minimum,
        iii. Average.

2. Coagulant: Supplier to provide preferred coagulation parameters, if applicable:

    a. Name
    b. Strength
    c. Dosage in mg/L:

        i. Maximum allowable,
        ii. Minimum,

iii. Average.

d. Other defining parameters as needed

2.3 MEMBRANE FILTRATION UNITS

A. General: The filtration system shall be complete with membrane modules, piping, valves, and controls as required for a complete system.

B. Membrane Modules: Provide membrane modules with hollow fibers operating in an outside to in mode, sealed at both ends, and enclosed in a housing.

1. The fibers and all module parts shall be resistant to the cleaning chemicals including acid (down to pH 2.0) and chlorine. Chlorine cumulative resistance must be a minimum of 750,000 ppm-hours.
2. Each module shall be identifiable by a unique serial number identifying the location of production, module batch, and period of production.
3. Membrane pore size shall be consistent with pore size piloted.
4. Membrane modules and system components in contact with process water shall be NSF 61 certified.
5. The membrane fibers shall be encased in a UV-resistant plastic housing that is suitable for operating pressures up to 55 psig.
6. The modules will not require special lifting mechanisms for handling and will be able to be individually moved. The maximum acceptable weight for a dry membrane module is sixty-six (66) pounds, and no more than one hundred (100) pounds wet.
7. The membrane modules or membrane module rack shall be configured to attach to the valve rack as follows:

    a. Having no more than two (2) rows of modules.
    b. Membranes can be pinned in place; maximum time for membrane train to be out of service for pinning shall not exceed ten (10) minutes.
    c. Modules must have a clear section of pipe on the feed/reject to each module that makes it possible to see air bubbles or Supplier shall provide sonic device to identify leaks.

8. Provide isolation valves for each membrane module or the option for a flange plate (blind flange) so module may be isolated and removed from service.

C. Frame: Membrane modules will either be installed on a rack (to be supplied by the Supplier, fully assembled with rack frame, pipes, valves, instrumentation, and other appurtenances) or be self-supporting that can be anchored to a concrete foundation.

D. System Integrity: Provide equipment to verify the integrity of the membrane modules in accordance with the Pressure Decay Test method described in US EPA Membrane Guidance Manual.

1. Provide equipment to perform integrity test on each train while other trains remain in operation. Include a means to identify which module does not meet integrity requirements.

2. The integrity test shall be initiated automatically by the control system at a frequency determined by the operator. Manual initiation of the integrity test shall also be possible from the Operator Interface Terminal (OIT).
3. Once initiated, the inside of the membrane fibers shall be pressurized to the appropriate test pressure for the module. The pressure is recorded and the pressure decay rate is calculated and displayed on the OIT. The air-pressure hold test must be set up to allow correlation of the test result with a log removal value (LRV) using the calculation method developed in the US EPA Membrane Guidance Manual.
4. When the integrity of the membrane system falls below a log removal value of 4.2, a warning alarm will be generated on the OIT and the operator will be prompted to start the air leak test to identify the source of integrity decay. Shutdown alarm will occur if the LRV falls below a value of 4.0.
5. Furnish all equipment, tools, and programming for a complete integrity test system including means to repair the membrane modules when necessary.

2.4 PIPING AND SUPPORTS

A. All piping located on each skid with unique termination points located at the edge of each skid for the following services: feed, filtrate, CIP feed solution, CIP return filtrate, CIP return feed, backwash drain, manual drain, filtrate exhaust, process air, control air, and air scour.

1. Termination points for pipes greater than 2 inches: Flange connections.
2. Termination points for pipes 2 inches or less: Threaded fittings.

B. Piping material:

1. Chemical cleaning supply or recirculation piping: Schedule 80 CPVC, HDPE, providing that operating pressure never exceed 30 psig during the cleaning process, or 316 Stainless Steel.
2. Headers, permeate, feed, reject, CIP, air piping, and compressed air: Schedule 10 316 Stainless Steel.
3. Pneumatic control air: nylon tubing.

C. Slope air piping approximately 1:100 toward point of drain and provide drip legs at low points of air piping provided.

D. Support piping, valves, fittings, and appurtenances to manufacturer requirements and to allow for longevity of the system and system components.

E. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

F. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of fiberglass-reinforced resin.

a. Flammability: ASTM D635, ASTM E84, UL 94.

2. Hanger Rod and Fittings: Continuous thread rod, washer, and nuts made of stainless steel.

G. All pipe hangers, supports, fasteners, and appurtenances shall be made of a material that prevents corrosion in the water treatment environment.

2.5 VALVE RACK

A. The valve rack contains valves and instrumentation required for the membrane train to cycle through production, backwash, chemical cleans, membrane integrity tests, and, if provided, excess recirculation.

B. Provide fully skidded valve racks, one per membrane train.

C. Frame: Provide a single frame to support all piping, valving, instrumentation, and other appurtenances.

1. The membrane filtration skid shall be shop assembled to the greatest extent possible.
2. Provide a frame that can be anchored to a concrete foundation with anchor bolts.
3. General Contractor to provide 304 stainless steel anchor bolts, expansion anchors, or epoxy anchors for anchoring frame to concrete foundation. Supplier to provide design requirements and recommendation for anchors.
4. The surface finish shall be coated per Supplier recommendation and with Engineer's written approval. Surface finish shall be compatible with all process chemicals, process water, and process environment.

D. Design valve bodies, trims, seats, and packing to be capable of continuous 24-hour operation and rated for the operating line pressure and temperature.

E. Actuators:

1. Use actuators capable of shutting off the associated valve against the specified upstream and downstream pressures.
2. Size quarter-turn and multi-turn actuators for a torque which is greater than that required to operate the valve at any point, including the torque required to fully open a valve from the fully closed position. Actuators shall have a minimum safety factor of 1.5.

F. Valve racks must be shipped to site fully assembled and wired and must meet the following requirements:

1. Can be offloaded either by hoist or forklift.
2. Piping should be securely fastened to frame to prevent any lateral movement.

G. Electrical Panel

1. Factory-wire the remote I/O electrical panel mounted on the valve rack.
2. Provide a disconnect switch mounted on the outside of the panel to be used by the operator to lock a train out of service for electrical maintenance without impacting the other trains' abilities to run (does not impact the Ethernet communication).

3. The Contractor will provide no more than the following electrical connections to the valve rack that are needed for each membrane train:

    a. 120 Volt, single (1) phase power to the Remote I/O panel
    b. Ethernet connection from the Master Control Panel

H. Solenoid Valve Bank

1. All solenoid valves required to drive air actuated valves for the valve rack will be housed in a common skid mounted solenoid valve bank located on the valve rack. Each solenoid valve will have the ability to adjust the speed of exhaust directly on the valve bank.

I. Accessories: Provide the pneumatic tubing for all valves located in the membrane trains.

J. Cross-Connection Control

1. Design the membrane process with cross-connection control to assure that cleaning solutions used as part of the Maintenance Wash or Clean-In-Place processes do not come in contact with feed or filtrate.
2. Any cleaning process, other than backwashing, must use a cross-connection control strategy. Cross-connection control shall be automated.
3. The cross-connection control strategy shall isolate the individual membrane trains from the membrane train during the Maintenance Wash or Clean-In-Place process.
4. Provide Cross-connection control consisting of the following to create an air gap in the process line:

    a. One (1) isolation valve located on the valve rack.
    b. One (1) block valve located off the valve rack on the interconnect pipe.
    c. One (1) bleed valve located off the valve rack on the interconnect pipe.

5. Cross-connection control shall be used on the following lines, at a minimum: CIP, feed and filtrate.
6. The block and bleed valves shall be wired to the remote I/O panel mounted on the valve rack. The control of the entire cross-connection control system shall function through the membrane system PLC.

2.6 VALVES

A. Design valve bodies, trims, seats, and packing to be capable of continuous 24-hour operation and rated for the operating line pressure and temperature.

B. General Valve Requirements

1. Where there is an applicable recommended standard for the design, construction, and testing of a valve and/or actuator, i.e. AWWA, CGA, CSA, NSF 61 Potable Water System Components etc., equipment to be supplied under this section will refer to this standard and the equipment supplied shall comply in all respects. Where specifically requested, provide certificates of compliance with the applicable standards.

2. All valves shall have the name of the manufacturer, pressure rating and the nominal size of the valve on the body or bonnet or shown on a permanently attached plate in die-stamped letters.
3. All flanged valves shall have flanges as specified for the line into which they are to be installed. As a minimum standard a Class 150 rating will be required.
4. Equip the valve with a disc position indicator and a direction of flow indicator where applicable.
5. Size actuator to provide adequate torque based on service and pressure differential. Follow AWWA C-540 in determining the required torque for AWWA valves.
6. Limit the allowable pull on a manual operator to open or close the valve to less than or equal to 60 lb force. Operate manual operators in a clockwise motion to close the valve.
7. The actuators shall be complete with a handwheel and lockable lever for bypass handwheel engagement.

C. Butterfly Valves:

1. Standard: CE/PED Certification, SIL Certification, ABS Certification, Bureau Veritas Certification, DNV.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Bray International
    b. Keystone
    c. Or Engineer approved equal

3. Body Material: Cast iron per ASTM A126 or ductile iron
4. Disc: 316 Stainless Steel
5. Stem: 416, 304, or 316 stainless steel
6. Seat: NBR or EPDM
7. Connection: Flanged per ANSI B16.1, Class 125
8. The valve body shall be protected by a polyester coating for corrosion protection.
9. Provide a lockable handle for all manually operated valves.
10. Provide a gear operator for all automatically operated valves.
11. Automatic valves shall be equipped with a double acting pneumatic actuator with limit switches where determined to be required. Actuators shall be selected for a minimum air pressure supply of 80 psig.
12. Pneumatic positioners shall be furnished for valve modulation services. Valves with pneumatic positioners do not require pilot solenoids installed on the valve body.
13. All butterfly valves must be by the same manufacturer.

D. Ball Valves: Provide pneumatically actuated and manual ball valves on the membrane skid.

1. Water Service Valves:

a. Standard: CAS CGA 3.16-M88, NACE MR0175
b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Apollo
2) CFF
3) Hayward
4) Or Engineer approved Equal

c. Body Design: 3-piece body
d. Body Material: Stainless Steel
e. Port: Full
f. Ends: Threaded
g. Lockable handle
h. Minimum pressure rating of 1000 psi WOG.

2. Air Service Valves:

a. Body: 3-piece
b. Body Material: Stainless Steel
c. Port: Full
d. Ends: Threaded
e. Lockable handle
f. Minimum pressure rating of 1000 psi WOG

3. CPVC Union Ball Valves:

a. Standard: ASTM D1784, ANSI.
b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) George Fischer
2) Spears
3) Or Engineer approved equal.

c. Pressure Rating: 150 psig at 73 deg F.
d. Body Material: CPVC.
e. Body Design: Union type.
f. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
g. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, flanged.
h. Ball: CPVC; full port.
i. Seals: PTFE.
j. Handle: Tee shaped.

4. Automatic ball valve shall have double acting pneumatic actuators with limit switches, where determined to be required. Actuators shall be selected for a minimum air pressure supply at 60 psig.
5. Provide one manual sample valve/point on each skid for the following services: feed and filtrate.

6. When necessary, quick disconnect, shut off valves shall be used for air service. Shut off valves shall be full port, gray acetal construction with a long handle to operate a ¼ turn on/off action.

E. Check Valves: Class 125, Iron, Single-Plate, Swing Check Valves with Resilient Seat.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Bray International
   b. Or Engineer approved equal

2. NPS 2-1/2 to NPS 12, CWP Rating: minimum 200 psig.
3. NPS 14 to NPS 24, CWP Rating: minimum 150 psig.
4. Body Design: Clear, full flow waterway.
5. Body Material: ASTM A 126, gray iron or ductile iron with bolted bonnet.
6. Ends: Flanged.
7. Disc: Stainless Steel.
8. Gasket: Asbestos free.
9. Shaft: stainless steel.
10. Coating: Rubber lining or NSF approved epoxy coating on interior
11. External position indicator with proximity switches for closed position.
12. External spring and lever operator

F. Diaphragm Valves:

1. Chemical feed system: CPVC bodies, full port with threaded or true union ends
2. CIP and neutralization systems: CPVC bodies, with true union ends

G. System Valves and Instrumentation:

1. Provide pressure gauge with isolation hand valve on the suction and on the discharge of each backwash and CIP pump.
2. Provide isolation valve both upstream and downstream of each backwash and CIP pump, if applicable.
3. Provide check valve on the discharge of each backwash and CIP pump, if applicable.
4. Provide CIP isolation valve on each train.
5. Provide isolation valve on each backwash line.
6. Provide isolation valve for each of the following items on the permeate line: pressure transmitter, turbidity analyzer, and controller.
7. Provide isolation valve on each membrane aeration line.
8. Provide pressure transmitter with hand isolation valve on each MIT line.
9. Provide pressure transmitter with hand isolation valve on each air scour line, if using compressed air for air scour.
10. Provide actuated isolation valves on the feed and permeated line of each train.
11. Provide actuated valve on each backwash tank, CIP tank, and neutralization tank line, if applicable.
12. Provide actuated valve on each CIP waste line.
13. Provide actuated valve on each backwash feed line.
14. Provide actuated valve on each backwash waste line.
15. Provide drain valve for each membrane train.

16. Provide actuated valves for each air scour line.
17. Provide actuated valve for each MIT line.
18. Provide isolation valves on each MIT line.
19. Provide isolation valves on each air scour line.
20. Provide flow meter on each membrane train feed line.

2.7 BACKWASH SYSTEM

A. Furnish cleaning equipment to create a complete, integral, and automatic membrane cleaning system designed to restore and maintain performance by reducing membrane fouling.

B. Design the backwash system to clean the membrane modules in place without requiring their disconnection from the membrane block or array. The backwash system shall be connected to all skids and shall be designed to clean one skid at a time while the other skids remain in normal operation.

C. Backwash Pump: Provide a minimum of one duty and one standby end suction, centrifugal pump sized for the maximum train cleaning demand with all module spaces on a train filled. Meet the following design criteria:

   a. Control: VFD or motor starters.
   b. Wetted Parts: stainless steel or ductile iron.
   c. Impeller: 316 stainless steel.
   d. Seal: single mechanical seal.
   e. Motor: 460 Volt, three-phase electric motor, totally enclosed fan cooled (TEFC), class B temperature rise, class F insulation, normal starting torque.

D. Backwash System Valves and Instrumentation:

   1. Backwash flow meter with automation signals.
   2. Automatic valving that allows the backwash tank contents to be directed to a membrane train for cleaning.
   3. 120 Volt, single phase power.

E. Backwash Tank: Provide backwash tank sizing requirements for a tank that will serve the purpose of a permeate storage tank for cleaning. Meet the following criteria:

   1. Furnish a level detector and transmitter with local display and hand isolation valve; to be 120 Volt, single phase power.
   2. The tank must be sufficiently sized to hold sufficient cleaning solution for a membrane train, taking into account the volume for membranes with all membrane spaces filled and the interconnecting piping, plus a 20% safety factor.

2.8 MAINTENANCE WASH AND CLEAN-IN-PLACE SYSTEM

A. Furnish chemical cleaning equipment to create a complete, integral and automatic membrane cleaning system designed to restore and maintain performance by reducing or controlling the transmembrane pressure.

B. Design the MW/CIP system to clean the membrane modules in place without requiring their disconnection from the membrane block or array. The MW/CIP system shall be connected to all skids and shall be designed to clean one skid at a time while the other skids remain in normal operation.

C. MW/CIP Pump: Provide a minimum of one duty and one standby end suction, centrifugal pump sized for the maximum train cleaning demand with all module spaces on a train filled. Meet the following design criteria:

a. Control: VFD or motor starters.
b. Wetted Parts: 316 stainless steel.
c. Impeller: 316 stainless steel.
d. Seal: single mechanical seal.
e. Motor: 460 Volt, three-phase electric motor, totally enclosed fan cooled (TEFC), class B temperature rise, class F insulation, normal starting torque.

D. MW/CIP System Valves and Instrumentation:

1. MW/CIP flow meter with automation signals made of a material compatible with cleaning chemicals.
2. MW/CIP waste line flow meter with automation signals made of a material compatible with cleaning chemicals.
3. Temperature sensor and transmitter with local display and hand isolation valve.
4. Automatic valving that allows the MW/CIP tank contents to be directed for heating, chemical mixing, neutralization, or to a membrane train for cleaning.
5. 120 Volt, single phase power.

E. MW/CIP Tank: Provide MW/CIP tank sizing requirements for a tank that will serve the purpose of a permeate storage tank for cleaning. Meet the following criteria:

1. Furnish a level detector and transmitter with local display and hand isolation valve; to be 120 Volt, single phase power.
2. The tank must be sufficiently sized to hold sufficient cleaning solution for a membrane train, taking into account the volume for membranes with all membrane spaces filled and the interconnecting piping, plus a 20% safety factor.

F. MW/CIP Neutralization Requirements: Neutralization of the MW/CIP waste chemical is required prior to discharge to the waste lagoons. All waste streams must be dechlorinated and pH adjusted according to the following requirements.

Parameters	Unit	Discharge Limitations
pH	S.U.	6.0 – 8.5
Total Residual Chlorine	mg/L	0.5 mg/L

G. MW/CIP Neutralization Tank: If the membrane system control does not allow for neutralization of chemical waste, provide MW/CIP neutralization tank sizing requirements for a separate tank that will serve the purpose of a pH adjustment and/or dechlorination for wastewater after chemical cleaning.

1. Furnish a level sensor and transmitter with local display and hand isolation valve; to be 120 Volt, single phase power.
2. The tank must be sufficiently sized to hold wastewater from one CIP and one maintenance wash, taking into account the volume for membranes with all membrane spaces filled and the interconnecting piping, plus a 20% safety factor.

H. CIP Heater: Include a three-phase electrical in-line or in-tank heater suitable for the heating of the chemical cleaning solution to the required heated cleaning temperature, in 5 hours or less, at the minimum feed water temperature specified.

1. Provide a heater with protections to avoid overheating the solution and damaging piping, membranes or tanks. These must include:

a. Low flow switch with hard wired interlock to ensure water is always flowing across the heater.
b. High temperature switch with hard wired interlock.
c. If the heater is in-line, it must be installed in a S10 316SS pipe.
d. If the heater is in contact with cleaning solution, it must be of a titanium alloy construction, to avoid corrosion. Ideally, the heater will not come in contact with cleaning solution, in which case it's acceptable for the heater to be of 316SS construction.
e. An automated drain valve to ensure heater is dry whenever not in operation in order to prevent corrosion.
f. Temperature sensor and transmitter with local display and hand isolation valve.
g. Include a 480 Volt, 3-phase in-line heater or 480 Volt, 3-phase in-tank heater
h. Provided device to turn heater on and off.

I. Neutralization and pH Instrument Panel: Provide a neutralization and pH instrument panel used to ensure pH of the cleaning solution is at the set pH for optimal cleaning performance, and to ensure the neutralized cleaning solution is at an acceptable pH. Ship panel to site fully assembled. Include the following equipment:

1. In line chlorine sensor, complete with display, capable of measuring 5 ppm or less of free chlorine, and tolerant of up to 200 ppm of chlorine.
2. If the sensor's accuracy is impacted by high chlorine levels, it must be fed by a sample line isolated by a solenoid valve.
3. In line pH sensor meter to measure pH of cleaning solution throughout the clean.
4. Flush line to ensure both sensors are in contact with water during MW/CIP downtime.
5. Panel is to be 120 Volt, single phase power.

J. Chemical Injection Assemblies: Provide chemical injection assemblies for each chemical used in chemical cleaning and neutralization of chemical waste.

1. Each injection assembly must include the following equipment, to ensure predictable, consistent chemical dosing, and to avoid accidental mixing of inappropriate chemicals:

a. Injection quill, if required
b. Hand valve
c. Pneumatically actuated valve
d. Back pressure valve

K. Chemical Dosing Pump Conditions: Chemical dosing pumps for membrane system cleaning and neutralization of chemical waste will be supplied by others. Membrane System Supplier is to provide chemical dosing pump requirements including flow rate, total head, shutoff conditions, any flow pace requirements, and required chemical concentration at location prior to injection quill.

L. Chemical Dosing Requirements: Membrane System Supplier is to provide chemical dosing parameters for all chemical cleans, neutralization, and dechlorination as required by the membrane filtration system. For Maintenance Wash, assume at average Feed Water Quality per Section 2.1 A.

a. Name
b. Concentration
c. Dosage in mg/L:

i. Maximum allowable,
ii. Minimum,
iii. Average.

d. Other defining parameters as needed.

2.9 AIR SYSTEM

A. Provide a system design sufficiently sized so that ample supply of compressed air is available for the processes and the pneumatically controlled valves with one air compressor permanently out of service. Provide a minimum of one duty and one standby air compressor.

B. Air system should provide the plant with additional compressed air for intermittent use of tool operation and cleaning: 10 cfm at 90 psi.

C. Provide a compressed air system that includes compressors, dryers (one duty and one standby), outlet filter, supply air filter assemblies, air receivers, process air regulators, control panels for both plant air and membrane process air, air intake/silencer, discharge silencer/check valve, motor starters, and instrumentation and control panels. Ancillary equipment including pressure relief valves, isolation valves, discharge pressure gauges, and other related appurtenances to produce, deliver, monitor, and control a complete process and pneumatically actuated valve control system should also be provided.

D. Alternately: Provide a minimum of one duty and one standby air blowers used to air scour the membranes during backwash and provide the above described air system for pneumatic valve control and plant air. Each blower shall be controlled by 480 Volt, 3-Phase variable frequency drive (VFD) manufactured by Allen-Bradley.

2.10 INSTRUMENTATION & CONTROL SYSTEM

A. Electrical control system: a single programmable logic controller (PLC) with distributed I/O over Ethernet. The PLC CPU and Ethernet communication modules will be located in the Master Control Panel (MCP), shipped loose, to be mounted in a temperature controlled electrical room. The Human-Machine Interface (HMI) or operator interface terminal (OIT) will

be located on the door of the MCP. Ethernet connections to the Supplier's MCP and other communication nodes is by the Contractor. The MCP will also provide terminations for all non-train equipment, such as, but not limited to, chemical equipment, air compressors, blowers, CIP, MW, and Backwash equipment, and any loose shipped equipment supplied by the Supplier.

B. Control System: The control system shall be designed based on a distributed I/O architecture. The control system shall be based around Allen Bradley Control Logix platform of PLC, or approved equal. The control system shall include the following equipment:

1. One Master Control Panel (MCP). The MCP PLC executes all control functions required for the operation of the filtration system. The MCP PLC receives data from the local I/O distributed throughout the filtration system via Profibus DP, Control Net, Ethernet communications link, or approved equal, as appropriate. The MCP PLC shall include a minimum of 15% spare I/O for future use. Power integrity shall be furnished via Uninterruptible Power Supply (UPS) supplied by others.
2. Provide a Remote Access Server (RAS modem) for external system maintenance and support access. The RAS modem will allow for dial up capability to the communications network.
3. The MCP will include a 15" color touch screen OIT mounted in the door of the enclosure. The OIT will provide a graphical interface to the membrane filtration system process. Historical logging in a CSV format will be native to the OIT. Logged historical data is to be stored via a USB memory stick, memory card, or network drive. The terminal will communicate via an Ethernet connection to the PLC. The terminal will be an Allen Bradley PanelView Plus or Engineer approved equal.
4. The MCP will include a five-port industrial Ethernet switch to facilitate communication between the PLC, OIT, RAS modem, and to the plant-wide control network as required. The switch will be DIN rail mounted, and be 24VDC powered.
5. Local remote I/O panels shall be rated NEMA 4X and secured to the valve rack frame. The local I/O shall be Allen-Bradley FLEX (1794) IO. The remote I/O shall communicate via Ethernet.

C. Overview of Control Strategy: Systems will operate to maintain a pressure set point in the feed to each membrane train by varying the speed of the feed pump. Individual unit flow shall be maintained regardless of TMP via a PID loop monitoring unit flow and pressure and by varying the feed pump speed to each membrane train. The dedicated feed pump, strainer, and mixer may change based on manual valve selection. Operator will be able to select feed pump and strainer to use with each membrane train.

1. When the TMP has reached 90% of the maximum TMP, the system will automatically request a chemical clean to the control system. In response, the PLC will allocate the cleaning resources to the requesting unit if available. The PLC will then initiate the CIP preparation sequence, including filling the CIP tank(s), prompting the operator to switch the CIP heater on through the OIT/HMI. When the cleaning temperature is reached, the PLC will prompt the operator to initiate the CIP through the OIT/HMI.
2. All automatic sequences such as backwash, membrane integrity test, and maintenance wash are initiated by the MCP PLC with minimal operator intervention. If a loss of power occurs during any of these sequences (including CIP), the control system will automatically resume operation in the current or first safe step (i.e. complete the CIP or backwash sequence automatically).
3. The backwash cycle and/or maintenance wash cycle can be initiated automatically based on a timer or a rise in TMP or drop in membrane permeability. The backwash cycle

and/or maintenance wash cycle can also be triggered by the operator changeable setpoints or manually by operator.

4. The membrane integrity test (MIT) shall be initiated at a frequency determined by the operator to comply with local regulations. The MIT can also be initiated manually by operator changeable setpoints. The MIT results are logged and archived for review and reporting by the operator. If the filtration system integrity level falls below the required log removal values, alarms shall be generated on the OIT/HMI and at the plant-wide instrumentation and control system. Integrity is managed by way of isolating modules as needed and periodic repair conducted on a yearly basis whenever is convenient.
5. Supplier shall work with Owner and Engineer to include system communication between Supplier provided controls and overall plant-wide instrumentation and control system.
6. Historical filtration system operational data shall be logged and archived for review by the operator.
7. PLC shall control the membrane feed pumps.
8. PLC shall control the strainers.

D. Instrumentation: The skids shall be set up to have all control instrumentation mounted on the skid frame.

E. Programming: Provide all programming of the Master Process Control Panel PLC and operator interface terminal, as to deliver a functional membrane system. Provide all I/O configuring and scaling required for the membrane system.

F. The PLC shall be compatible for communication and integration with the Water Treatment Plant-wide instrumentation and control system. The panels shall comply with NEC and be UL 508A listed as an assembly.

G. Base the control architecture on a programmable logic controller located in the master process control panel with distributed I/O to control the membrane skids. Provide controls for all elements scope supplied. Provide all instrumentation required to control and monitor the operation of the filtration system. Provide all PLC and OIT/HMI programming for all supplied equipment. Supply all software updates to control, monitor, and operate the filtration system.

H. The membrane system controls shall not be fully controlled by the Plant SCADA system.

I. Membrane system PLC should include necessary signal and control connections for the following equipment and instrumentation which will be supplied by the Contractor:

1. One (1) common feed water turbidimeter.
2. One (1) filtrate turbidimeter per membrane train.
3. One (1) pressure transmitter downstream of each membrane system feed pump, minimum of four (4) total.
4. One (1) pressure transmitter before each membrane train.
5. Two (2) level transmitters in clearwells.
6. Chemical dosing pumps for MW/CIP and neutralization chemicals.
7. Membrane feed pumps.
8. Strainers.
9. Up to four (4) additional transmitters to be determined during design phase.

2.11 ELECTRICAL

A. All work shall be done in accordance with the requirements of the National Electrical Code, NFPA #70, Latest Edition and all local and state codes.

B. All electrical items covered by this specification shall be U.L. labeled and listed for the purpose.

C. Junction Boxes

1. Junction boxes to facilitate field wiring will only be supplied for skid or panel-mounted equipment where it is possible to group numerous electrical connections together in order to minimize field installation.
2. Design, supply, and installation of all other junction boxes will be by the Contractor.
3. NEMA 4X, Stainless steel.

D. Electrical Panel Wiring

1. All wiring within the control panel will conform to the following standards, at a minimum:

    a. All conductors shall be copper and have 600 Volt rated insulation.
    b. Control circuit and instrument wires will be a minimum of 18AWG (max 7 Amps) Type MTW construction B, or TFFN for UL or type TEWN for CSA.
    c. Power circuits (branch and feeder circuits) and bonding conductors will be a minimum of 14 AWG (max 15 Amps) Type THWN-2 or THHN/THWN for UL or type T90 Nylon for CSA.
    d. Wiring of all the I/O to and from the control panels to devices on the Valve Racks will be by Supplier in accordance with wiring diagrams.
    e. Control panels will be designed primarily to accommodate field wiring entering from the bottom of the enclosure.

E. Field Device Wiring

1. Factory Field device wiring within the boundaries of the membrane skids conforms to NFPA 70 National Electrical Code.

    a. All conductors shall be copper and have 600 Volt rated insulation.
    b. Wire sizes and types will be as follows:

1) Control circuit and instrument wires will be a minimum of 18AWG (max 7 Amps) Type MTW construction B, or TFFN for UL or type TEWN for CSA.
2) Control circuits will be 16 AWG Type TFFN for NFPA70 or Type TEWN for CSA for overprotection current not more than 6 amps.
3) Control circuits as well as protected equipment grounding and bonding conductors will be 14 AWG Type THWN-2 or TFFN/THWN for NFPA70 or Type T-90 Nylon for CSA for overprotection current not more than 10 amps.

2. Instrument Cables are generally shielded multiconductor type with 300 Volt insulation minimum and will be certified to conform to one of the following standards:

   a. UL 13 Power-Limited Circuit Cables (UL CCN: QPTZ)
   b. UL 444 Communications Cables (UL CCN: DUZX, same as CSA C22.2 No. 214)
   c. UL 2250 Instrumentation Tray Cable (UL CCN: NYTT
   d. CSA C22.2 No. 239 Control and instrumentation cables

3. Low voltage multiconductor cables to field devices within the membrane skids boundary are routed in a central cable tray internal to the skid.
4. Field devices within the membrane skids boundary requiring 120VAC power are wired using liquid-tight flexible conduit.
5. Wiring of all the field-mounted instrumentation I/O to and from the membrane filtration system panels will be by the Contractor in accordance with wiring diagrams provided by the Supplier.

2.12 SPECIAL TOOLS

A. Furnish all special tools required for routine operation of the filtration system. Special tools include but are not limited to the following:

1. Hand tools used for module isolation and removal.
2. Membrane repair tools for repair of the membrane modules.
3. Sonic analyzer or means to identify the source of integrity breach.
4. Calibration devices.
5. Instruments required for operation, calibration, and maintenance of the equipment.

PART 3 - EXECUTION

3.1 DESIGN ASSISTANCE

A. Provide assistance to the Engineer during the design of the project. Design assistance will include the following:

1. Design Conferences:

   a. Conduct Preliminary Conference within seven (7) days of Effective Date of Agreement. Allow minimum of two hours per design conference.

b. Conduct design review conference within twenty-one (21) days of Effective Date of Agreement and following initial submittal receipt by Engineer. Allow minimum of two hours per design conference.
c. Attend one design review meeting at the Engineer's office within forty-two (42) days of Effective Date of Agreement and following the 99% design submittal, including the following personnel at a minimum, and will be responsible for all associated costs for travel, lodging, meals, etc. for personnel. Design meetings are eight-hour days.

1) Project Manager
2) Project Designer/Engineer
3) Process Engineer

d. Conduct one additional design review conference at Engineer’s request. Allow minimum of two hours per design conference.

e. Conduct a minimum of two design coordination conferences at Engineer’s request following final design submittal. Allow minimum of two hours per design conference.
f. Attend one Engineer’s design review meeting at the Engineer's office at Engineer’s request, including the following personnel at a minimum, and will be responsible for all associated costs for travel, lodging, meals, etc. for personnel. Design meetings are eight-hour days.

1) Project Manager
2) Project Designer/Engineer
3) Process Engineer

g. Require representatives of each entity directly concerned with membrane filtration units to attend and participate.
h. Conferences may be conducted by virtual conferencing methods including both audio and visual. All conference attendees are required to attend and fully participate using both audio and visual.

2. Provide the detailed drawings described in these Specifications, in AutoCAD 2020 format.
3. Review Engineer’s design details and examine procedures for ensuring quality of membrane filtration design.

3.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference prior to shipment and scheduled with Engineer and Contractor.

1. Require representatives of each entity directly concerned with membrane filtration units to attend.
2. Review construction details and examine procedures for ensuring quality of membrane filtration installation.
3. Allow minimum of two hours per preinstallation conference.

3.3 DELIVERY

A. Supplier shall have personnel on site at the time of equipment delivery or deliveries to verify the acceptance and satisfactory condition of the equipment provided to the Owner.

B. Supplier will include for travel time to and from the job site for Supplier's Field Service personnel. Travel/living expenses will also be included by the Supplier.

C. Supplier will assume an 8-hr on-site workday per day and no weekends or holidays are required."

3.4 STARTUP & TRAINING

A. Supplier will provide field support, operator training, startup, commissioning, and testing.

B. Supplier will provide timeframe necessary with a minimum of twenty-nine (29) days of on-site services as specified below, allocated across the specific number of trips to site included.

# Trips	Mini-mum Days	General Scope of Work / Description
1	2	Pre-start-up Inspection Visit: Supplier will provide time to inspect installation work, address questions, assist Contractor in development of punch list of completion items necessary prior to return visit, and provide guidance in assembling the membrane racks.
2	21	System commissioning including: - Electrical and mechanical checkouts - Membrane installation verification - Controls testing including integration - Process start-up
1	3	Operator Training: Supplier will provide formal training to the operators
1	3	Acceptance Test: Supplier will provide technical advisory services in support of set-up of and witness of the first 72 hours / 3 days of the Acceptance Test without intervention beyond normal operational activities.
Total = 5	Total = 29	Supplier will include for travel time to and from the job site for Supplier's Field Service personnel. Travel/living expenses will be also included by the Supplier. Supplier will assume an 8-hr on-site workday per day and no weekends or holidays are required. Engineer will provide the Supplier a minimum of two weeks advance notice to schedule all trips to site.

3.5 FIELD TESTING

A. Acceptance testing shall not begin until all pre-acceptance testing requirements have been completed including, but not limited to pressure/leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests and disinfection.

1. Pre-requisites: Acceptance testing shall not begin until after final approval of the O&M manuals and submittal of a plan for the acceptance testing of the equipment no later than fourteen days prior to the day the test is scheduled to begin.
2. Acceptance testing is designed to demonstrate the proper operation of all equipment and train the Owner's staff to the operation of the filtration system. During acceptance testing, at least one train shall be operated at nominal flow to demonstrate the system complies with the water quality objectives as well as with the cleaning interval set forth in this specification.
3. The acceptance testing shall be conducted during a minimum period of fourteen days. During the first 72 hours/3 days of the acceptance test, the Supplier's representative will be present on-site to monitor the test and to provide assistance with corrective actions. The Owner will afford Supplier full access to the system and to all operating data pertaining to system performance until the successful completion of the test. The Supplier's representative will be knowledgeable with the equipment and systems and will be expected to effectively interface with the general contractor, the Engineer and Owner during troubleshooting activities (electrical, I&C, SCADA, mechanical) that may arise during the test. The Supplier's representative will also provide for the correction of any defects in Supplier's equipment or systems. The Owner will furnish the power and chemicals required for normal operation of the filtration system during the acceptance testing period.
4. During the Acceptance Test the system will demonstrate the performance criteria per the production capacity specified and permeate water quality specified. The proposed performance criteria will be met on a daily basis calculated as an arithmetic mean of values over a 24-hour period (midnight to midnight).
5. The Acceptance test shall be deemed successful if units operate continuously for the full duration of the test at design flow without requiring a CIP. Interruption of operation not attributable to the Supplier (power outage, absence of feed water, etc.) will not cause the Acceptance Test to be re-started. The Owner will bear the cost of additional expenses incurred by the Supplier due to these interruptions.
6. Supplier will bear the cost of additional expenses incurred for incomplete or failed acceptance testing and retests not otherwise described in this section.

3.6 CONTINUAL SUPPORT

A. Following Substantial Completion, the Supplier shall provide the following services. The cost of these services is to be included as a separate line item on the Membrane Filtration System Form.

1. Monitoring of Membrane Performance: Operating information shall be transmitted to the Supplier for ongoing monitoring of the membrane filtration system performance. The Supplier shall maintain continual data logging for performance monitoring, support, and warranty maintenance purposes. The Supplier shall provide recommendations for operation and maintenance on an as-needed basis, with monthly reports (minimum) during the first two (2) years of membrane system operation. Reports shall include performance curves and recommendations for operational improvements.
2. Site Visits: The Supplier shall provide the following visits per year by a factory representative (not including sales representatives) to the project site to ensure that the membrane system is properly operated and maintained.

    a. One (1) visit per year for the duration of the membrane warranty (ten (10) years).

b. Each visit is to include three (3) days on-site.
c. During the site visits, the Supplier's factory representative will, in conjunction with the Buyer's priorities:

1) Assist in cleaning the membranes, if necessary.
2) Provide follow-up training to plant personnel.
3) Inspect the membranes.
4) Review operation and maintenance data.
5) Provide summary report of findings and recommendations.

3. Emergency Support Services – Telephone Assistance: The Supplier shall provide 24-hour per day, seven-day per week telephone support for two (2) years for troubleshooting assistance by technical support specialists.

END OF SECTION 466100

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SECTION 466173 - AUTOMATIC STRAINING EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes Automatic Self-Cleaning Strainers for water treatment, including electric motor, control panel, instrumentation, and anchor bolts.

B. Related Requirements:

1. Section 460506 - Water Treatment Piping for connection to pipes.
2. Section 460106 - Operating and Maintenance Manual
3. Section 460500 - Common Work Results for Water and Wastewater Equipment
4. Section 460923 - Monitoring and Control Instrumentation
5. Section 460916 - Control Valves

1.3 COORDINATION

A. Coordinate installation with pipe installation. Deliver items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. See Section 013000 - Administrative Requirements for Submittal Procedures.

B. Product Data: For each type of product.

1. Description of capacities, performance, operation, and applied forces to foundation.
2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Installation methods.
5. Manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each equipment unit complies with the requirements of the Specifications and is intended generally for the installation applications shown.
6. Calculation sheets (input and output if using modeling software).

C. Shop Drawings showing general arrangement and installation details of each main equipment unit and each separately installed accessory, including the location and nature of each service and utility connection. Shop drawings will also include:

1. Plans, elevations, sections, mounting, and attachment details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Tag numbers of all equipment
4. Detail fabrication and assembly of automatic self-cleaning strainers.

1.5 INFORMATIONAL SUBMITTALS

A. Submit manufacturer’s literature including standard plans, performance data, parts list, installation instructions, and operations and maintenance procedures.

1.6 QUALITY ASSURANCE

A. Furnish equipment produced by firms generally recognized as engaged in the manufacture of equipment suitable for the applications of the Project, as determined by the Engineer and which have a minimum of ten (10) years’ experience in the production of equipment

proposed for this Project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver strainers cartoned or crated where necessary to provide protection during transit and job storage.

B. Store equipment in location and manner which protects against dust, moisture, and physical damage.

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

E. Do not under any circumstances store equipment in contact with ground surface.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For automatic self-cleaning strainers include in emergency, operation, and maintenance manuals.

1. See Section 460106 - Operation and Maintenance Manual.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Fluid Engineering, Inc.
2. Amiad Corporation
3. Eaton Corporation, Inc.
4. Acme Engineering Products, Inc.

B. Spare Parts: As recommended by the manufacturer for two (2) years of operation.

C. One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

2.2 GENERAL

A. Do not use strainers which require significant control or electrical design modifications.

B. Vendors furnishing strainers are required to satisfy themselves as to the suitability of their equipment to function properly and dependably as an element in the specific system of which they are a part. The act of furnishing the equipment is interpreted to mean that the vendor recommends their equipment for the specific application, and guarantees its proper functioning as a system element.

C. Furnish complete strainers including all related accessories and components, not otherwise specified, which are necessary for proper and dependable equipment functioning.

D. ASME Compliance:

1. ASME B16.1 for iron flanges.
2. ASME B16.5 for steel flanges.

E. NSF Compliance: NSF 61

2.3 AUTOMATIC SELF-CLEANING STRAINER

A. Furnish complete automatic self-cleaning strainers consisting generally of a housing, mesh strainer element, backwash assembly, drive motor, backwash outlet to drain, pressure indicators, control panel systems, and anchorage with the purpose of filtering out debris and suspended solids from the water stream to protect downstream membrane filtration.

1. Backwash cleaning should not interrupt process flow.

B. Refer to accompanying Drawings for general arrangement requirements and dimensional limitations.

C. Design Requirements:

a.

Number of Strainers to be installed	Three (3), Two Duty, One Standby
Process Fluid	Raw Water (for drinking water purposes)
Suspended Solids Average	2 mg/L
Minimum Flow, Each	500 GPM
Maximum Flow, Each	1,340 GPM
Maximum Clean Screen Pressure Loss at Maximum Flow	2 PSIG
Water Temperature (F)	40 – 80
Mesh Opening Size	500 Microns
Backwash Control Options	Auto intermittent (timer or pressure switch) or Continuous
Backwash Flow	Not to exceed 5% of total flow
Motor	1/2 HP max
Electrical Power (each)	120/3/60
Pipe Inlet, Outlet Diameter Size	8 inch
Minimum Screen Open Area	3 times area of connecting pipe
Strainer Backwash Connection Size	Minimum 1.5 inches diameter

D. Cleaning Mechanism: Provide motor and gear driven rotating cleaning arm or blade that allows periodic cleaning and flushing of debris based on pressure loss without interrupting process stream flow through the unit. Provide motor operated automatic backwash discharge valve to control discharge of wastewater.

E. Gear Reducer: Furnish gear reducers of the helical or spiral bevel gear type sized for a minimum service factor of 2.0 times the drive motor nameplate horsepower rating in accordance with applicable American Gear Manufacturers Association (AGMA) standards. Use drive gears of quality not less than AGMA No. 10, designed for at least 100,000 continuous hours operation when transmitting the full motor nameplate horsepower, and which under full load produce noise levels no greater than the lesser of (a) current OSHA Occupational Noise Standards, or (b) AGMA Standard 297.01, Sound For Enclosed Helical, Herringbone and Spiral Bevel Gear Drives. Provide gear reducer bearings of the antifriction type, having a minimum AFBMA B-10 life of 100,000 hours when operating continuously at design speed and full motor nameplate horsepower, except provide a minimum life of 300,000 hours for the output shaft bearings.

1. Select gear reducer housings constructed of high quality, close-grained cast iron or fabricated steel, stress relieved and reinforced, and equipped with lifting attachment provision. Use housing arrangement to accommodate either horizontal or vertical input shafts directly connected to the electric motor drive through flexible couplings, and incorporating vertical downward output shaft. Provide assemblies suitable for unprotected outdoor environment.

2. For each gear reducer, utilize a lubrication system suitable for all weather starting that incorporates an internally driven, integral mechanical oil circulating pump or efficient oil splash mechanism, which also incorporates an oil reservoir for instant lubrication of gears on starting. Utilize an effective grease lubricated dry-well system to positively prevent oil leakage down the output shaft. Provide oil drain and fill lines at easily accessible locations, and arranged to permit flushing of the drive interior bottom housing during oil changes. Include easily accessible grease fittings for grease lubricated bearings. For splash type lubrication systems, equip the housing with an oil level sight glass and oil flow indicator to observe oil levels while the unit is in operation.

F. Drive Motor: Furnish totally enclosed fan cooled motors rated at 40 C ambient with Class F non-hygroscopic insulation, and having a service factor of 1.15 and maximum 1800 rpm speed. Conform with applicable NEMA standards. Provide motors having a minimum B-10 bearing life of 30,000 hours. Use motor and gear reducer assembly such that motor does not operate above the nominal nameplate rating under any operating condition. Equip motors with gasketed, water-tight conduit boxes which prevent moisture from entering the stator through the conduit box. Provide amply sized lubrication reservoirs, and conveniently arranged relubrication fittings.

G. Material Requirements:

1. Housing: Cast Iron or fabricated steel with a minimum working pressure rating of 150 psig.
2. Straining Element and Cleaning Mechanism: 304 or 316 Stainless Steel

H. Accessories:

1. Pressure gauges and isolation valves on inlet and outlet pipe connections.
2. Sequence Controller Control Package
    a. PLC Control Panel with HMI capable of interfacing with onsite SCADA system.
        1) Strainer to have a 90 second delay before entering backwash state to allow control valve movement, see Specification 460916 for Control Valve information.
    b. Step down transformer and circuit breaker to supply power to devices.
    c. NEMA 4X Enclosure
    d. Backwash Valve with Electric Actuator
    e. Adjustable Differential Pressure Switch
    f. Local Start/Reset Button
    g. Remote Start/Stop
    h. System Fault Alarms
        1) Dry Contact
        2) Differential Pressure
    i. Adjustable Timed Interval and Backwash Durations
    j. Counters and Average Flush Interval

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate delivery of anchoring devices to project site to avoid delaying progress.

3.2 INSTALLATION

A. Refer to contract Drawings and shop drawings, and coordinate and fit equipment accordingly. Place sleeves, bolts, and inserts as structure construction progresses.

B. Install equipment in accordance with manufacturer's written recommendations. Advise Engineer of any conflict between Contract Documents and recommendations of manufacturer, before commencing installation.

C. Provide all necessary accessories for proper installation and operation of mixers.

D. Effectively protect mixers from damage and accelerated wear or deterioration during Project construction and until final Project acceptance.

E. Protect equipment against damage from freezing.

3.3 INITIAL OPERATION

A. Thoroughly clean equipment and related systems as necessary before attempting initial operation. In addition, use temporary strainers or other means to initially protect equipment from damage resulting from foreign matter entering through connecting piping.

B. Place all equipment in service, and monitor operation until proper and reliable functioning is fully demonstrated. For all but the simplest equipment items, initially operate equipment under supervision of vendor's service technician.

C. Establish that all related safety devices, including but not limited to safety valves, limit switches, moving machinery guards and handrails, are in place and working properly before leaving any equipment in operation.

D. Before leaving any equipment in service, comprehensively brief the Owner and Engineer regarding its operation and maintenance.

E. In the event any equipment unit, system or component fails to meet specified requirements or proves to be unreliable in service, make all necessary changes required to correct such deficiencies. Should the equipment unit remain unable to reliably meet specified requirements, remove the unit and replace it with equipment that does reliably meet specified requirements.

3.4 FIELD QUALITY CONTROL

A. Field testing shall be performed after installation of the equipment. The field testing shall demonstrate the following:

1. The equipment has been properly installed in accordance with manufacturer’s instructions and recommendations.

2. The equipment has been installed in the specified location and orientation or as shown on the Contract Drawings.

3. There are not physical defects in any of the parts.

END OF SECTION

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EXHIBIT A

PRE-PURCHASED EQUIPMENT
MEMBRANE FILTRATION SYSTEM
CONTRACT AND PROCUREMENT DOCUMENTS
BUFORD WATER WORKS REPLACEMENT

For The

CITY OF BUFORD, GEORGIA

April, 14 2021

Prepared by
KECK & WOOD, INC.
3090 Premiere Parkway, Suite 200
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TABLE OF CONTENTS

proposal to supply a ZeeWeed membrane filtration system for the City of Buford, Georgia water treatment plant replacement

SUEZ proposal no. 241527 CONTRACTOR BID PROPOSAL

submitted to:
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2300 Buford Highway
Buford, Georgia 30518

submitted by:

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October 21, 2020

SUEZ Water Technologies & Solutions

The following are trademarks of SUEZ Water Technologies & Solutions and may be registered in one or more countries:

InSight, RMS (Rackless Modular System), ZeeWeed, and ZENON.

table of contents

1 commercial notes

1.1 system price

Pricing shall be as outlined on the Bid Forms in the Contract Documents.

Please note that the presented pricing does not include provision for any procurement restrictions imposed on Seller by Buyer's funding parties. Should these restrictions be required, such as "Buy America", Seller reserves the right to adjust the pricing herein upon review of the restrictions.

1.2 price validity

Pricing is based upon receipt of a Notice to Proceed (NTP) for Manufacturing/Equipment Procurement being provided by **January 5, 2021**. In the event the NTP for Manufacturing/Equipment Procurement is not received before this date, the equipment and service prices contained herein will be subject to adjustment for any increase in the North American Consumer Price Index (CPI) + 1.0%. This adjustment will be from the end of the proposal validity date to the date of the NTP for Manufacturing/Equipment Procurement is received.

If a formal NTP for Manufacturing/Equipment Procurement is not received and accepted within three (3) months of the NTP date referenced above, Seller will be afforded the right to review and adjust the scope of supply, pricing and delivery schedule offered herein.

1.3 payment terms

Upon approved credit from the Buyer, payment terms will be as outlined in Article 7 of the Agreement and article SC-10.01 of the Supplementary Conditions for Procurement Contracts (see **appendix a** of this proposal). In summary:

- ❑ 10% of the Contract Price for Manufacturing of Goods upon submission of Final Design Submittal to the General Contractor;
- ❑ 65% of the Contract Price for Manufacturing of Goods after receipt of the Goods has been acknowledged;
- ❑ 25% of the Contract Price for Manufacturing of Goods after installation of Goods has been acknowledged;
- ❑ 100% of the Contract Price for Start-Up and Training upon completion of Start-Up and Training;
- ❑ 100% of the Contract Price for Field Testing upon completion of the Acceptance Test;
- ❑ 100% of the Contract Price for Allowance of Spare Parts upon Buyer's selection of spare parts.

All payments are subject to a 10% holdback.

1.4 proposed project schedule

The following is a summary of key dates. If a formal Notice to Proceed (NTP) for Manufacturing/Equipment Procurement is not approved within the Validity Period of this proposal, the delivery schedule is subject to review and adjustment.

Seller's equipment delivery schedule is as follows:

- Seller: submits Final Design Submittal to General Contractor – **within 30 days from assignment of Contract**;
- Buyer: issues NTP for Manufacturing/Equipment Procurement – **no later than January 5, 2021**;
- Buyer and Seller: conduct Preinstallation Conference Call – **prior to shipment of equipment**;
- Seller: shipment of equipment – **18 to 22 weeks from NTP for Manufacturing/Procurement of Equipment (partial shipments allowed);**
- Seller: start of Startup and Training of the membrane system;
- Buyer and Seller: start of Acceptance Test;
- Seller: Operation & Maintenance Manuals - **complete no later than the end of the Acceptance Test**;
- Buyer and Seller: Substantial Completion of the membrane system – **estimate 24 months from assignment of Contract**.

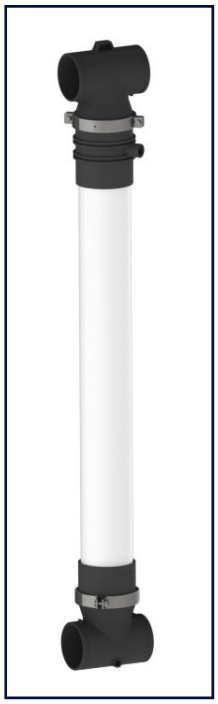
1.5 terms and conditions

Seller has prepared this proposal based on the Terms and Conditions included with the Procurement Proposal Package, found in **appendix a** of this proposal.

2 technical description

2.1 description of the proposed membrane system

The ultrafiltration membrane system proposed for the City of Buford Water Treatment Plant Replacement project consists of three (3) trains of ZeeWeed 1500 membranes to produce a maximum daily net capacity of 2.5 MGD when operating at 95% recovery, at a design temperature of ≥ 8°C, with all trains in service. The plant is designed to achieve a daily net capacity of 2.5 MGD under the same conditions, with one (1) train off-line for maintenance clean, recovery clean or membrane integrity test.



ZeeWeed 1500 RMS module

The membrane system has been sized and designed to be easily upgradable to achieve a daily net capacity of 5.0 MGD with one (1) train offline, via the addition of modules to the initial three (3) membrane trains and the addition of a fourth (4th) membrane train.

Each membrane train contains 46 installed modules, with a total of 64 module spaces available in each train. Of the 18 spare module spaces, 16 will be used for future plant expansion, and the remaining 2 module spaces are spare, as per the requirements of the Procurement Proposal Package.

The proposed water treatment system will treat raw water from Lake Lanier. The raw water is drawn from Lake Lanier and sent to a pre-settling pond. The turbidity of the pre-settled water is measured using a turbidimeter (supplied by others), then the pre-settled water will be dosed with chlorine (and coagulant – if required). The pretreated feed water is pumped using feed pumps (by others) (one (1) dedicated feed pump per membrane train, with VFD control), through the pre-screens (by others) (one (1) dedicated pre-screen per membrane train), and then to the membrane trains.

Each membrane train has a pre-assembled valve rack supplied by SUEZ. The valve rack will connect to the membranes such that each train only has two (2) rows of modules as required in the Procurement Proposal Package. SUEZ has made a slight modification its standard valve rack in order to meet the requirement that each train shall have no more than two (2) rows of modules. This will allow for full accessibility of the modules for the plant operators.

The membrane modules are self-supporting and modular in nature. The modules contain the membrane fibers. The pretreated feed water is pumped into the bottom of the module, pressurizing the water through the pores of the membrane. Clean water (permeate) passes into the permeate cavity of the module. This is known as an “outside-in” flow path. Particles that are bigger than the pore size of the membrane are rejected by the membrane and remain on the feed side of the module.

A dedicated turbidimeter will be supplied, by others, per membrane train, to measure the turbidity of the treated water before it is discharged to the clearwells.

Under normal operation, the membrane trains will automatically cycle between permeation mode and backwash mode. The treated water used for the backwash procedure is collected in the backpulse tank (backpulse tank supplied by others). A backpulse pump is used to draw the water from the backpulse tank and pump it to the inside of the membrane fibers ("inside-out" flow path), then air is injected to scour the fibers to remove solids through agitation. Two (2) backpulse pumps are supplied; one (1) duty and one (1) stand-by. The air used for the backwash procedure is supplied from the SUEZ-supplied blowers. Two (2) blowers are supplied; one (1) duty and one (1) stand-by. These dedicated blowers will allow for precise air volumes delivered to the membranes in each train initially, and in the future. Blowers offer lower energy use compared to using air compressors for this purpose, especially with the ancillary equipment needing to be sized for the future and spare space in each membrane train.

All cleaning activities are automated. Maintenance cleans can be scheduled and fully automated, or can be operator initiated. The membrane trains will return to permeation mode automatically at the completion of the clean. The recovery cleans (also known as Clean-in-Place or CIP) are operator-initiated and are also fully automated.

The treated water used for the maintenance clean and recovery clean procedures is taken from the CIP tank (CIP tank supplied by others) The CIP system is equipped with an in-line heater to heat the stored water (permeate) before the beginning of a recovery clean. A CIP pump is used to transfer the water from the CIP tank to the membrane train. Two (2) CIP pumps are supplied; one (1) duty and one (1) stand-by. Cleaning chemicals are dosed automatically using chemical dosing pumps (chemical dosing pumps supplied by others). Neutralization of the used cleaning chemical solution at the end of the chemical clean will be performed using the CIP tank and CIP pump. Neutralization chemicals are dosed automatically using chemical dosing pumps (chemical dosing pumps supplied by others).

The membrane system includes the ability to perform direct membrane integrity testing (MIT) using a pressure decay testing (PDT) method. The MIT is programmed to occur once per day, per membrane train. The air required for the pressure decay test is provided by an air compressor. One (1) duty and one (1) stand-by air compressor and one (1) duty and one (1) stand-by air drier are supplied, each mounted on a 240 gallon horizontal air receiver tank.

All automatic valves on the membrane system are pneumatically actuated. The supplied air compressors provide air for the pneumatically actuated valves.

SUEZ's systems incorporate a high level of automation to enable easy and operator- friendly plant operations. The system also includes a high level of operator overrides and manual operational capability. This combination provides a highly flexible operating system. The control system looks after all operating sequences and routine operations (such as maintenance cleans and membrane integrity tests) so operators are free to monitor and provide value added services. Schedules are easy to understand and can be modified at the HMI by the operator.

The system design summary is depicted in the following table. The proposed system meets the performance requirements listed in the Procurement Proposal Package:

system parameters	
type of membrane	ZeeWeed 1500
membrane area per module	600 ft^2
total number of membrane trains to produce 2.5 MGD (net)	3
number of installed modules per train	46/64 (2 wide x 23 long installed)

number of spare module spaces per train - total area increase available per train = 18/46 = 39% - total area available for expansion = 16/46 = 35% - total spare module spaces after expansion = 2	18 (2 wide x 8 long future) (2 wide x 1 long spare)
instantaneous flux with all three (3) membrane trains in operation to produce 2.5 MGD (net) at 95% recovery	33.2 gfd
instantaneous flux with one (1) train out of service – system producing 2.5 MGD (net) at 95% recovery	51.9 gfd
maintenance clean (MC) protocol	1/day/train using 250 mg/L NaOCl MCs are not heated
membrane integrity test protocol	1/day/train
recovery clean (RC) protocol	9/year/train 500 mg/L NaOCl with NaOH for pH adjustment to 11 followed by 2 g/L citric acid with mineral acid for pH adjustment to 2.1 RC solutions are heated prior to each clean

2.2 scope of supply by SUEZ

The SUEZ equipment included for the supply of the City of Buford Water Treatment Plant Replacement project is listed in the following SUEZ documents:

- ❑ Process Flow Diagram (PFD)
- ❑ Piping & Instrumentation Diagrams (P&IDs)
- ❑ General Arrangement Drawings (GAs)
- ❑ Valve Lists
- ❑ Equipment List
- ❑ Instrument List
- ❑ Cutsheets
- ❑ Single Line Diagram
- ❑ I/O List
- ❑ Network Architecture
- ❑ Load List
- ❑ Panel Drawings
- ❑ Control Documentation
- ❑ Additional Contractor Information Documentation

Note that the P&IDs define SUEZ's scope of supply and that provided by the General Contractor or Owner (by others). In case of conflict, the P&IDs take precedence for SUEZ supplied equipment and devices. On the P&IDs, items within SUEZ's scope of supply are shown as solid, and items not included in SUEZ's scope of supply are shown dotted.

Piping shown as dotted are to be furnished by the General Contractor (by others). The sizes of all pipes are depicted on the P&IDs. Valves are typically the same size as the pipe on which they are located.

Other items included in SUEZ's scope of supply but not shown on the P&IDs include:

- ❑ allowance for spare parts
- ❑ special tools – see table below
- ❑ all supplied equipment delivered to project site
- ❑ preinstallation meetings, delivery visits, startup and training, and field testing – see **section 3 – services**
- ❑ continual support – see **section 3 - services**
- ❑ operation & maintenance manuals
- ❑ one (1) year mechanical warranty – see **section 4 - warranty**
- ❑ ten (10) year membrane module warranty – see **section 4 - warranty**

special tools

As per the Procurement Proposal Package, the following special tools are included in the Contract Price:

quantity	description
1	ZeeWeed 1500 membrane repair kit
2	flange plates (used to blank off an individual module)
2	slings (for transporting modules during installation and repair)

2.3 scope of supply by others

All delivery or services not specified in the Seller's scope of supply are included in the Buyer's scope of supply.

safety and environmental

- ❑ first aid, emergency medical response, eyewash and safety showers in the water treatment area. Chemical spill response, security and fire protection systems per local codes.
- ❑ environmental use and discharge permits for all chemicals at the Buyer's facility either listed in this document or proposed for use at a later date
- ❑ any special permits required for Seller's or Buyer's employees to perform work related to the water treatment system at the facility. All site testing, including soil, ground and surface water, and air emissions, etc.

- ❑ disposal of all solid and liquid waste from Seller's system including waste materials generated during construction, startup and operation
- ❑ provide appropriate protection of the environment and local community, the health and safety of all workers and visitors at the site and the security of the facility. Provide safety related equipment and services such as site security, fire systems, lifting equipment and its operation, fall protection, adequate floor grating, ventilation, and safe access to equipment and electrical systems areas.
- ❑ equipment and trained support personnel for any confined space entry required during equipment installation/startup/commissioning/servicing. For permit-required confined space entry, a qualified rescue team on stand-by and available to respond within four (4) minutes of an emergency.
- ❑ the Buyer will identify and inform Seller's personnel of any hazards present in the work place that could impact the delivery of Seller's scope of supply and agrees to work with Seller to remove, monitor, and control the hazards to a practical level
- ❑ the Buyer will provide training to Seller's personnel on all relevant and standard company operating procedures and practices for performing work on site. Such training programs may include, but are not limited to, general environmental health & safety (EHS), HAZOP, fire protection, drug testing, incident notice, site conduct, standard first aid, chemical receiving, electrical safety, etc. Buyer will provide a certificate of training for Seller's personnel. This program will be fully documented, training materials will be provided, and attendance list will be kept.

jobsite and installation review

- ❑ review of Seller's supplied equipment drawings and specifications
- ❑ all easements, licenses and permits required by governmental or regulatory authorities in connection with the supply, erection and operation of the system
- ❑ overall plant design, detail drawings of all termination points where Seller's equipment or materials tie into equipment or materials supplied by others
- ❑ all applicable civil design and works, including any building, site preparation, grading, excavations, piping supports, structural steel, foundations and trenches and accessories. For ergonomic design, Seller assumes that the bottom of free-standing equipment will not be elevated (by any combination of leveling devices and housekeeping pads) to more than 6 inches above the floor adjacent to the equipment.
- ❑ design, supply and installation of panel boards, transformers, and other equipment as necessary to provide power distribution to the membrane system
- ❑ all electrical labor and supplies including fittings, conduit, supports, cable trays, wire and hardware, and air-conditioning of panels as required for installation and ongoing operations
- ❑ all labor and supplies including fittings, conduit, supports, cable trays, wire and hardware, required to appropriately ground / earth the equipment as required for installation and ongoing operations

- ❑ all mechanical labor and supplies including interconnecting piping, heat tracing (if required), fittings, conduit, pipe supports, structural steel, and hardware as required for installation and ongoing operations
- ❑ connection spools between the valve rack and RMS modules
- ❑ all tubing for automatic pneumatic valves not installed on the valve racks, including but not limited to; air/sample line tubing, fittings, conduit, supports, isolating valves as required for installation and ongoing operations
- ❑ design, supply and installation of all floor drains
- ❑ loading, unloading and transportation of the equipment and materials required for Seller to perform the duties outlined in the Seller's scope of supply to the jobsite and/or warehouse
- ❑ the Buyer will provide all access structures (scaffolding) and mechanical lifting equipment (cranes, forklifts and scissor lifts)
- ❑ providing a suitable site/shelter for the placement of the proposed equipment, either inside appropriate housing, or outdoors. Note: electrical equipment including the PLC may require air-conditioned rooms to prevent overheating of sensitive electronic equipment depending on climatic conditions.
- ❑ storage of UF modules on site must meet SUEZ's requirements. These must be stored in a sheltered area, protected from freezing, direct sunlight or extreme heat, and sealed as shipped until ready for use. Storage should be in a dark, dry, level area, out of direct sunlight and at a temperature of 5-30°C (39-86°F).
- ❑ supply and installation of a common feed water turbidimeter to measure the turbidity of the pre-settled water upstream of the pre-treatment system
- ❑ design, supply and installation of pre-treatment system as per Seller's recommendations
- ❑ design, supply and installation of membrane system feed pumps including appurtenances such as isolation valves, pressure gauges and pressure transmitter, one (1) dedicated feed pump per membrane train, as per Seller's recommendations
- ❑ design, supply and installation of membrane system pre-screens including appurtenances such as isolation and/or drain valves, differential pressure transmitters and pressure transmitter, one (1) dedicated pre-screen per membrane train, as per Seller's recommendations
- ❑ supply and installation of one (1) permeate turbidimeter per membrane train
- ❑ design, supply and installation of the backpulse tank, as per Seller's recommendations
- ❑ design, supply and installation of the CIP tank, as per Seller's recommendations
- ❑ day and/or bulk chemical storage and tanks, including secondary containment in accordance with local codes
- ❑ design, supply and installation of chemical dosing systems for maintenance clean, recovery clean and neutralization chemicals per Seller's recommendations

- ❑ the Buyer will receive, off-load, log, and store all chemical and materials in accordance with Manufacturer's recommendation that are shipped to the site
- ❑ supply and installation of all equipment anchor bolts, based on design by Seller
- ❑ any on-site painting or touch-up painting of equipment supplied
- ❑ flushing and disposal of membrane preservative
- ❑ Variable Frequency Drives (VFD) and Motor Control Centre (MCC) for all Seller's equipment

start-up and commissioning

- ❑ installation and removal of temporary screens (0.5 mm mesh or punch hole) on all process lines feeding the membrane system to prevent membrane damage if permanent screens not in place during start-up and commissioning
- ❑ flushing and disinfection of all piping and tanks (including process equipment tanks) and verification of removal of all residual debris from construction
- ❑ alignments and required materials for rotating equipment
- ❑ MEG testing of all field motor power wiring (as required)
- ❑ continuity checks for all electrical field wiring per installation checklist
- ❑ hydro-testing of all field installed piping
- ❑ supply of all chemicals (pre-treatment chemicals and chemicals used for the cleaning of the membrane modules) during start-up, commissioning and acceptance testing of the membrane system
- ❑ supply raw materials, oils/lubricants chemicals and utilities during start-up and operation
- ❑ supply of telephone/modem access while Seller's staff members are on-site
- ❑ laboratory services, operating and maintenance personnel during equipment checkout, start-up and operation
- ❑ electrical and mechanical support labor for commissioning activities
- ❑ assembly of RMS modules to the valve racks

facility management

- ❑ the Buyer will provide such warehouse storage space and facilities, as are available at the site, and are reasonably appropriate to store parts, consumables, tools, etc. in accordance with manufacturers' recommendations. Such warehouse storage space will be a segregated area, secured and protected from adverse climate as may reasonably be required. Buyer will be responsible for risk of loss of Seller's parts while in storage at the site. Buyer will maintain Seller's parts stored at the site free and clear of any and all liens of Buyer and Buyer's lenders, bondholders, contractors, and other creditors of any nature.
- ❑ the Buyer will afford Seller's personnel free access and egress of the facility for all authorized work

- the Buyer will provide workshop facilities with standard workshop tools and equipment, as is reasonably appropriate, that are necessary to meet the repair and maintenance requirements of the system. Such equipment includes, but is not limited to, benches, vices, drill press, electric saws, hand tools, power tools, pneumatic tools, etc.
- the Buyer will provide adequate illumination and emergency lighting for all areas in which the Seller will be executing the scope of supply
- the Buyer will identify a Buyer project contact person to be available to Seller's personnel to address any issues related to Seller's execution of Seller's scope of work
- the Buyer will be responsible for the equipment for movement of chemical drums, totes, and resins, as is reasonable
- the Buyer will provide all site utilities such as raw water, instrument quality air, potable water and power required for operation of the proposed equipment included in this scope of supply

3 services

3.1 commissioning services

With over 700 full scale membrane based wastewater and water treatment plants commissioned and in operation, the commissioning group has developed a powerful infrastructure that provides timely support and management of all commissioning activities.

During the construction phase of the project, communication will occur between SUEZ, the General Contractor, Owner, and Consulting Engineer in the following ways:

- our project manager will continue to be the prime contact for all communication and will coordinate all activities to ensure all appropriate team members are available as required. Telephone, e-mail, video conferencing and participation in site meetings will be the prime modes of interaction during this period.
- our field service representative (FSR) will come to site to review, with the General Contractor, the installation of the SUEZ-supplied equipment

In addition, the General Contractor will complete “installation checklists” provided by SUEZ to ensure that all equipment has been installed properly for commissioning of the membrane system to begin. Following the initial inspection by SUEZ, the General Contractor will make any necessary field adjustments to installed equipment to ensure the system complies with the design specifications.

During the later stages of equipment installation, SUEZ will provide the services of a factory trained field service representative (FSR). Upon arrival at site, the SUEZ FSR will advise the General Contractor on equipment readiness, confirm that all field installed piping systems and connections to and from the membrane treatment system have been made correctly and will verify that all field installed instrumentation is wired correctly to the PLC system. The FSR will work closely with the project and process engineers to confirm that all components meet the design specifications.

Throughout commissioning, testing and start-up, we will assign an internal field service supervisor that will support the FSR to ensure rapid response to any on-site issues that may arise.

During the commissioning phase of the project, regular updates will be provided to document site progress. Potential delay issues, site issues and planning for future activities will be highlighted within these reports.

3.1.1 preinstallation meeting

As per the Procurement Proposal Package, Section 466100, item 3.2, a Preinstallation Conference Call will be scheduled with the Engineer and the General Contractor prior to shipment of equipment. The table below summarizes the allocations that have been included in the Contract Price for the Preinstallation Conference Call.

task	SUEZ personnel	time
preinstallation conference call	project manager field service representative	one (1) 2-hour conference call

3.1.2 delivery

As per the Procurement Proposal Package, Section 466100, item 3.3, SUEZ will have personnel on site at the time of equipment delivery to verify the acceptance and satisfactory condition of the equipment.

The table below summarizes the allocations that have been included in the Contract Price for delivery visits. The cost of transportation to and from site, lodging and meals is included for the meetings described below.

task	no. of person days note 1	no. of trips
delivery visit #1	1	1
delivery visit #2	1	1

note 1: No. of person days is based on a not-to-exceed 8-hour workday.

3.1.3 startup and training

SUEZ will provide the Owner and General Contractor with:

- ❑ assistance during pre-startup inspection visit;
- ❑ assistance with commissioning and startup of the membrane system;
- ❑ operator training; and
- ❑ assistance with the acceptance testing of the system.

The following is a summary of the onsite technical support services provided by SUEZ as per the Procurement Proposal Package, Section 466100, item 3.4. Services will be provided by trained SUEZ field service representatives.

task	no. of person days note 1	no. of trips
pre-startup inspection visit	2	1
system commissioning including: - electrical and mechanical checkouts - membrane installation verification - controls testing including integration - process startup	21	2
operator training	3	1
assistance during the acceptance test	3	1
total	**29**	**5**

note 1: No. of person days is based on a not-to-exceed 8-hour workday.

note 2: The cost of transportation to and from site, lodging, and meals has been included.

additional commissioning services

Additional services required, beyond what has been included in the commissioning proposal above, are chargeable at the rates indicated in SUEZ's prevailing field service labor rates sheet (see following page – rates are valid through December 31, 2021).

north america on-site hourly rates – $USD/hr

field service representative		standard	overtime	holiday
field service representative	product support representative	**$175**	**$262**	**$350**
engineer level				
project manager	electrical/controls engineer	**$195**	**$292**	**$390**
process engineer	operator training			

scheduling & technical support

contact services at +1 (866) 271-5425 to schedule service. Support is available by phone M-F 8:30am to 5:00pm Eastern time (GMT-5).

conditions

1. Rates are inclusive of travel and living expenses in Canada and the lower US. Remote sites, or those requiring special or urgent travel or accommodations, may incur additional charges.
2. In times of special circumstances (i.e. pandemic/national emergencies) additional costs may be incurred.
3. A minimum booking of 40 hours (one working week) is required for commissioning, startup or training services on capital projects or additional charges may be applied.
4. Travel time is charged at the applicable service rate. Travel hours begin at the SUEZ representative's residence or airport and end at arrival to the hotel or work site, and vice versa.
5. Hours exceeding a 10-hour day or a 40-hour work week may be considered overtime. Holiday rates apply based on US/Canada holidays and/or holidays observed in the country where the work is performed.
6. For extended duration assignments, staff rotations are scheduled on a monthly basis. Site-specific training required by customer will be billed as time worked.
7. Supplies, materials, consumables or services purchased for direct use during service will be charged separately.
8. State/provincial taxes, use taxes, withholding taxes and all other taxes are extra where applicable. Buyer is responsible to provide any applicable tax exemption certificates with its purchase order or work order.
9. All services provided are governed by SUEZ Water Technologies & Solutions general term and conditions. Additional or conflicting terms contained in purchase orders which authorize work are prohibited and shall not apply except where agreed to in writing.
10. For multiple scheduled or recurring site visits, please request a firm service proposal.
11. These rates are valid through December 31, 2021.

3.2 continual support

SUEZ is a proven leader in delivering tangible value to our customers over the life of the plant. Our measure of success is how well we deliver solutions that help our customers meet their critical business objectives in each and every year of operation.

SUEZ has distinguished itself from other UF membrane manufacturers with the quality and range of post-commissioning service support offered to its customers. After initial project start-up and commissioning is complete, SUEZ equipment system owners have access to comprehensive support through flexible, responsive, and professional service packages. SUEZ has developed the systems and technical expertise necessary to anticipate and resolve any process or equipment problem.

For ZeeWeed membrane systems alone, SUEZ has over 110 service staff in North America including:

- technical support staff for 24/7 emergency telephone support;
- process support engineers and technicians;
- system controls staff;
- local field service representatives;
- pre- or post-commissioning training staff;
- spare parts personnel;
- warranty support and service planning specialists, and
- regional lifecycle managers.

3.2.1 summary of services offered

The following services are included in the Contract Price:

- **24/7 emergency telephone technical support:**
  - calls during business hours – included for the life of the system
  - calls after hours – emergency telephone technical support – included for two (2) years
- **ModuleTrac:**
  - ModuleTrac – membrane tracking service – included for the first year
- **monitoring of membrane performance:**
  - **InSight Pro** – process consulting service – for a period of two (2) years
- **site visits:**
  - one (1) service person on-site for three (3) 8-hour days, one (1) time per year over ten (10) years
- **partnership communication:**
  - regional lifecycle manager (RLM);
  - ZeeWeed users group participation;
  - warranty support.

Description of each of these services follows below.

3.2.2 24/7 telephone technical support

SUEZ's 24/7 telephone technical support provides a team of specialists available to help keep your system online and in production in the event of the membrane system operating outside of specified conditions.

calls during business hours

Plant operators have telephone access to a skilled SUEZ technical support specialist who will assist plant operators in troubleshooting of system problems such as electrical (PLC/HMI), mechanical and process control issues.

Plant operators can call the daytime hours telephone number at any time during business hours and ask for technical support.

calls after-hours - emergency telephone technical support

Our technical support team is always on call and is equipped with system information to effectively talk a plant operator through an emergency, potentially averting loss of plant production and expensive call outs. The telephone technical support group maintains access to all plant drawings for rapid reference during 24/7 support calls. The telephone technical support group has portable computers equipped to access the plant control system remotely, in order to gain a better understanding of the situation, and to make any necessary adjustments to control set-points or software. Remote access requires a high-speed internet connection at your facility and requires that you have permissions set up in advance. The technical support specialist will manage the resources needed within SUEZ to assist you in resolving your plant issues. All customer issues are tracked through to resolution using SUEZ's state-of-the-art issue tracking software.

3.2.3 ModuleTrac

ModuleTrac, SUEZ's new mobile application for iOS and Android devices, offers a simplified, streamlined way to manage data collection and record-keeping for your ZeeWeed ultrafiltration membranes. ModuleTrac scans and organizes ZeeWeed membrane data, including location, repair and maintenance history, using a barcode located on each module.

The app is also linked with InSight, our powerful Asset Performance Management system, to help you:

- ❑ organize and archive information into one, easy-to-use application;
- ❑ view historical data to understand the best and least-performing modules;
- ❑ run reports and build graphs, charts and other visualizations;
- ❑ uncover the root cause of issues and their location relationships.

3.2.4 monitoring membrane performance through InSight

InSight captures and transforms your plant data into meaningful and actionable information, ultimately providing the knowledge you need to maximize performance, avoid operational interruptions, optimize your processes, and reduce the total cost of operation. InSight provides:

- ❑ **analytics:** InSight allows review of historical and current plant performance against success criteria.

- **early detection and alarming:** InSight helps operators detect emerging problems, so that action can be taken before a failure is experienced in the future.
- **productivity:** InSight's automated data collection reduces the tedious work of entering and reporting operator-collected data, including data required for membrane warranties. InSight helps staff get more done with tools that enhance their personal productivity, enabling them to see and do more.
- **reporting:** InSight's automated performance reports highlight operational details for key performance indicators.
- **membrane replacement strategy:** InSight data provides the information needed to plan a cost effective strategy for membrane replacement and upgrades with a deep understanding of factors affecting membrane performance.

features of InSight

- **simplicity:** InSight makes it easy to see how well your applications are performing over a specified time horizon.
- **reports:** InSight provides regular scheduled performance reports and summaries**.**
- **alerts:** InSight provides alerts if any process parameters fall outside their normal operating range.
- **mobility:** InSight provides smartphone or tablet access allowing the user the same abilities to see system health, current data, trends, reports and even enter operational data and notes as within the control room.
- **security:** InSight can archive all plant data securely in an off-site central database. Data is password protected.
- **data sources:** InSight allows for data to be acquired from a wide range of sources and modes of capture – including automatic (wired and wireless) and direct manual data entry.

key benefits

- InSight allows you to consolidate all your data to pull out valuable information to drive better business results.
- InSight helps to drive safety, reliability, accountability and increased throughput in your plant.
- InSight digitizes data and tools to liberate your operations and service teams to do their jobs more effectively.
- InSight provides peace of mind by having another level of surveillance which allows you to redefine operational excellence.

InSight Pro – process consulting service

InSight Pro puts a professional SUEZ process expert onto your team, collaborating to empower your operating team to apply the power of InSight.

The process expert is specifically assigned to your plant and will monitor key parameters on a regular rhythm using the InSight platform. The process expert will be in regular contact with the key members of your operations team to discuss and resolve performance, process and operational issues. While supporting your operations team with day-to-day issues, the process expert will also use InSight to bring attention to long term trends and provide operational recommendations.

As part of InSight Pro, the process expert provides monthly process reports with analysis of key trends and recommendations to support plant operation, membrane cleaning and overall performance. In addition, an annual summary performance report is provided.

If the need for troubleshooting does arise, your SUEZ process expert is accessible, familiar with your system and empowered with accurate information to assist.

3.2.5 site visits

SUEZ and the City of Buford will cooperatively plan the time allotted to service visits to complete priority activities identified by the City of Buford or selected from the scope of service below and produce maximum value from the service visit. Not all items in this scope or checklist are necessarily performed on every visit. The SUEZ field service representative (FSR) and the plant operators will initially define priority deliverables and jointly revise these priorities as required. Activities to monitor, diagnose and repair membrane issues will take precedence over other activities.

process monitoring

- ❑ Inspect and confirm proper operation of the membrane system in accordance with the SUEZ operation & maintenance manual.
- ❑ Review operating logs, analytical tests and InSight data (if available) with the operator(s). Discuss operator concerns and SUEZ issues emerging from this review.
- ❑ Discuss imminent seasonal shifts. Plan and implement forward looking adjustments.
- ❑ Advise the operations manager of technical updates as they become available from SUEZ.

membrane integrity

- ❑ Assess pressure decay test or bubble test data as it correlates to the membrane condition and/or permeate water quality. Assist plant operators to repair membrane fibers as required.
- ❑ Assess the effectiveness of on-going membrane cleaning procedures (recovery cleaning, maintenance cleaning, backwashing) and provide recommendations to the plant operators as necessary.

controls

- ❑ Review system alarm history, discuss any related issues with operator(s) and recommend appropriate actions to be taken.
- ❑ Perform limited PLC code modifications as planned in advance, secured by proper documentation, dial-in capabilities and file backup precautions.

- ❑ Verify operation of all safety interlock/controllers, pressure switches and temperature switches.

verification of instrument calibration

- ❑ Review set points, verify the condition of all control instruments, sensors, probes, and transmitters, including switching action and output. Assist operators with re-calibration, as necessary.
- ❑ Collaborate with the plant operator in maintaining a log of calibration activities.

preventive maintenance planning

- ❑ Develop a preventive maintenance plan with the plant operator.
- ❑ Review the spare parts provisions with the plant operator and identify any additional parts to provide the desired level of security, including spares related to non-SUEZ equipment.

training

During scheduled site visits, the SUEZ service representative can provide operators with informal training on any areas of concern; to explain the operation, process, maintenance or troubleshooting activities and, in general, to enhance operator ability and confidence.

reporting

SUEZ will provide a report to record membrane condition, tasks accomplished during the visit and identify key operating and maintenance issues.

spares

The SUEZ service representative will review the spares provisions with the plant operator to identify any additional spare parts which should be brought into inventory to provide the desired level of security to the plant including spares related to non-SUEZ equipment.

3.2.6 partnership communication

SUEZ knows the importance and long term implications involved in selecting a membrane supplier. SUEZ is committed to building a partnership with the City of Buford and believes communication is the essential ingredient to achieve this. SUEZ invests in the partnership through the following communication mechanisms:

- ❑ access to a regional lifecycle manager (RLM);
- ❑ participation in the ZeeWeed users group;
- ❑ dedicated warranty coordinator.

regional lifecycle manager

The regional lifecycle manager (RLM) will act as the SUEZ “quarterback”, engaging in frequent communication with plant staff, ensuring timely access to all the technical resources provided by SUEZ. Craig Brown has been in this role for the past 15 years and is based in Dacula, less than a 30 minute drive from Buford Waterworks. The RLM will also design a schedule and package of services suited to your needs and budget, including:

- additional years of InSight and 24/7 telephone technical support coverage;
- greater frequency of site visits and or special provisions for emergency site visits;
- plant optimization & plant upgrades;
- membrane replacement planning/budgeting;
- membrane cleaning studies.

2018 Drinking Water User's Group Meeting at Knox Chapman Utility District, TN

ZeeWeed users group

As an on-going support to ZeeWeed plants, an annual, two-day ZeeWeed users group meeting is chaired by an Owner and SUEZ helps organize the group meetings and a tour of the hosting ZeeWeed plant. New technologies are introduced, current issues are tabled, and roundtable discussions ensue. The users group has become an excellent forum for experienced operators to keep current, to renew old acquaintances, to exchange the "tricks of the trade" with each other, and to impart their hard won knowledge to newer ZeeWeed operators. Generous hospitality combines with informal experiences and exercises to enhance the esprit de corps between domestic and international plant operators.

All ZeeWeed plants are invited to send operators representing the plant. SUEZ covers conference, food, and hospitality expenses. The plant must cover the operator's travel and hotel expenses, and a small conference fee. SUEZ supports this forum to facilitate interaction between ZeeWeed plant operators and to provide a forum for real-world feedback to SUEZ's management, design and operations staff.

warranty support

To promptly manage warranty claims, SUEZ lifecycle services has a warranty coordinator dedicated to that function and that function only. Our warranty coordinator has access to all SUEZ resources to ensure timely resolution of problems that may occur.

4 warranty

The Seller offers a comprehensive two-part warranty for the City of Buford Water Treatment Plant Replacement project as follows:

- **mechanical warranty**: The Seller will repair or replace any device or part thereof that was supplied by the Seller that proves to be defective. This warranty excludes the membrane modules.
- **membrane module warranty**: This warranty provides protection and assurances to the Buyer/Owner with respect to the membrane modules.

Unless otherwise noted, all of the warranties start upon Substantial Completion, which is defined in Article SC-1.01.A.37 in the Supplementary Conditions. Substantial Completion of the membrane system is considered to be upon the Engineer's acceptance of the Acceptance Test.

4.1 warranty provisions

In addition to the membrane warranty limitations as defined in the "seller's warranty – ZeeWeed membrane modules" document (found at the end of this section), all of the warranties are subject to the following provisions:

general

- the equipment is operated and maintained at all times in accordance with the Seller's Operations & Maintenance manual;
- the Seller has, until performance of its obligation herein is met, reasonable access to the equipment and the operational data relating thereto;
- the Buyer/Owner furnishes adequate and competent operating, supervisory and maintenance staff, and necessary laboratory facilities with test equipment and personnel;
- the Buyer/Owner utilizes the services of the Seller until its performance obligations are met;
- the Buyer/Owner supplies all necessary raw materials and services of a quantity and of a quality specified by the Seller; and
- an adequate and continuous power supply is available that will enable operation of all required equipment.

screening

- screening is required upstream of the membrane system. The opening size for the screens in any dimension must be 500 microns or less.
- pre-screening must use mesh, punched hole or disc filter type screens. Wedge wire screens are not acceptable, nor is any unscreened bypass (even temporary).

- all tanks, clarifiers, settlers, channels, etc. following the screens are to be covered and protected from the outside elements such that no leaves, twigs or any foreign materials can enter the membrane train.

process parameters and water quality

- the use of any chemicals added to the treatment process (e.g. polymers, flocculants, coagulants, coagulant aids, oxidants, acids, bases…) that may come in contact with the ZeeWeed membranes must be approved by the Seller prior to use. This includes, but is not limited to, chemicals used in the feed water to the membranes, and chemicals used in processes outside of the Seller's system, streams which may be recycled or transferred directly or indirectly to the Seller's system (e.g. treated backwash waste water recycle). Pre-treatment chemical dosages must be properly optimized by the Buyer/Owner based on feed water quality and membrane requirements.
- the membrane system is guaranteed to perform its contractual obligations under the water quality parameters outlined in table 1 below. Any value above or below the ranges stated may impact the system performance.
- any compound not listed in table 1 and for which analytical data has not been supplied in the Procurement Proposal Package is assumed to be in such a concentration that it does not require removal by the treatment process, does not affect membrane performance, and will not need to be targeted by chemical cleanings to restore performance (e.g. algae, oil & grease).
- the system's operation is warranted under the original membrane system design, and pre- and post-treatment designs as described in **section 2** of this proposal. Any changes such as, but not limited to, the design or operation of the membrane system, the configuration of the upstream or downstream unit operations, equipment sizing, chemical types and dosing rates must be reviewed and assessed by the Seller to determine their feasibility and potential impact on the system performance and warranty.

treated waste water recycle

- the membrane system is designed assuming that no streams such as backwash or chemical wastes from the membrane system or any other unit operations in other parts of the plant are directly or indirectly recycled ahead of the membrane system. If recycle streams are to be implemented at a later date, the performance of the membrane system may be impacted due to the buildup of foulants in the process loop, and consultation with the Seller would be required to define the new operating conditions and feasibility of the changes proposed.

Table 1 presents the water quality on which the design of the membrane system is based, as supplied in item 2.1.A of Section 466100 of the Procurement Proposal Package.

The proposed water treatment system will treat raw water from Lake Lanier. The raw water is drawn from Lake Lanier and sent to a pre-settling pond. The pre-settled water will be dosed with chlorine (and coagulant – if required).

table 1: membrane system feed water quality

parameter	specified or assumed note 1	units	average	minimum	maximum
alkalinity note 2	specified	mg/L as $CaCO_3$	15	9	20
hardness	specified	mg/L as $CaCO_3$	4.3	2.9	7.1
pH note 3	specified	-	7.0	6.0	9.0
temperature	specified	°C	20	8	35
total organic carbon (TOC)	specified	mg/L	1.6	1	3
dissolved organic carbon (DOC)	assumed	mg/L	1.4	0.9	2.7
color	specified	HU	12	5	20
turbidity	specified	NTU	2.6	0	50
suspended solids note 4	specified	mg/L	6	0	10
total dissolved solids (TDS)	specified	mg/L	41	20	70
iron	specified	mg/L	0.09	0	1.4
dissolved iron	assumed	mg/L	0.08	BDL	0.3
dissolved aluminum	assumed	mg/L	0.01	BDL	0.02
manganese	specified	mg/L	0.02	0	0.2
dissolved manganese	assumed	mg/L	0.01	BDL	0.02
Langelier Saturation Index (LSI)	assumed	-	negative	negative	negative

note 1: This column identifies whether the parameters listed in each row are assumed values because they were not supplied to the Seller in the Procurement Proposal Package, or if the values listed reference the specifications in the Procurement Proposal Package.

note 2: The minimum alkalinity in the raw water must be such that a minimum of 10 to 15 mg/L of alkalinity as $CaCO_3$ is still present in the feed water to the membranes after coagulant addition, if coagulant is dosed. If this is not the case, alkalinity correction should be implemented by the Buyer/Owner and discussed and approved by the Seller.

note 3: The pH must be controlled through the pre-treatment process to minimize solubility of the metal-based coagulant, if coagulant is dosed.

note 4: The pre-treatment process contributes to the total suspended solids in the feed to the membrane system. The maximum acceptable coagulant dose is 0.75 mg/L (as Al^{3+}).

note 5: Chlorine residual in the membrane system feed water must not exceed 1.0 mg/L.

4.2 mechanical warranty

The mechanical warranty period on all equipment supplied, unless otherwise noted, is twelve (12) months from the date of Substantial Completion or twenty four (24) months from the date of final equipment delivery, whichever occurs first. The mechanical warranty is only applicable to equipment supplied by the Seller. The Seller's obligation under this warranty is to repair or replace, at its factory, any device or part thereof, which shall prove to have been thus defective. Warranty repair, replacement or re-performance by Seller shall not extend or renew the applicable warranty period.

The Seller assumes no liability for any damage to the equipment caused by inadequate storage or handling per manufacturer's recommendations in supplied technical literature, or by defective or sub-standard workmanship of materials provided by the Buyer/Owner or any other third party responsible for handling, storing or installing the equipment.

The Buyer/Owner undertakes to give immediate notice to the Seller if goods or performance appear defective and to provide the Seller with reasonable opportunity to make inspections and tests. If the Seller is not at fault, the Buyer/Owner shall pay the Seller the costs and expenses associated with the inspections and tests.

Goods shall not be returned to the Seller without the Seller's permission. The Seller will provide the Buyer/Owner with a "Return Goods Authorization" (RGA) number to use for returned goods. All returns are F.C.A. – Oakville, Ontario, Canada. All costs associated with the removal and shipment of the defective part from the Buyer/Owner's facility to the Seller's factory and all costs related to return shipment to the Buyer/Owner's facility and installation of a repaired or replacement part shall be the Buyer/Owner's responsibility.

Implied warranties, including but not limited to warranties of fitness for particular purpose, use or application, and all other obligations or liabilities on the part of the Seller, unless such warranties, obligations or liabilities are expressly agreed to in writing by the Seller, are null and void.

4.3 membrane module warranty

A ten (10) year warranty is offered on the membrane modules with the first twenty-four (24) months offered as a full replacement warranty and the remaining ninety-six (96) months as a prorated warranty. The membrane warranty shall begin at the date of Substantial Completion or six (6) months from the date of delivery of the membranes to the Buyer, whichever occurs earliest. Refer to the "seller's warranty – ZeeWeed membrane modules" document (found at the end of this section) for a detailed description of the membrane warranty offered.

The parameters outlined in the sub-sections below are covered by the membrane warranty.

4.3.1 capacity guarantee

The Seller warrants, subject to the provisions set forth herein, that after stable operation of the system has been attained and operators have acquired reasonable skills, the membrane modules supplied for this project will be capable of producing the results set forth in table 2.

table 2: guaranteed membrane filtration system performance - capacity

parameter	guaranteed values
design daily net capacity with all trains operational at a temperature ≥ 8°C	2.5 MGD
design daily net capacity under firm capacity conditions at a temperature ≥ 8°C	2.5 MGD

note 1: The membrane filtration system proposed as part of this offer is designed to provide its rated capacity on a net daily basis. Instantaneous permeate flows will vary as trains cycle through backwashes. The feed flow rate to the membrane trains will be varied as trains cycle through backwashes. The feed upstream process shall be designed to allow for raw water flow variations into the plant for backwashes. It is anticipated that any feed equipment and controls provided by others will be responsive and deliver timely flow variation that is appropriate to manage the feed demand fluctuations of the membrane system at all capacities.

note 2: The membrane filtration system proposed includes train redundancy (N-1 redundancy). During recovery cleans, maintenance cleans, and membrane integrity tests, operating trains will ramp up to a higher flow to compensate. As a result, production capacity is not reduced under these conditions.

4.3.2 water quality guarantee

The Seller warrants, subject to the provisions set forth above, that after stable operation of the system has been attained and operators have acquired reasonable skills, the membrane modules supplied for this project will be capable of producing the results set forth in table 3.

table 3: guaranteed membrane filtration system performance – water quality

parameter	guaranteed values
turbidity (NTU) note 2	≤ 0.1 NTU 95% of the time ≤ 0.3 NTU 100% of the time
log removal value (LRV) for *Giardia* and *Cryptosporidium* note 3	≥ 4 log
color, hardness, iron, manganese, total dissolved solids, total organic carbon, pH note 4	these parameters shall not degrade by the membrane filtration process

note 1: All guarantees are contingent upon proper maintenance, calibration and service of instruments and other related equipment as per Seller's and original equipment manufacturers instruction.

note 2: Guaranteed values are as measured by online instrumentation on the permeate for each train.

note 3: The membrane integrity test (MIT) and LRV calculation will be performed in accordance with the latest versions of the USEPA's Long Term 2 Enhanced Surface Water Treatment Rule and the Membrane Filtration Guidance Manual, as outlined in SUEZ's LRV FAQ document.

note 4: Pre-treatment includes the addition of chlorine (and coagulant – if required), which may have an impact on the pH and TDS of the permeate.

4.3.3 membrane integrity warranty

Table 4 defines limits for the number of fiber repairs as a percentage of the total number of fibers in each module. Beyond the limits indicated, the membrane module warranty will be triggered.

table 4: guaranteed membrane filtration system performance – membrane integrity

parameter	guaranteed values
maximum number of fibers that require pin repair per module per any twelve (12) month period	0.3%
maximum number of fibers that require pin repair per module over the warranty duration	0.9%

note 1: Repairs completed by the Seller's personnel prior to Substantial Completion are not counted against the maximum allowable limits above.

note 2: Leaking fibers do not constitute a cause for repair, as long as the permeate quality is within the guaranteed values.

note 3: Provided the membrane system integrity breach has been linked to fiber integrity, and other potential causes have been dismissed, fibers should be repaired by prioritizing the largest leaks and defects first to maximize the benefits of repairs in the facility, and should only be performed when:

- ❑ the turbidity is reaching the notification alarm setpoint in at least 20% of the readings
- ❑ the turbidity is reaching the shutdown alarm setpoint
- ❑ the LRV of a train is within 0.2 units of the guaranteed LRV
- ❑ the LRV of a train is reaching the shutdown alarm setpoint

4.4 acceptance test

A fourteen (14) day Acceptance Test will be completed to demonstrate the ability of the Seller's system to meet the required performance. During the Acceptance Test at least one (1) membrane train will be operated at nominal flow to demonstrate the system complies with the water quality objectives (see table 3 above) as well as with the cleaning interval set forth in the Procurement Proposal Package.

Acceptance testing is designed to demonstrate proper operation of all equipment. The Owner will furnish the power and chemicals required for normal operation of the membrane system during the acceptance testing period. The membrane system will demonstrate the performance criteria per the production capacity specified (see table 2 above) and permeate water quality specified (see table 3 above).

The Acceptance Test will be deemed successful if the membrane train(s) operate continuously for the full duration of the test at design flow without requiring a recovery clean.

For more information about the Acceptance Test, refer to item 3.5 in Section 466100 of the Procurement Proposal Package.

seller's warranty - ZeeWeed membrane modules

This schedule sets out the warranty with respect to ZeeWeed Membrane Modules ("Membrane Modules"). No other warranties, expressed or implied are made in connection with the sale of these products, including, without limitation, warranties as to fitness for any particular purpose or use or merchantability of these products. The warranty provided herein will be the exclusive and sole remedy of the Buyer, and in no event will the Seller be liable for any special, direct, indirect or consequential damages, including, without limitation, loss of profits. Buyer is not entitled to extend or transfer this warranty to any other party, without the express written consent of Seller.

1 product

This warranty applies to only the Membrane Modules supplied under the contract of sale. Membrane Module means the fibers and potted plastic header(s). This warranty does not cover air piping to the Membrane Module, permeate piping from the Membrane Module, piping connection fittings, connecting hardware with their associated components including but not limited to spacers, aerator tubes, aerator assemblies, screen, module dummies or module blanks.

Identification: Membrane Modules are shipped by the Seller with a serial number identification which confirms their place in the cohort set of Membrane Modules covered by this Membrane Module warranty.

2 seller

SUEZ WTS Systems USA, Inc. is the name of the Seller, and means a business component of, or legal entity within the SUEZ Water Technologies & Solutions business (SUEZ) which is selling ZeeWeed modules and is the Seller offering this warranty. The Seller may assign this warranty to other SUEZ affiliates.

3 buyer

Buyer is **the City of Buford, Georgia,** and means the party purchasing the ZeeWeed modules from the Seller.

4 project

Project means **the City of Buford Water Treatment Plant Replacement project**

5 contract of sale

Contract of sale means the sales contract governing the sale of Membrane Module(s) between the Buyer and the Seller or its SUEZ affiliate.

6 scope of warranty

The Seller warrants that its Membrane Module(s) will be free of defects due to faulty materials or errors in manufacturing workmanship.

Regular Membrane Module inspection and normal fiber repair shall be the responsibility of the Buyer.

All replacement Membrane Modules will be shipped on the basis of INCOTERMS 2010 FCA SUEZ membrane manufacturing facility.

All ancillary costs including but not limited to bagging, boxing, crating, freight, freight insurance, applicable taxes, import duties, brokerage, receiving, forklift services, storage at site, re-attachment hardware, hose/clamp/camlock replacement, crane services, installation, fiber repair materials, glycerin flushing, commissioning and waste disposal are the responsibility of Buyer.

full replacement – Full replacement means that in the case of a valid warranty claim for a Membrane Module failure, the Buyer receives a replacement Membrane Module and does not pay for the value of use of the Membrane Module prior to failure.

prorated replacement – Prorated replacement means the Buyer pays for actual use of a membrane module from which the Buyer has derived value over time. See **section 12 membrane module replacement price – prorated replacement** for the formula for calculating the prorated amount payable. Prorated replacement allows the Seller to pay reasonable compensation under warranty for any product use not enjoyed by the Buyer due to premature failure.

The ratio of full replacement to prorated replacement in this warranty is set out in **section 8 warranty duration**.

7 warranty start date

This warranty will start on the earlier of:

a) the date that installation of the original Membrane Module(s) has been substantially completed, or

b) six (6) months from the date of delivery of the original Membrane Module(s) to the Buyer as per supplied bill of lading date

For replacement Membrane Modules, this warranty will start the earlier of:

a) the date of installation as provided in writing by Buyer to Seller, or

b) one (1) month from the date of delivery by Seller to the plant site

8 warranty duration

total warranty duration: a total of **one hundred twenty (120) months** composed of a base period and an extended period.

base period with full replacement: twenty-four (24) months

All purchasers of ZeeWeed Membrane Modules are entitled to this base period of full replacement warranty coverage without purchasing an extended Seller's warranty.

extended period with prorated replacement: a total of ninety-six (96) months following the base period

Replacement Membrane Modules are covered by warranty only for the balance of the warranty of the original Membrane Module which has been replaced. At all events, this warranty shall expire and be of no force or effect **one hundred twenty (120) months** following the warranty start date.

9 notification of claim

All claims filed under this warranty shall be made in writing by the Buyer within thirty (30) days of identifying a defect.

The Buyer shall provide the following information:

a) a description of the defect giving rise to the claim

b) photographs showing the manufacturing defect

c) the serial number(s) of the Membrane Module(s) which is (are) the subject of the warranty claim and

d) operating data and repair history for the life of Membrane Modules which are the subject of a warranty claim

10 verification of claim

After receipt of written notification of a defect, the Seller will promptly undertake such investigations as, in the Seller's opinion, are necessary to verify whether a defect exists. The Seller reserves the right to require additional data as necessary to validate claims. Buyer may, in the course of these investigations, be requested to return Membrane Module(s) to the Seller for examination. The Seller may also conduct reasonable tests and inspections at the Buyer's plant or premises. If the results of the investigation do not validate the defect claimed, the Buyer will reimburse the Seller for all reasonable expenses associated with said investigation, including expenses for all tests, inspections, and associated travel.

11 satisfaction of claims

The Seller will have the right to satisfy claims under this warranty in a flexible manner. Such flexibility may include the repair of existing Membrane Modules or changes in operating protocols or Membrane Module replacement or by upgrading failed Membrane Modules with newer Membrane Module(s) that may embody design and efficiency improvements. The Buyer consents to the supply of replacement Membrane Modules which may be of a different design than original Membrane Modules.

12 membrane module replacement price – prorated replacement

The base Membrane Module Replacement Price (MMRP) used to calculate the prorated amount to be paid by the Buyer to replace defective Membrane Modules under warranty shall be **$1,095.00USD/module** + adjustment for inflation. The inflation adjustment will be calculated according to changes in the Consumer Price Index (CPI), US City Average, All Urban Consumers, All Items less Food and Energy, as published by the US Bureau of Labor Statistics) for the period from date Seller receives Notice to Proceed With Manufacturing/Procurement (NTP) through to the latest available CPI index report.

For Membrane Modules supplied under valid warranty claims, the prorated share that the Buyer will pay is calculated as follows:

prorated share of price	=	number of whole months elapsed between the membrane module replacement date and the warranty start date / warranty duration in months	x	membrane module replacement price	x	changes in CPI index

Note - This Membrane Module Replacement Price (MMRP) is not applicable for Membrane Modules requested for purchase by Buyer for any non-warranty or other purposes, including but not limited to flux reduction, or plant hydraulic capacity increases. Modules purchased under these or other scenario's will be sold to Buyer by Seller at the list price in effect at the time of order.

13 operating information

To maintain the Membrane Module warranty, membrane system operation records from initial start-up date until claim must be maintained by the Buyer and made available to the Seller upon request. Records must be provided in sufficient detail to verify uninterrupted compliance with the Seller's operations and maintenance manual prepared by the Seller and supplied to the Buyer as part of the contract. At a minimum, operation data must include information on feedwater quality, temperatures, flows, trans-membrane pressures, aeration rates, permeate quality, cleaning intervals, cleaning chemical concentrations, elapsed time since start-up, relevant analytical data and reporting of any screen bypass events.

The Buyer shall maintain and share access to a single reference copy in electronic form of a Membrane Module map containing the history of activity by Membrane Module. The Buyer shall log its procedures performed related to a Membrane Module including relocation of Membrane Modules, repairs, replacements and any other noteworthy events.

The Buyer authorizes the Seller to conduct any reasonable review of operation and maintenance records or to inspect facilities where Membrane Modules are installed, upon reasonable notice to the Buyer. Such reviews and/or inspections are intended to also assist the Seller and the Buyer in detection of membrane system faults and to optimize the care and operation of the Membrane Modules.

14 limitation of warranties

Occurrence of any of the following as reasonably determined by the Seller will void this warranty:

a) a material failure to operate the membrane system in accordance with Seller's operations and maintenance manual supplied to the Buyer as part of the contract, including material failure to adhere to the Seller's specified Membrane Module cleaning procedures and the use of anything other than Seller-approved Membrane Module cleaning agents

b) failure to adhere to the preventive maintenance program as presented in the Seller's operations and maintenance manual, and all published product manuals & specifications

c) failure to adhere to all transportation and module storage recommendations as outlined by Seller

d) failure to ensure correct operation and/or functioning of the screening equipment.

e) introduction of destructive foreign materials into the Membrane Modules. Destructive foreign materials may include natural or man-made materials that are introduced into the membranes originating from construction and maintenance activities or from inadequate pretreatment or from aquatic species including clams and snails or from damage to upstream tanks or tank coating. The Buyer shall be responsible to maintain correct function of the screen mechanism and to flush membranes and upstream tanks of any accumulated foreign materials.

f) failure to install and maintain operating data acquisition and electronic data transmission functions at the plant

g) physical abuse or misuse, incorrect removal or installation of Membrane Modules by non-Seller personnel including fiber damage caused by operator error in handling of Membrane Modules

h) unauthorized alteration of any components or parts originally supplied by the Seller

i) intentional damage

15 return procedure

In the event that the return of a Membrane Module is required pursuant to this warranty, the Buyer will first obtain a Return Goods Authorization (RGA) number from the Seller. Membrane Module(s) shipped to the Seller for warranty examination must be shipped freight prepaid. If the Buyer desires temporary replacement Membrane Module(s) to replace those alleged to be defective and returned to the Seller for warranty examination, the Buyer shall be responsible for the cost associated with any such replacements until examination of the returned Membrane Modules pursuant to this warranty is complete. Any Membrane Module examined by Seller as part of a warranty claim where the Membrane Module is subsequently found to be performing as warranted or where a Membrane Module failure is not covered under the warranty will be returned to the Buyer, freight collect.

appendix a – terms and conditions

Find attached the following documents, from SUEZ's signed contract with the City of Buford:

- ❑ EJCDC P-520, Agreement Between Buyer and Seller for Procurement Contracts (effective January 22, 2020)
- ❑ EJCDC P-700, Standard General Conditions for Procurement Contracts
- ❑ EJCDC P-800, Supplementary Conditions

AGREEMENT

THIS AGREEMENT is by and between City of Buford, Georgia ("Buyer")
and ZENON Environmental Corporation ("Seller").

Buyer and Seller hereby agree as follows:

ARTICLE 1 – GOODS AND SPECIAL SERVICES

1.01 Seller shall furnish the Goods and Special Services as specified or indicated in the Contract Documents.

ARTICLE 2 – THE PROJECT

2.01 The Project, of which the Goods and Special Services may be the whole or only a part, is identified as follows:

Water Plant Membrane Filtration System

ARTICLE 3 – ENGINEER

3.01 The Contract Documents for the Goods and Special Services have been prepared by **Keck & Wood, Inc.** ("Engineer"), which is to act as Buyer's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with Seller's furnishing of Goods and Special Services.

ARTICLE 4 – POINT OF DESTINATION

4.01 The Point of Destination is designated as:

3370 North Waterworks Road, Buford, GA 30518.

ARTICLE 5 – CONTRACT TIMES

5.01 *Time of the Essence*

A. All time limits for Milestones, if any, including the submittal of Shop Drawings and Samples, the delivery of Goods, and the furnishing of Special Services as stated in the Contract Documents, are of the essence of the Contract.

5.02 *Milestones*

A. Days for Submittal of Shop Drawings and Samples: Seller shall submit all Initial Shop Drawings and Samples required by the Contract Documents to Buyer for Engineer's review and approval within 15 days from Effective Date of Agreement as provided in Paragraph 2.04 of the General Conditions. Seller shall submit all 90% Shop Drawings and Samples required by the Contract Documents to Buyer for Engineer's review and

approval within 35 days from Effective Date of Agreement as provided in Paragraph 2.04 of the General Conditions. Seller shall submit all 100% Shop Drawings and Samples required by the Contract Documents to Buyer for Engineer's review and approval within 56 days from Effective Date of Agreement as provided in Paragraph 2.04 of the General Conditions. It is the intent of the parties that (1) Engineer conduct such review and issue its approval, or a denial accompanied by substantive comments regarding information needed to gain approval, within 14 days of Seller's submittal of such Shop Drawings and Samples; and (2) resubmittals be limited whenever possible. If more than one resubmittal is necessary for reasons not the fault and beyond the control of Seller, then Seller shall be entitled to seek appropriate relief under Paragraph 7.02.B of the General Conditions.

B. *Days to Achieve Delivery of Goods:* The Goods are to be delivered to the Point of Destination and ready for Buyer's receipt of delivery at agreed upon date per Contract Documents.

C. Days for Furnishing Special Services: The furnishing of Special Services to Buyer will commence at the Effective Date of Agreement, and shall be completed with Engineer's written approval.

5.03 *Buyer's Final Inspection*

A. Days to Achieve Final Inspection: Buyer shall make its final inspection of the Goods pursuant to Paragraph 8.01.C of the General Conditions within 14 days after Buyer's acknowledgement of receipt of delivery of the Goods and Seller's completion of furnishing Special Services, if any.

5.04 *Liquidated Damages*

A. Buyer and Seller recognize that Buyer will suffer financial loss if the Goods are not delivered at the Point of Destination and ready for receipt of delivery by Buyer within the times specified in Paragraph 5.02 above, plus any extensions thereof allowed in accordance with Article 7 of the General Conditions. The parties also recognize that the timely performance of services by others involved in the Project is materially dependent upon Seller's specific compliance with the requirements of Paragraph 5.02. Further, they recognize the delays, expense, and difficulties involved in proving the actual loss suffered by Buyer if complete acceptable Goods are not delivered on time. Accordingly, instead of requiring such proof, Buyer and Seller agree that as liquidated damages for delay (but not as a penalty) Seller shall pay Buyer $1,000.00 for each day that expires after the time specified in Paragraph 5.02.B for delivery of acceptable Goods.

B. Seller shall have no liability to Buyer under this Article if Seller's delay causes no damages or losses to Buyer.

C. The liquidated damages set forth in Article 5.04 shall constitute the Buyer's sole and exclusive remedy for delay by Seller in achieving completion of the Work within the time specified in the Contract Documents. Seller's obligation to pay liquidated damages pursuant to Article 5.04 shall be limited to an amount equal to ten percent (10%) of the Seller's Contract Price.

ARTICLE 6 – CONTRACT PRICE

6.01 Buyer shall pay Seller for furnishing the Goods and Special Services in accordance with the Contract Documents as follows:

A. Base Proposal plus Allowance: Design Assistance and Shop Drawing Preparation, Manufacturing of Goods, Pre-Installation Meeting, Start-Up and Training, Field Testing, and Allowance for Spare Parts:

Nine Hundred Eighty-Nine Thousand US Dollars ($ 989,000.00), as described in Seller's Proposal and the Contract Documents.

B. Continual Support Total Package:

Forty-Nine Thousand Two Hundred Twenty-Nine US Dollars ($49,229.00), as described in Seller's Proposal Form Exhibit A and the Contract Documents.

C. Total Contract Price: Includes Base Bid Plus Allowance and Continual Support Total Package:

One Million Thirty-Eight Thousand Two Hundred Twenty-Nine US Dollars ($1,038,229.00).

D. The above prices stated in Seller's Proposal, attached hereto as an exhibit.

ARTICLE 7 – PAYMENT PROCEDURES

7.01 *Submittal and Processing of Payment*

A. Seller shall submit Applications for Payment in accordance with Article 10 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

7.02 *Progress Payments; Retainage*

A. Buyer shall make progress payments on account of the Contract Price on the basis of Seller's Applications for Payment as follows:

1. Upon receipt of the first Application for Payment accompanied by Engineer's recommendation of payment in accordance with Paragraph 10.01.A.2 of the General Conditions, an amount equal to the cost of 10% of the Contract Price for Design Assistance and Shop Drawing Preparation, less such amounts as Engineer may determine in accordance with Paragraph 10.02.A.3 of the General Conditions.

2. Upon receipt of the second Application for Payment accompanied by Engineer's recommendation of payment in accordance with Paragraph 10.01.A.2 of the General Conditions, an amount equal to the cost of 80% of the Contract Price for Design Assistance and Shop Drawing Preparation, less such amounts as Engineer may determine in accordance with Paragraph 10.02.A.3 of the General Conditions.

3. Upon receipt of the third Application for Payment accompanied by Engineer's recommendation of payment in accordance with Paragraph 10.01.A.2 of the General Conditions, an amount equal to the cost of 10% of the Contract Price for Design Assistance and Shop Drawing Preparation, less such amounts as Engineer may determine in accordance with Paragraph 10.02.A.3 of the General Conditions.

4. Upon receipt of the fourth Application for Payment submitted in accordance with Paragraph 10.01.A.1 of the General Conditions and accompanied by Engineer's recommendation of payment in accordance with Paragraph 10.02.A of the General Conditions, an amount equal to 65% of the cost of the Contract Price for Manufacturing of Goods, less any amounts retained by the Owner from the Buyer, less such amounts as Engineer may determine in accordance with Paragraph 10.02.A.3 of the General Conditions.

5. Upon receipt of the subsequent Application for Payment accompanied by Engineer's recommendation of payment in accordance with Paragraph 10.01.A.2 of the General Conditions, an amount sufficient to increase total payments to Seller by up to 5 percent of the Contract Price, less any amounts retained by the Owner from the Buyer, less such amounts as Engineer may determine in accordance with Paragraph 10.02.A.3 of the General Conditions.

7.03 *Final Payment*

A. Upon receipt of the final Application for Payment accompanied by Engineer's recommendation of payment, Buyer shall pay Seller the amount recommended by Engineer, less any sum Buyer is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages.

7.04 *Additional Costs*

A. $500.00 The Seller's daily fee for storage of Goods at Seller's facilities in the event that Buyer desires to delay shipment beyond the shipment dates stated in Paragraph 5.02 above, unless another shipment date is agreed to in writing by Buyer and Seller, in which case such agreed to date shall be the date used to calculate such additional costs. Such fee shall include interest on money due Seller.

ARTICLE 8 – INTEREST

8.01 All monies not paid when due as provided in Article 10 of the General Conditions shall bear interest at the statutory rate.

ARTICLE 9 – SELLER'S REPRESENTATIONS

9.01 In order to induce Buyer to enter into this Agreement, Seller makes the following representations:

A. Seller has examined and carefully studied the Contract Documents and the other related data identified in the Proposal Documents, as applicable to Seller's obligations identified in Article 1 above.

B. If required by the Proposal Documents to visit the Point of Destination and site where the Goods are to be installed or Special Services will be provided, or if, in Seller's judgment, any local condition may affect cost, progress, or the furnishing of the Goods and Special Services, Seller has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided and become familiar with and is satisfied as to the observable local conditions that may affect cost, progress, and the furnishing of the Goods and Special Services.

C. Seller is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and the furnishing of the Goods and Special Services.

D. Seller has carefully studied, considered, and correlated the information known to Seller; information commonly known to sellers of similar goods doing business in the locality of the Point of Destination and the site where the Goods will be installed or where Special Services will be provided; information and observations obtained from Seller's visits, if any, to the Point of Destination and site where the Goods are to be installed or Services will be provided; and any reports and drawings identified in the Proposal Documents regarding the Point of Destination and the site where the Goods will be installed or where Special Services will be provided, with respect to the effect of such information, observations, and documents on the cost, progress, and performance of Seller's obligations under the Contract Documents.

E. Seller has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Seller has discovered in the Contract Documents, and the written resolution (if any) thereof by Engineer is acceptable to Seller.

F. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing Goods and Special Services.

9.02 The Buyer shall allow the authorized personnel of the Seller access to the Site during normal working hours for the purpose of performing its obligations under this Contract.

9.03 If Seller is performing installation, oversight or commissioning services and, in the reasonable opinion of the Seller, it is necessary to remove or disconnect any existing equipment of the Buyer in order to install or commission the System, the Seller shall give the Buyer a minimum of 48 hours of notice of such requirements and the Buyer shall provide the Seller, at Buyer's cost, with such assistance as is reasonably necessary to facilitate such removal or disconnection.

ARTICLE 10 – CONTRACT DOCUMENTS

10.01 *Contents*

A. The Contract Documents consist of the following:

1. This Agreement (pages 1 to 13, inclusive);

2. Performance Bond (pages 1 to 4, inclusive).

3. Payment Bond (pages 1 to 4, inclusive).

4. General Conditions (pages 1 to 33, inclusive);

5. Supplementary Conditions (pages 1 to 12, inclusive);

6. Specifications Sections: 466100 "Filtration Equipment" (pages 1 to 27, inclusive);

7. Addenda (Numbers 1 to 2, inclusive);

8. Exhibits to this Agreement (enumerated as follows):

   a. Seller's Proposal dated December 17, 2019, solely as to the prices set forth therein (pages 1 to 118, inclusive);

      i. Membrane Filtration System Form (pages 1 to 13, inclusive);

      ii. Exceptions List (pages 1 to 1, inclusive).

   b. Documentation submitted by Seller prior to Notice of Award: None.

9. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:

   a. Change Order(s);

   b. Work Change Directive(s).

   c. Field Order(s).

B. The documents listed in Paragraph 10.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 10.

D. The Contract Documents may only be amended, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 11 – MISCELLANEOUS

11.01 *Terms*

A. Terms used in this Agreement will have the meanings indicated in the General Conditions and the Supplementary Conditions.

11.02 *Assignment of Contract*

A. Buyer has the right to assign this Contract for furnishing Goods and Special Services, but only to a person or entity with sufficient ability to satisfy all of Buyer's obligations under this Contract, and Seller hereby consents to such assignment. Forms documenting the assignment of the Contract, and consent of Seller's surety to the assignment, have been executed by Buyer, Seller, and Seller's surety, and are attached as exhibits to this Agreement.

1. The Contract will be executed in the name of Buyer initially, and will be assigned to a construction contractor designated by Buyer. Such construction contractor's responsibilities will include the installation of the Goods. The assignment will occur on the effective date of the agreement between Buyer and the construction contractor, which is expected to occur within 270 calendar days of the effective date of this Agreement. As of the date of acceptance of assignment by the construction contractor, all references in the Contract Documents to Buyer shall mean the designated construction contractor.

2. The assignment of the Contract shall relieve the assignor from all further obligations and liabilities under this Contract. After assignment, Seller shall become a subcontractor or supplier to the assignee and, except as noted herein, all rights, duties, and obligations of Buyer under the Contract shall become the rights, duties, and obligations of the assignee.

3. After assignment:

    a. All performance warranties, guarantees, and indemnifications required by the Contract Documents will continue to run for the benefit of assignor and, in addition, for the benefit of the assignee. However, if assignor and assignee make the same warranty or guarantee claim, then Seller shall only be liable once for such claim.

    b. Except as provided in this Paragraph 11.02.A.3.b, all rights, duties, and obligations of Engineer to assignee and Seller under this Contract will cease.

        1) Engineer will review Seller's Applications for Payment and make recommendations to assignee for payments as provided in Paragraphs 10.02 and 10.06 of the General Conditions.

        2) Upon the written request of either the assignee or Seller, Engineer will issue with reasonable promptness clarifications or interpretations of the Contract Documents pursuant to the terms of Paragraph 9.02.A of the General Conditions.

B. No other assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound. Specifically, but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by Laws and Regulations). Unless specifically stated to the contrary in any written consent to such an assignment, such an assignment will not release or discharge the assignor from any duty or responsibility under the Contract Documents.

C. For the purposes of estimating the Seller's time period involved with the Project, a 24-month Contract Time Period for the Construction Contract of the Project may be assumed. This time period is provided for estimation purposes only.

11.03 *Successors and Assigns*

A. Buyer and Seller each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

11.04 *Severability*

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Buyer and Seller. The Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

11.05 *Seller's Certifications*

A. Seller certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 11.05:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the proposing process or in the Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the proposing process or the execution of the Contract to the detriment of Buyer, (b) to establish Proposal or Contract prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Proposers, with or without the knowledge of Buyer, a purpose of which is to establish Proposal prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the proposing process or affect the execution of the Contract.

11.06 *Limitations*

A. Buyer and Seller waive against each other, and against the other's officers, directors, members, partners, employees, agents, consultants, and subcontractors, any and all claims for or entitlement to incidental, indirect, or consequential damages arising out of, resulting from, or related to the Contract. Upon assignment the terms of this Paragraph 11.06.A shall be binding upon the assignee with respect to Seller and assignor. The terms of this mutual waiver do not apply to or limit any claim by either Buyer or Seller against the other based on any of the following: (a) contribution or indemnification with respect to third-party claims, (b) costs, losses, or damages attributable to personal or bodily injury, sickness, disease, or death, or to injury to or destruction of the tangible property of

others, (c) intentional or reckless wrongful conduct, or (d) rights conferred by any bond provided by Seller under this Contract.

B. Upon assignment the terms of this Paragraph 11.06.B shall be binding upon both the assignor and assignee with respect to Seller's liability, and upon Seller with respect to both assignor's and assignee's liabilities. The terms of this mutual limitation do not apply to or limit any claim by either Buyer or Seller against the other based on any of the following: (a) contribution or indemnification with respect to third-party claims, losses, and damages; (b) costs, losses, or damages attributable to personal or bodily injury, sickness, disease, or death, or to injury to or destruction of the tangible property of others, (c) intentional or reckless wrongful conduct, or (d) rights conferred by any bond provided by Seller under this Contract.

C. Excluding Seller's third-party indemnity obligations, Gross Negligence or Willful Misconduct and liability for breach of confidentiality, the total liability of the Seller for use of any equipment or services shall not exceed the total price paid by Buyer under this agreement.

IN WITNESS WHEREOF, Buyer and Seller have signed this Agreement. Counterparts have been delivered to Buyer and Seller. All portions of the Contract Documents have been signed or identified by Buyer and Seller or on their behalf.

This Agreement will be effective on 1-22-20 (which is the Effective Date of the Agreement).

Buyer: CITY OF BUFORD, GEORGIA	Seller: ZENON ENVIRONMENTAL CORPORATION
By: _____ [Individual's Signature]	By: _____ [Corporate Seal]
Date: 1-22-20 *(date signed)*	Date: JANUARY 20, 2020 *(date signed)*
Name: Bryan Kerlin	Name: DAVID BINGHAM *(typed or printed)*
Title: City Manager	Title: COMMERCIAL DIRECTOR *(typed or printed)* *(Attach evidence of authority to sign.)*
Attest: _____	Attest: _____
Title: Kim Wolfe, City Clerk	Title: APPLICATIONS ENGINEER *(typed or printed)*
Address for giving notice: 2300 Buford Highway Buford, GA 30518 USA	Address for giving notice: 3239 Dundas Street West Oakville, Ontario L6M 4B2 Canada
(If Buyer is a corporation, attach evidence of authority to sign. If Buyer is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Buyer-Seller Agreement.)	Agent for service of process: DAVID BINGHAM (If Seller is a corporation or a partnership, attach evidence of authority to sign.)

Designated Representative:

Name: Bryan Kerlin
Title: City Manager
Address: 2300 Buford Highway
Buford, GA 30518
Phone: 770-945-6761

Designated Representative:

Name: GLEN CONNERS
Title: PROJECT MANAGER
Address: AS ABOVE.

Phone: 205-465-3030

EXHIBIT A-1 to Agreement Between Buyer and Seller dated 1-22-20

ASSIGNMENT OF CONTRACT; CONSENT TO ASSIGNMENT; AND ACCEPTANCE OF ASSIGNMENT

This assignment will be effective on the Effective Date of the Agreement between Buyer and Construction Contractor.

The Contract between _____("Buyer") and _____("Seller")
for furnishing Goods and Special Services under the Contract Documents entitled

_____

is hereby assigned, transferred, and set over to _____ ("Construction Contractor"). Construction Contractor shall be totally responsible for the performance of Seller and for the duties, rights and obligations of Buyer, not otherwise retained by Buyer, under the terms of the Contract between Buyer and Seller.

ASSIGNMENT DIRECTED BY: _____
Buyer

(If Buyer is a corporation, attach evidence of authority to sign. If Buyer is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Buyer-Seller Agreement.)

By: _____
(Signature) (Title)

ASSIGNMENT ACKNOWLEDGED AND ACCEPTED BY: _____
Seller

(If Seller is a corporation, attach evidence of authority to sign.)

By: _____
(Signature) (Title)

ASSIGNMENT ACCEPTED BY: _____
Construction Contractor

(If Construction Contractor is a corporation, attach evidence of authority to sign.)

By: _____

EXHIBIT A-2 to Agreement Between Buyer and Seller dated 1-22-20

AGREEMENT TO ASSIGNMENT BY SELLER'S SURETY

Surety hereby acknowledges and agrees that the Contract for furnishing Goods and Special Services under the Contract Documents entitled _____ _____ by and between _____ ("Buyer") and _____ ("Seller") may be assigned, transferred, and set over to _____ ("Construction Contractor"), in accordance with Paragraph 11.02 of Agreement between Buyer and Seller.

Surety further agrees that, upon assignment of the Contract, the Construction Contractor shall have all the rights of the Buyer under the Performance Bond.

(Corporate Seal)

Surety

Company: _____

By: _____
Signature and Title
(Attach Power of Attorney)

TABLE OF CONTENTS

Page

STANDARD GENERAL CONDITIONS FOR PROCUREMENT CONTRACTS

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Whenever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to the singular or plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument signed by both Buyer and Seller covering the Goods and Special Services and which lists the Contract Documents in existence on the Effective Date of the Agreement.

3. *Application for Payment*—The form acceptable to Buyer which is used by Seller in requesting progress and final payments and which is accompanied by such supporting documentation as is required by the Contract Documents.

4. *Bid*— The offer or proposal of a Seller submitted on the prescribed form setting forth the prices for the Goods and Special Services to be provided.

5. *Bidder*—The individual or entity that submits a Bid directly to Buyer.

6. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).

7. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and Bid Form with any supplements.

8. *Buyer*—The individual or entity purchasing the Goods and Special Services.

9. *Change Order*—A document which is signed by Seller and Buyer and authorizes an addition, deletion, or revision to the Contract Documents or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement. Change Orders may be the result of mutual agreement by Buyer and Seller, or of resolution of a Claim.

10. *Claim*—A demand or assertion by Buyer or Seller seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*—The entire and integrated written agreement between Buyer and Seller concerning the Goods and Special Services. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*—Those items so designated in the Agreement. Shop Drawings and other Seller submittals are not Contract Documents, even if accepted, reviewed, or approved by Engineer or Buyer.

13. *Contract Price*—The moneys payable by Buyer to Seller for furnishing the Goods and Special Services in accordance with the Contract Documents as stated in the Agreement.

14. *Contract Times*—The times stated in the Agreement by which the Goods must be delivered and Special Services must be furnished.

15. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Goods and Special Services to be furnished by Seller. Shop Drawings and other Seller submittals are not Drawings as so defined.

16. *Effective Date of the Agreement*—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

17. *Engineer*—The individual or entity designated as such in the Agreement.

18. *Field Order*—A written order issued by Engineer which requires minor changes in the Goods or Special Services but which does not involve a change in the Contract Price or Contract Times.

19. *General Requirements*—Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

20. *Goods*—The tangible and movable personal property that is described in the Contract Documents, regardless of whether the property is to be later attached to realty.

21. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, including Goods, as defined herein, and Special Services, if any, as defined herein. This term refers to both the Goods and the Special Services, or to either the Goods or the Special Services, and to any portion of the Goods or the Special Services, as the context requires.

22. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

23. *Milestone*—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to the Contract Times.

24. *Notice of Award*—The written notice by Buyer to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Buyer will sign and deliver the Agreement.

25. *Notice to Proceed*—A written notice given by Buyer to Seller fixing the date on which the Contract Times commence to run and on which Seller shall start to perform under the Contract.

26. *Point of Destination*—The specific address of the location where delivery of the Goods shall be made, as stated in the Agreement.

27. *Project*—The total undertaking of which the Goods and Special Services may be the whole, or only a part.

28. *Project Manual*—The documentary information prepared for bidding and furnishing the Goods and Special Services. A listing of the contents of the Project Manual is contained in its table of contents.

29. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Goods and Special Services and which establish the standards by which such portion of the Goods and Special Services will be judged.

30. *Seller*—The individual or entity furnishing the Goods and Special Services.

31. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Seller and submitted by Seller to illustrate some portion of the Goods and Special Services.

32. *Special Services*—Services associated with the Goods to be furnished by Seller as required by the Contract Documents.

33. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the furnishing of the Goods and Special Services, and certain administrative requirements and procedural matters applicable thereto.

34. *Successful Bidder*—The Bidder submitting a responsive Bid, to whom Buyer makes an award.

35. *Supplementary Conditions*—That part of the Contract Documents which amends or supplements these General Conditions.

36. *Work Change Directive*—A written statement to Seller issued on or after the Effective Date of the Agreement and signed by Buyer ordering an addition, deletion, or other revision in the Contract Documents with respect to the Goods and Special Services. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B and 1.02.C are not defined, but have the indicated meanings when used in the Bidding Requirements or Contract Documents.

B. *Intent of Certain Terms or Adjectives:*

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Goods and Special Services. It is intended that such exercise of professional judgment, action, or determination will be commercially reasonable and will be solely to evaluate, in general, the Goods and Special Services for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to Engineer any duty or authority to supervise or direct the furnishing of Goods or Special Services or any duty or authority to undertake responsibility contrary to any other provision of the Contract Documents.

2. The word "non-conforming" when modifying the words "Goods and Special Services," "Goods," or "Special Services," refers to Goods and Special Services that fail to conform to the Contract Documents.

3. The word "receipt" when referring to the Goods, shall mean the physical taking and possession by the Buyer under the conditions specified in Paragraph 8.01.B.3.

4. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

5. The word "furnish," when used in connection with the Goods and Special Services shall mean to supply and deliver said Goods to the Point of Destination (or some other

specified location) and to perform said Special Services fully, all in accordance with the Contract Documents.

C. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 *Delivery of Bonds*

A. When Seller delivers the executed counterparts of the Agreement to Buyer, Seller also shall deliver such bonds as Seller may be required to furnish.

2.02 *Evidence of Insurance*

A. When Seller delivers the executed counterparts of the Agreement to Buyer, Seller shall deliver to Buyer, with copies to each additional insured identified by name in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Seller is required to purchase and maintain in accordance with Article 4.

2.03 *Copies of Documents*

A. Buyer shall furnish Seller up to five printed or hard copies of the Contract Documents. Additional copies will be furnished upon request at the cost of reproduction.

2.04 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.05 *Designated Representatives*

A. Buyer and Seller shall each designate its representative at the time the Agreement is signed. Each representative shall have full authority to act on behalf of and make binding decisions in any matter arising out of or relating to the Contract.

2.06 *Progress Schedule*

A. Within 15 days after the Contract Times start to run, Seller shall submit to Buyer and Engineer an acceptable progress schedule of activities, including at a minimum, Shop Drawing and Sample submittals, tests, and deliveries as required by the Contract Documents. No progress payment will be made to Seller until an acceptable schedule is submitted to Buyer and Engineer.

B. The progress schedule will be acceptable to Buyer and Engineer if it provides an orderly progression of the submittals, tests, and deliveries to completion within the specified Milestones and the Contract Times. Such acceptance will not impose on Buyer or Engineer responsibility for the progress schedule, for sequencing, scheduling, or progress of the work nor interfere with or relieve Seller from Seller's full responsibility therefor. Such acceptance shall not be deemed to acknowledge the reasonableness and attainability of the schedule.

2.07 *Preliminary Conference*

A. Within 20 days after the Contract Times start to run, a conference attended by Seller, Buyer, Engineer and others as appropriate will be held to establish a working understanding among the parties as to the Goods and Special Services and to discuss the schedule referred to in Paragraph 2.06.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

2.08 *Safety*

A. Buyer and Seller shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss. When Seller's personnel, or the personnel of any subcontractor to Seller, are present at the Point of Destination or any work area or site controlled by Buyer, the Seller shall be responsible for the compliance by such personnel with any applicable requirements of Buyer's safety programs that are made known to Seller.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT AND AMENDING

3.01 *Intent*

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce or furnish the indicated Goods and Special Services will be provided, whether or not specifically called for, at no additional cost to Buyer.

C. Clarifications and interpretations of, or notifications of minor variations and deviations in, the Contract Documents, will be issued by Engineer as provided in Article 9.

3.02 *Standards, Specifications, Codes, Laws and Regulations*

A. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws and Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws and Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

B. No provision of any such standard, specification, manual or code, or any instruction of a supplier shall be effective to change the duties or responsibilities of Buyer or Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall any such provision or instruction be effective to assign to Buyer or Engineer, or any of their consultants, agents, or employees any duty or authority to supervise or direct the performance of Seller's obligations or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

1. *Seller's Review of Contract Documents Before the Performance of the Contract*: Before performance of the Contract, Seller shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Seller shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Seller discovers or has actual knowledge of and shall obtain a written interpretation or clarification from Engineer before proceeding with the furnishing of any Goods and Special Services affected thereby.

2. *Seller's Review of Contract Documents During the Performance of the Contract:* If, during the performance of the Contract, Seller discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Contract, any standard, specification, manual or code, or of any instruction of any Supplier, Seller shall promptly report it to Engineer in writing. Seller shall not proceed with the furnishing of the Goods and Special Services affected thereby until an amendment to or clarification of the Contract Documents has been issued.

3. Seller shall not be liable to Buyer or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Seller had actual knowledge thereof.

B. *Resolving Discrepancies:* Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

1. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

2. the provisions of any Laws or Regulations applicable to the furnishing of the Goods and Special Services (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Clarifying Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions to the Goods and Special Services or to modify contractual terms and conditions by a Change Order.

B. Buyer may issue a Work Change Directive providing for additions, deletions, or revisions to the Goods and Special Services, in which case (1) the Contract Price shall be equitably adjusted to account for any reasonable and necessary credits to Buyer for any such deletion, or for costs (including reasonable overhead and profit) incurred by Seller to accommodate such an addition or revision and (2) the Contract Times shall be equitably adjusted to account for any impact on progress and completion of performance. Such adjustments subsequently shall be duly set forth in a Change Order.

C. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Goods and Special Services may be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 5.06.D.3); or

3. Engineer's written interpretation or clarification.

ARTICLE 4 - BONDS AND INSURANCE

4.01 *Bonds*

A. Seller shall furnish to Buyer performance and payment bonds, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Seller's obligations under the Contract Documents. These bonds shall remain in effect until 1) one year after the date when final payment becomes due or 2) completion of the correction period specified in Paragraph 8.03, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Seller shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.

C. If the surety on any bond furnished by Seller is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases

to meet the requirements of Paragraph 4.01.B, Seller shall promptly notify Buyer and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 4.01.B and 4.02.

4.02 *Insurance*

A. Seller shall provide insurance of the types and coverages and in the amounts stipulated in the Supplementary Conditions.

B. Failure of Buyer to demand certificates of insurance or other evidence of Seller's full compliance with these insurance requirements or failure of Buyer to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Seller's obligation to maintain such insurance.

C. Upon assignment of this Contract, Seller shall comply with the written request of assignee to provide certificates of insurance to assignee.

D. Buyer does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Seller.

E. The insurance and insurance limits required herein shall not be deemed as a limitation on Seller's liability under the indemnities granted to Buyer in the Contract Documents.

4.03 *Licensed Sureties and Insurers*

A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Buyer or Seller shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

ARTICLE 5 - SELLER'S RESPONSIBILITIES

5.01 *Supervision and Superintendence*

A. Seller shall supervise, inspect, and direct the furnishing of the Goods and Special Services competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform its obligations in accordance with the Contract Documents. Seller shall be solely responsible for the means, methods, techniques, sequences, and procedures necessary to perform its obligations in accordance with the Contract Documents. Seller shall not be responsible for the negligence of Buyer or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure that is shown or indicated in and expressly required by the Contract Documents.

5.02 *Labor, Materials and Equipment*

A. Seller shall provide competent, qualified and trained personnel in all aspects of its performance of the Contract.

B. All Goods, and all equipment and material incorporated into the Goods, shall be as specified, and unless specified otherwise in the Contract Documents, shall be:

1. new, and of good quality;

2. protected, assembled, connected, cleaned, and conditioned in accordance with the original manufacturer's instructions; and

3. shop assembled to the greatest extent practicable.

5.03 *Laws and Regulations*

A. Seller shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of its obligations in accordance with the Contract Documents. Except where otherwise expressly required by such Laws and Regulations, neither Buyer nor Engineer shall be responsible for monitoring Seller's compliance with any Laws or Regulations.

B. If Seller furnishes Goods and Special Services knowing or having reason to know that such furnishing is contrary to Laws or Regulations, Seller shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such performance. It shall not be Seller's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this provision shall not relieve Seller of Seller's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance shall be the subject of an adjustment in Contract Price or Contract Times. If Buyer and Seller are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 9.06.

5.04 *Or Equals*

A. Whenever the Goods, or an item of material or equipment to be incorporated into the Goods, are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular supplier or manufacturer, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item is permitted, other items of material or equipment or material or equipment of other suppliers or manufacturers may be submitted to Buyer for Engineer's review.

1. If in Engineer's sole discretion, such an item of material or equipment proposed by Seller is functionally equal to that named and sufficiently similar so that no change in related work will be required, it may be considered by Engineer as an "or-equal" item.

2. For the purposes of this paragraph, a proposed item of material or equipment may be considered functionally equal to an item so named only if:

   a. in the exercise of reasonable judgment, Engineer determines that: 1) it is at least equal in quality, durability, appearance, strength, and design characteristics; 2) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole; 3) it has an acceptable record of performance and availability of responsive service; and

   b. Seller certifies that if approved: 1) there will be no increase in any cost, including capital, installation or operating costs, to Buyer; and 2) the proposed item will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraph 5.04.A. Engineer will be the sole judge of whether to accept or reject such a proposal or submittal. No "or-equal" will be ordered, manufactured or utilized until Engineer's review is complete, which will be evidenced by an approved Shop Drawing. Engineer will advise Buyer and Seller in writing of any negative determination. Notwithstanding Engineer's approval of an "or-equal" item, Seller shall remain obligated to comply with the requirements of the Contract Documents.

C. *Special Guarantee:* Buyer may require Seller to furnish at Seller's expense a special performance guarantee or other surety with respect to any such proposed "or-equal."

D. *Data:* Seller shall provide all data in support of any such proposed "or-equal" at Seller's expense.

5.05 *Taxes*

A. Seller shall be responsible for all taxes and duties arising out of the sale of the Goods and the furnishing of Special Services. All taxes are included in the Contract Price, except as noted in the Supplementary Conditions.

5.06 *Shop Drawings and Samples*

A. Seller shall submit Shop Drawings and Samples to Buyer for Engineer's review and approval in accordance with the schedule required in Paragraph 2.06.A. All submittals will be identified as required and furnished in the number of copies specified in the Contract Documents. The data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Seller proposes to provide.

B. Where a Shop Drawing or Sample is required by the Contract Documents, any related work performed prior to Engineer's approval of the pertinent submittal will be at the sole expense and responsibility of Seller.

C. *Submittal Procedures:*

1. Before submitting each Shop Drawing or Sample, Seller shall have determined and verified:

   a. all field measurements (if required), quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto; and

   b. that all materials are suitable with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the furnishing of Goods and Special Services.

2. Seller shall also have reviewed and coordinated each Shop Drawing or Sample with the Contract Documents.

3. Each submittal shall bear a stamp or include a written certification from Seller that Seller has reviewed the subject submittal and confirmed that it is in compliance with the requirements of the Contract Documents. Both Buyer and Engineer shall be entitled to rely on such certification from Seller.

4. With each submittal, Seller shall give Buyer and Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both in a written communication separate from the submittal and by specific notation on each Shop Drawing or Sample.

D. *Engineer's Review:*

1. Engineer will provide timely review of Shop Drawings and Samples.

2. Engineer's review and approval will be only to determine if the Goods and Special Services covered by the submittals will, after installation or incorporation in the Project, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole.

3. Engineer's review and approval shall not relieve Seller from responsibility for any variation from the requirements of the Contract Documents unless Seller has complied with the requirements of Paragraph 5.06.C.4 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Seller from responsibility for complying with the requirements of Paragraph 5.06.C.1.

E. *Resubmittal Procedures:*

1. Seller shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Seller shall direct specific attention in writing to any revisions other than the corrections called for by Engineer on previous submittals.

5.07 *Continuing Performance*

A. Seller shall adhere to the progress schedule established in accordance with Paragraph 2.06.A., and the Goods shall be delivered and the Special Services furnished within the Contract Times specified in the Agreement.

B. Seller shall carry on furnishing of the Goods and Special Services and adhere to the progress schedule during all disputes or disagreements with Buyer. No furnishing of Goods and Special Services shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraphs 11.03 or 11.04, or as Buyer and Seller may otherwise agree in writing.

5.08 *Seller's Warranties and Guarantees*

A. Seller warrants and guarantees to Buyer that the title to the Goods conveyed shall be proper, its transfer rightful, and free from any security interest, lien, or other encumbrance. Seller shall defend, indemnify, and hold Buyer harmless against any liens, claims, or demands contesting or affecting title of the Goods conveyed.

B. Seller warrants and guarantees to Buyer that all Goods and Special Services will conform with the Contract Documents, and with the standards established by any Samples approved by Engineer. Engineer shall be entitled to rely on Seller's warranty and guarantee. If the Contract Documents do not otherwise specify the characteristics or the quality of the Goods, the Goods shall comply with the requirements of Paragraph 5.02.B.

C. Seller's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, improper modification, improper maintenance, or improper operation by persons other than Seller; or

2. corrosion or chemical attack, unless corrosive or chemically-damaging conditions were disclosed by Buyer in the Contract Documents and the Contract Documents required the Goods to withstand such conditions;

3. use in a manner contrary to Seller's written instructions for installation, operation, and maintenance; or

4. normal wear and tear under normal usage.

D. Seller's obligation to furnish the Goods and Special Services in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Goods and

Special Services that are non-conforming, or a release of Seller's obligation to furnish the Goods and Special Services in accordance with the Contract Documents:

1. observations by Buyer or Engineer;

2. recommendation by Engineer or payment by Buyer of any progress or final payment;

3. use of the Goods by Buyer;

4. any acceptance by Buyer (subject to the provisions of Paragraph 8.02.D.1) or any failure to do so;

5. the issuance of a notice of acceptance by Buyer pursuant to the provisions of Article 8;

6. any inspection, test or approval by others; or

7. any correction of non-conforming Goods and Special Services by Buyer.

E. Buyer shall promptly notify Seller of any breach of Seller's warranties or guarantees.

F. Seller makes no implied warranties under this Contract.

5.09 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Seller shall indemnify and hold harmless Buyer and Engineer, and the officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of Seller's obligations under the Contract Documents, provided that any such claim, cost, loss, or damages attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Goods themselves), including the loss of use resulting therefrom, but only to the extent cause by any negligent act or omission of Seller, or any individual or entity directly or indirectly employed by Seller or anyone for whose acts Seller may be liable.

B. In any and all claims against Buyer or Engineer or any of their respective assignees, consultants, agents, officers, directors, members, partners, employees, agents, consultants, contractors, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Seller, any subcontractor, any supplier, or any individual or entity directly or indirectly employed by any of them to furnish any of the Goods and Special Services, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 5.09.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for seller or any such subcontractor, supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Seller under Paragraph 5.09.A shall not extend to the liability of Engineer and Engineer's officers, directors, partners, employees, agents, and consultants arising out of:

1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

5.10 *Delegation of Professional Design Services*

A. Seller will not be required to provide professional design services unless such services are specifically required by the Contract Documents or unless such services are required to carry out Seller's responsibilities for furnishing the Goods and Special Services. Seller shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to the Goods and Special Services are specifically required of Seller by the Contract Documents, Buyer and Engineer will specify all performance and design criteria that such services must satisfy. Seller shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Goods and Special Services designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Buyer and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Buyer and Engineer have specified to Seller all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 5.10, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 5.06.D.2.

E. Seller shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 6 - SHIPPING AND DELIVERY

6.01 *Shipping*

A. Seller shall select the carrier and bear all costs of packaging, transportation, insurance, special handling and any other costs associated with shipment and delivery.

6.02 *Delivery*

A. Seller shall deliver the Goods F.O.B. the Point of Destination in accordance with the Contract Times set forth in the Agreement, or other date agreed to by Buyer and Seller.

B. Seller shall provide written notice to Buyer at least 10 days before shipment of the manner of shipment and the anticipated delivery date. The notice shall also include any instructions concerning special equipment or services required at the Point of Destination to unload and care for the Goods. Seller shall also require the carrier to give Buyer at least 24 hours' notice by telephone prior to the anticipated time of delivery.

C. Buyer will be responsible and bear all costs for unloading the Goods from carrier.

D. Buyer will assure that adequate facilities are available to receive delivery of the Goods during the Contract Times for delivery set forth in the Agreement, or another date agreed by Buyer and Seller.

E. No partial deliveries shall be allowed, unless permitted or required by the Contract Documents or agreed to in writing by Buyer.

6.03 *Risk of Loss*

A. Risk of loss and insurable interests transfer from Seller to Buyer upon Buyer's receipt of the Goods.

B. Notwithstanding the provisions of Paragraph 6.03.A, if Buyer rejects the Goods as non-conforming, the risk of loss on such Goods shall remain with Seller until Seller corrects the non-conformity or Buyer accepts the Goods. If rejected Goods remain at the Point of Destination pending modification and acceptance, then Seller shall be responsible for arranging adequate protection and maintenance of the Goods at Seller's expense.

6.04 *Progress Schedule*

A. Seller shall adhere to the progress schedule established in accordance with Paragraph 2.06 as it may be adjusted from time to time as provided below.

1. Seller shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.06) proposed adjustments in the progress schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the progress schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 7. Adjustments in Contract Times may only be made by a Change Order.

ARTICLE 7 - CHANGES: SCHEDULE AND DELAY

7.01 *Changes in the Goods and Special Services*

A. Buyer may at any time, without notice to any surety, make an addition, deletion, or other revision to the Contract Documents with respect to the Goods and Services, within the general scope of the Contract, by a Change Order or Work Change Directive. Upon receipt of any such document, Seller shall promptly proceed with performance pursuant to the revised Contract Documents (except as otherwise specifically provided).

B. If Seller concludes that a Work Change Directive issued by Buyer affects the Contract Price or Contract Times, then Seller shall notify Buyer within 15 days after Seller has received the Work Change Directive, and submit written supporting data to Buyer within 45 days after such receipt. If Seller fails to notify Buyer within 15 days, Seller waives any Claim for such adjustment. If Buyer and Seller are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 9.06.

C. Seller shall not suspend performance while Buyer and Seller are in the process of making such changes and any related adjustments to Contract Price or Contract Times.

7.02 *Changing Contract Price or Contract Times*

A. The Contract Price or Contract Times may only be changed by a Change Order.

B. Any Claim for an adjustment in the Contract Price or Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 9.06.

C. If Seller is prevented from delivering the Goods or performing the Special Services within the Contract Times for any unforeseen reason beyond its control and not attributable to its actions or inactions, then Seller shall be entitled to an adjustment of the Contract Times to the extent attributable to such reason. Such reasons include but are not limited to acts or neglect by Buyer, inspection delays, fires, floods, epidemics, abnormal weather conditions, acts of God, and other like matters. If such an event occurs and delays Seller's performance, Seller shall notify Buyer in writing within 15 days of knowing or having reason to know of the beginning of the event causing the delay, stating the reason therefor.

D. Seller shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Seller. Delays attributable to and within the control of Seller's subcontractors or suppliers shall be deemed to be delays within the control of Seller.

E. If Seller is prevented from delivering the Goods or furnishing the Special Services within the Contract Times due to the actions or inactions of Buyer, Seller shall be entitled to any reasonable and necessary additional costs arising out of such delay to the extent directly attributable to Buyer.

F. Neither Buyer nor Seller shall be entitled to any damages arising from delays which are beyond the control of both Buyer and Seller, including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God, and other like matters.

ARTICLE 8 - BUYER'S RIGHTS

8.01 *Inspections and Testing*

A. *General:*

1. The Contract Documents specify required inspections and tests. Buyer shall have the right to perform, or cause to be performed, reasonable inspections and require reasonable tests of the Goods at Seller's facility, and at the Point of Destination. Seller shall allow Buyer a reasonable time to perform such inspections or tests.

2. Seller shall reimburse Buyer for all expenses, except for travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, for inspections and tests specified in the Contract Documents. If as the result of any such specified testing the Goods are determined to be non-conforming, then Seller shall also bear the travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, and all expenses of re-inspection or retesting.

3. Buyer shall bear all expenses of inspections and tests that are not specified in the Contract Documents (other than any re-inspection or retesting resulting from a determination of non-conformity, as set forth in Paragraph 8.01.A.2 immediately above); provided, however, that if as the result of any such non-specified inspections or testing the Goods are determined to be non-conforming, then Seller shall bear all expenses of such inspections and testing, and of any necessary re-inspection and retesting.

4. Seller shall provide Buyer timely written notice of the readiness of the Goods for all inspections, tests, or approvals which the Contract Documents specify are to be observed by Buyer prior to shipment.

5. Buyer will give Seller timely notice of all specified tests, inspections, and approvals of the Goods which are to be conducted at the Point of Destination.

6. If, on the basis of any inspections or testing, the Goods appear to be conforming, Buyer will give Seller prompt notice thereof. If on the basis of said inspections or testing, the Goods appear to be non-conforming, Buyer will give Seller prompt notice thereof and will advise Seller of the remedy Buyer elects under the provisions of Paragraph 8.02.

7. Neither payments made by Buyer to Seller prior to any tests or inspections, nor any tests or inspections shall constitute acceptance of non-conforming Goods, or prejudice Buyer's rights under the Contract.

B. Inspection on Delivery:

1. Buyer or Engineer will visually inspect the Goods upon delivery solely for purposes of identifying the Goods and general verification of quantities and observation of apparent condition in order to provide a basis for a progress payment. Such visual inspection will not be construed as final or as receipt of any Goods and Special Services that, as a result of subsequent inspections and tests, are determined to be non-conforming.

2. Within ten days of such visual inspection, Buyer shall provide Seller with written notice of Buyer's determination regarding conformity of the Goods. In the event Buyer does not provide such notice, it will be presumed that the Goods appear to be conforming and that Buyer has acknowledged their receipt upon delivery.

3. If, on the basis of the visual inspection specified in Paragraph 8.01.B.1, the Goods appear to be conforming, Buyer's notice thereof to Seller will acknowledge receipt of the Goods.

C. Final Inspection:

1. After all of the Goods have been incorporated into the Project, tested in accordance with such testing requirements as are specified, and are functioning as indicated, Buyer or Engineer will make a final inspection.

2. If, on the basis of the final inspection, the Goods are conforming, Buyer's notice thereof will constitute Buyer's acceptance of the Goods.

3. If, on the basis of the final inspection, the Goods are non-conforming, Buyer will identify the non-conformity in writing.

8.02 *Non-Conforming Goods and Special Services*

A. If, on the basis of inspections and testing prior to delivery, the Goods and Special Services are found to be non-conforming, or if at any time after Buyer has acknowledged receipt of delivery and before the expiration of the correction period described in Paragraph 8.03, Buyer determines that the Goods and Special Services are non-conforming, then Seller shall promptly, without cost to Buyer and in response to written instructions from Buyer, either correct such non-conforming Goods and Special Services, or, if Goods are rejected by Buyer, remove and replace the non-conforming Goods with conforming Goods, including all work required for reinstallation.

B. Buyer's Rejection of Non-Conforming Goods:

1. If Buyer elects to reject the Goods in whole or in part, Buyer's notice to Seller will describe in sufficient detail the non-conforming aspect of the Goods. If Goods have been delivered to Buyer, Seller shall promptly, and within the Contract Times, remove and replace the rejected Goods.

2. Seller shall bear all costs, losses and damages attributable to the removal and replacement of the non-conforming Goods as provided in Paragraph 8.02.E.

3. Upon rejection of the Goods, Buyer retains a security interest in the Goods to the extent of any payments made and expenses incurred in their testing and inspection.

C. Remedying Non-Conforming Goods and Special Services:

1. If Buyer elects to permit the Seller to modify the Goods to correct the non-conformance, then Seller shall promptly provide a schedule for such modifications and shall make the Goods conforming within a reasonable time.

2. If Buyer notifies Seller in writing that any of the Special Services are non-conforming, Seller shall promptly provide conforming services acceptable to Buyer. If Seller fails to do so, Buyer may delete the Special Services and reduce the Contract Price a commensurate amount.

D. Buyer's Acceptance of Non-Conforming Goods:

Instead of requiring correction or removal and replacement of non-conforming Goods discovered either before or after final payment, Buyer may accept the non-conforming Goods. Seller shall bear all reasonable costs, losses, and damages attributable to Buyer's evaluation of and determination to accept such non-conforming Goods as provided in Paragraph 8.02.E.

E. Seller shall pay all claims, costs, losses, and damages, including but not limited to all fees and charges for re-inspection, retesting and for any engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs arising out of or relating to the non-conforming Goods and Special Services. Seller's obligations shall include the costs of the correction or removal and replacement of the non-conforming Goods and the replacement of property of Buyer and others destroyed by the correction or removal and replacement of the non-conforming Goods, and obtaining conforming Special Services from others.

F. *Buyer's Rejection of Conforming Goods:*

If Buyer asserts that Goods and Special Services are non-conforming and such Goods and Special Services are determined to be conforming, or if Buyer rejects as non-conforming Goods and Special Services that are later determined to be conforming, then Seller shall be entitled to reimbursement from Buyer of costs incurred by Seller in inspecting, testing, correcting, removing, or replacing the conforming Goods and Special Services, including but not limited to fees and charges of engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs associated with the incorrect assertion of non-conformance or rejection of conforming Goods and Special Services.

8.03 *Correction Period*

A. Seller's responsibility for correcting all non-conformities in the Goods and Special Services will extend for a period of one year after the earlier of the date on which Buyer has placed the Goods in continuous service or the date of final payment, or for such longer period of time as may be prescribed by Laws or Regulations or by the terms of any specific provisions of the Contract Documents.

ARTICLE 9 - ROLE OF ENGINEER

9.01 *Duties and Responsibilities*

A. The duties and responsibilities and the limitations of authority of Engineer are set forth in the Contract Documents.

9.02 *Clarifications and Interpretations*

A. Engineer will issue with reasonable promptness such written clarifications or interpretations of the Contract Documents as Engineer may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents. Such written clarifications and interpretations will be binding on Buyer and Seller. If either Buyer or Seller believes that a written clarification or interpretation justifies an adjustment in the Contract Price or Contract Times, either may make a Claim therefor.

9.03 *Authorized Variations*

A. Engineer may authorize minor deviations or variations in the Contract Documents by: 1) written approval of specific variations set forth in Shop Drawings when Seller has duly noted such variations as required in Paragraph 5.06.C.4, or 2) a Field Order.

9.04 *Rejecting Non-Conforming Goods and Special Services*

A. Engineer will have the authority to disapprove or reject Goods and Special Services that Engineer believes to be non-conforming. Engineer will also have authority to require special inspection or testing of the Goods or Special Services as provided in Paragraph 8.01 whether or not the Goods are fabricated or installed, or the Special Services are completed.

9.05 *Decisions on Requirements of Contract Documents*

A. Engineer will be the initial interpreter of the Contract Documents and judge of the acceptability of the Goods and Special Services. Claims, disputes and other matters relating to the acceptability of the Goods and Special Services or the interpretation of the requirements of the Contract Documents pertaining to Seller's performance will be referred initially to Engineer in writing with a request for a formal decision in accordance with this paragraph.

B. When functioning as interpreter and judge under this Paragraph 9.05, Engineer will not show partiality to Buyer or Seller and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity. The rendering of a decision by Engineer pursuant to this Paragraph 9.05 with respect to any such Claim, dispute, or other matter (except any which have been waived by the making or acceptance of final payment as provided in Paragraph 10.07) will be a condition precedent to any exercise by Buyer or Seller of such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any such Claim, dispute, or other matter.

9.06 *Claims and Disputes*

A. *Notice*: Written notice of each Claim relating to the acceptability of the Goods and Special Services or the interpretation of the requirements of the Contract Documents pertaining to either party's performance shall be delivered by the claimant to Engineer and the other party to the Agreement within 15 days after the occurrence of the event giving rise thereto, and written supporting data shall be submitted to Engineer and the other party within 45 days after such occurrence unless Engineer allows an additional period of time to ascertain more accurate data.

B. *Engineer's Decision*: Engineer will review each such Claim and render a decision in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

C. If Engineer does not render a formal written decision on a Claim within the time stated in Paragraph 9.06.B., Engineer shall be deemed to have issued a decision denying the Claim in its entirety 31 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

D. Engineer's written decision on such Claim or a decision denying the Claim in its entirety that is deemed to have been issued pursuant to Paragraph 9.06.C, will be final and binding upon Buyer and Seller 30 days after it is issued unless within 30 days of issuance Buyer or Seller appeals Engineer's decision by initiating the mediation of such Claim in accordance with the dispute resolution procedures set forth in Article 13.

E. If Article 13 has been amended to delete the mediation requirement, then Buyer or Seller may appeal Engineer's decision within 30 days of issuance by following the alternative dispute resolution process set forth in Article 13, as amended; or if no such alternative dispute resolution process has been set forth, Buyer or Seller may appeal Engineer's decision by 1) delivering to the other party within 30 days of the date of such decision a written notice of intent to submit the Claim to a court of competent jurisdiction, and 2) within 60 days after the date of such decision instituting a formal proceeding in a court of competent jurisdiction.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 9.06.

G. The parties agree to endeavor to avoid or resolve Claims through direct, good faith discussions and negotiations whenever practicable. Such discussions and negotiations should at the outset address whether the parties mutually agree to suspend the time periods established in this Paragraph 9.06; if so, a written record of such mutual agreement should be made and jointly executed.

ARTICLE 10 - PAYMENT

10.01 *Applications for Progress Payments*

A. Seller shall submit to Buyer for Engineer's review Applications for Payment filled out and signed by Seller and accompanied by such supporting documentation as is required by the

Contract Documents and also as Buyer or Engineer may reasonably require. The timing and amounts of progress payments shall be as stipulated in the Agreement.

1. The first application for Payment will be submitted after review and approval by Engineer of all Shop Drawings and of all Samples required by the Contract Documents.

2. The second Application for Payment will be submitted after receipt of the Goods has been acknowledged in accordance with Paragraph 8.01.B and will be accompanied by a bill of sale, invoice, or other documentation reasonably satisfactory to Buyer warranting that Buyer has rightfully received good title to the Goods from Seller and that, upon payment, the Goods will be free and clear of all liens. Such documentation will include releases and waivers from all parties with viable lien rights. In the case of multiple deliveries of Goods, additional Applications for Payment accompanied by the required documentation will be submitted as Buyer acknowledges receipt of additional items of the Goods.

10.02 *Review of Applications for Progress Payments*

A. Engineer will, within ten days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Buyer, or return the Application to Seller indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Seller may make the necessary corrections and resubmit the Application.

1. Engineer’s recommendation of payment requested in the first Application for Payment will constitute a representation by Engineer, based on Engineer’s review of the Application for Payment and the accompanying data, that the Shop Drawings and Samples have been reviewed and approved as required by the Contract Documents and Seller is entitled to payment of the amount recommended.

2. Engineer’s recommendation of payment requested in the Application for Payment submitted upon Buyer’s acknowledgment of receipt of the Goods will constitute a representation by Engineer, based on Engineer’s review of the Application for Payment and the accompanying data Seller is entitled to payment of the amount recommended. Such recommendation will not constitute a representation that Engineer has made a final inspection of the Goods, that the Goods are free from non-conformities, acceptable or in conformance with the Contract Documents, that Engineer has made any investigation as to Buyer’s title to the Goods, that exhaustive or continuous inspections have been made to check the quality or the quantity of the Goods beyond the responsibilities specifically assigned to Engineer in the Contract Documents or that there may not be other matters or issues between the parties that might entitle Seller to additional payments by Buyer or Buyer to withhold payment to Seller.

3. Engineer may refuse to recommend that all or any part of a progress payment be made, or Engineer may nullify all or any part of any payment previously recommended if, in Engineer's opinion, such recommendation would be incorrect or if on the basis of subsequently discovered evidence or subsequent inspections or tests Engineer considers

such refusal or nullification necessary to protect Buyer from loss because the Contract Price has been reduced, Goods are found to be non-conforming, or Seller has failed to furnish acceptable Special Services.

10.03 *Amount and Timing of Progress Payments*

A. Subject to Paragraph 10.02.A., the amounts of the progress payments will be as provided in the Agreement. Buyer shall within 30 days after receipt of each Application for Payment with Engineer's recommendation pay Seller the amount recommended; but, in the case of the Application for Payment upon Buyer's acknowledgment of receipt of the Goods, said 30-day period may be extended for so long as is necessary (but in no event more than 60 days) for Buyer to examine the bill of sale and other documentation submitted therewith. Buyer shall notify Seller promptly of any deficiency in the documentation and shall not unreasonably withhold payment.

10.04 *Suspension of or Reduction in Payment*

A. Buyer may suspend or reduce the amount of progress payments, even though recommended for payment by Engineer, under the following circumstances:

1. Buyer has reasonable grounds to conclude that Seller will not furnish the Goods or the Special Services in accordance with the Contract Documents, and

2. Buyer has requested in writing assurances from Seller that the Goods and Special Services will be delivered or furnished in accordance with the Contract Documents, and Seller has failed to provide adequate assurances within ten days of Buyer’s written request.

B. If Buyer refuses to make payment of the full amount recommended by Engineer, Buyer will provide Seller and Engineer immediate written notice stating the reason for such action and promptly pay Seller any amount remaining after deduction of the amount withheld. Buyer shall promptly pay Seller the amount withheld when Seller corrects the reason for such action to Buyer’s satisfaction.

10.05 *Final Application for Payment*

A. After Seller has corrected all non-conformities to the reasonable satisfaction of Buyer and Engineer, furnished all Special Services, and delivered all documents required by the Contract Documents, Engineer will issue to Buyer and Seller a notice of acceptance. Seller may then make application for final payment following the procedure for progress payments. The final Application for Payment will be accompanied by all documentation called for in the Contract Documents, a list of all unsettled Claims, and such other data and information as Buyer or Engineer may reasonably require.

10.06 *Final Payment*

A. If, on the basis of final inspection and the review of the final Application for Payment and accompanying documentation, Engineer is reasonably satisfied that Seller has furnished the Goods and Special Services in accordance with the Contract Documents, and that Seller's has fulfilled all other obligations under the Contract Documents, then Engineer will, within ten days after receipt of the final Application for Payment, recommend in writing final payment subject to the provisions of Paragraph 10.07 and present the Application to Buyer. Otherwise, Engineer will return the Application to Seller, indicating the reasons for refusing to recommend final payment, in which case Seller shall make the necessary corrections and resubmit the Application for payment. If the Application and accompanying documentation are appropriate as to form and substance, Buyer shall, within 30 days after receipt thereof, pay Seller the amount recommended by Engineer, less any sum Buyer is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages to which Buyer is entitled.

10.07 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Buyer against Seller, except Claims arising from unsettled liens from non-conformities in the Goods or Special Services appearing after final payment, from Seller's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Seller's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Seller against Buyer (other than those previously made in accordance with the requirements herein and listed by Seller as unsettled as required in Paragraph 10.05.A, and not resolved in writing).

ARTICLE 11 - CANCELLATION, SUSPENSION, AND TERMINATION

11.01 *Cancellation*

A. Buyer has the right to cancel the Contract, without cause, at any time prior to delivery of the Goods by written notice. Cancellation pursuant to the terms of this paragraph shall not constitute a breach of contract by Buyer. Upon cancellation:

1. Buyer shall pay Seller for the direct costs incurred in producing any Goods that Seller has specially manufactured for the Project, plus a fair and reasonable amount for overhead and profit.

2. For Goods that are not specially manufactured for the Project, Seller shall be entitled to a restocking charge of 10 percent of the unpaid Contract Price of such Goods.

11.02 *Suspension of Performance by Buyer*

A. Buyer has the right to suspend performance of the Contract for up to a maximum of ninety days, without cause, by written notice. Upon suspension under this paragraph, Seller shall be entitled

to an increase in the Contract Times and Contract Price caused by the suspension, provided that performance would not have been suspended or delayed for causes attributable to Seller.

11.03 *Suspension of Performance by Seller*

A. Subject to the provisions of Paragraph 5.07.B, Seller may suspend the furnishing of the Goods and Special Services only under the following circumstance:

1. Seller has reasonable grounds to conclude that Buyer will not perform its future payment obligations under the Contract; and,

2. Seller has requested in writing assurances from Buyer that future payments will be made in accordance with the Contract, and Buyer has failed to provide such assurances within ten days of Seller's written request.

11.04 *Breach and Termination*

A. Buyer's Breach:

1. Buyer shall be deemed in breach of the Contract if it fails to comply with any material provision of the Contract Documents, including but not limited to:

a. wrongful rejection or revocation of Buyer's acceptance of the Goods,

b. failure to make payments in accordance with the Contract Documents, or

c. wrongful repudiation of the Contract.

2. Seller shall have the right to terminate the Contract for cause by declaring a breach should Buyer fail to comply with any material provisions of the Contract. Upon termination, Seller shall be entitled to all remedies provided by Laws and Regulations.

a. In the event Seller believes Buyer is in breach of its obligations under the Contract, Seller shall provide Buyer with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Buyer shall have seven days from receipt of the written notice declaring the breach (or such longer period of time as Seller may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

B. Seller's Breach:

1. Seller shall be deemed in breach of the Contract if it fails to comply with any material provision of the Contract Documents, including, but not limited to:

a. failure to deliver the Goods or perform the Special Services in accordance with the Contract Documents,

b. wrongful repudiation of the Contract, or

c. delivery or furnishing of non-conforming Goods and Special Services.

2. Buyer may terminate Seller's right to perform the Contract for cause by declaring a breach should Seller fail to comply with any material provision of the Contract Documents. Upon termination, Buyer shall be entitled to all remedies provided by Laws and Regulations.

a. In the event Buyer believes Seller is in breach of its obligations under the Contract, and except as provided in Paragraph 11.04.B.2.b, Buyer shall provide Seller with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Seller shall have seven days from receipt of the written notice declaring the breach (or such longer period of time as Buyer may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

b. If and to the extent that Seller has provided a performance bond under the provisions of Paragraph 4.01, the notice and cure procedures of that bond, if any, shall supersede the notice and cure procedures of Paragraph 11.04.B.2.a.

ARTICLE 12 - LICENSES AND FEES

12.01 *Intellectual Property and License Fees*

A. Unless specifically stated elsewhere in the Contract Documents, Seller is not transferring any intellectual property rights, patent rights, or licenses for the Goods delivered. However, in the event the Seller is manufacturing to Buyer's design, Buyer retains all intellectual property rights in such design.

B. Seller shall pay all license fees and royalties and assume all costs incident to the use or the furnishing of the Goods, unless specified otherwise by the Contract Documents.

12.02 *Seller's Infringement*

A. Subject to Paragraph 12.01.A, Seller shall indemnify and hold harmless Buyer, Engineer and their officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors from and against all claims, costs, losses, damages, and judgments (including but not limited to all reasonable fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement or alleged infringement of any United States or foreign patent or copyright by any of the Goods as delivered hereunder.

B. In the event of suit or threat of suit for intellectual property infringement, Buyer will promptly notify Seller of receiving notice thereof.

C. Seller shall promptly defend the claim or suit, including negotiating a settlement. Seller shall have control over such claim or suit, provided that Seller agrees to bear all expenses and to satisfy any adverse judgment thereof.

1. If Seller fails to defend such suit or claim after written notice by Buyer, Seller will be bound in any subsequent suit or claim against Seller by Buyer by any factual determination in the prior suit or claim.

2. If Buyer fails to provide Seller the opportunity to defend such suit or claim after written notice by Seller, Buyer shall be barred from any remedy against Seller for such suit or claim.

D. If a determination is made that Seller has infringed upon intellectual property rights of another, Seller may obtain the necessary licenses for Buyer's benefit, or replace the Goods and provide related design and construction as necessary to avoid the infringement at Seller's own expense.

12.03 *Buyer's Infringement*

A. Buyer shall indemnify and hold harmless Seller, and its officers, directors, partners, employees, agents, consultants, contractors, and subcontractors from and against all claims, costs, losses, damages, and judgments (including but not limited to all reasonable fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement or alleged infringement of any United States or foreign patent or copyright caused by Seller's compliance with Buyer's design of the Goods or Buyer's use of the Goods in combination with other materials or equipment in any process (unless intent of such use was known to Seller and Seller had reason to know such infringement would result).

B. In the event of suit or threat of suit for intellectual property infringement, Seller must after receiving notice thereof promptly notify Buyer.

C. Upon written notice from Seller, Buyer shall be given the opportunity to defend the claim or suit, including negotiating a settlement. Buyer shall have control over such claim or suit, provided that Buyer agrees to bear all expenses and to satisfy any adverse judgment thereof.

1. If Buyer fails to defend such suit or claim after written notice by Seller, Buyer will be bound in any subsequent suit or claim against Buyer by Seller by any factual determination in the prior suit or claim.

2. If Seller fails to provide Buyer the opportunity to defend such suit or claim after written notice by Buyer, Seller shall be barred from any remedy against Buyer for such suit or claim.

12.04 *Reuse of Documents*

A. Neither Seller nor any other person furnishing any of the Goods and Special Services under a direct or indirect contract with Seller shall: (1) acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or

bearing the seal of Engineer or its consultants, including electronic media versions; or (2) reuse any of such Drawings, Specifications, other documents, or copies thereof on any other project without written consent of Buyer and Engineer and specific written verification or adaptation by Engineer. This prohibition will survive termination or completion of the Contract. Nothing herein shall preclude Seller from retaining copies of the Contract Documents for record purposes.

12.05 *Electronic Data*

A. Unless otherwise stated in the Supplementary Conditions, copies of data furnished by Buyer or Engineer to Seller, or by Seller to Buyer or Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. The transferring party will correct any errors detected within the 60-day acceptance period.

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 13 - DISPUTE RESOLUTION

13.01 *Dispute Resolution Method*

A. Either Buyer or Seller may initiate the mediation of any Claim decided in writing by Engineer under Paragraph 9.06.B or 9.06.C before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the Engineer's decision from becoming final and binding.

B. Buyer and Seller shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the mediation process does not result in resolution of the Claim, then Engineer's written decision under Paragraph 9.06.B or a denial pursuant to Paragraph 9.06.C shall become final and

binding 30 days after termination of the mediation unless, within that time period, Buyer or Seller:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions, or

2. agrees with the other party to submit the Claim to another dispute resolution process, or

3. if no dispute resolution process has been provided for in the Supplementary Conditions, delivers to the other party written notice of the intent to submit the Claim to a court of competent jurisdiction, and within 60 days of the termination of the mediation institutes such formal proceeding.

ARTICLE 14 - MISCELLANEOUS

14.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if: 1) delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or 2) if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

14.02 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Point of Destination is located.

B. In the case of any conflict between the express terms of this Contract and the Uniform Commercial Code, as adopted in the state whose law governs, it is the intent of the parties that the express terms of this Contract shall apply.

14.03 *Computation of Time*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day shall be omitted from the computation.

14.04 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents, and the provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

14.05 *Survival of Obligations*

A. All representations, indemnifications, warranties and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Goods and Special Services and termination or completion of the Agreement.

14.06 *Entire Agreement*

A. Buyer and Seller agree that this Agreement is the complete and final agreement between them, and supersedes all prior negotiations, representations, or agreements, either written or oral. This Agreement may not be altered, modified, or amended except in writing signed by an authorized representative of both parties.

SUPPLEMENTARY CONDITIONS

TABLE OF CONTENTS

SUPPLEMENTARY CONDITIONS

SC-1.01 *Definitions*

REPLACE the word "Bid" with the word "Proposal".

REPLACE the word "Bids" with the word "Proposals".

REPLACE the word "Bidder" with the word "Proposer".

REPLACE the word "Bidding" with the word "Proposing".

In Paragraph 1.01.A.8 **INSERT** the word "public" prior to the word "entity".

SC-1.01.A.7 Proposing Requirements

REPLACE Paragraph 1.01.A.7 to read as follows: The Request for Proposal, Instructions for Proposers, and Proposal Form with any supplements.

SC-1.01.A.25. *Notice to Proceed*

DELETE Paragraph 1.01.A.25 in its entirety.

SC-1.01.A.34 *Successful Proposer*

REPLACE Paragraph 1.01.A.34 with the following:

"*Successful Proposer* -The Proposer submitting a responsive Proposal which is in the best interest of the Owner or with whom Buyer makes an agreement."

SC-1.01.A.37. *Substantial Completion*

After paragraph 1.01.A.36, insert the following new paragraph:

"37. *Substantial Completion* - The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof."

SC-2.03 *Copies of Documents*

REPLACE the Paragraph 2.03 A. in its entirety with:

"A. Buyer shall furnish Seller up to two printed or hard copies and one electronic pdf copies of the Contract Documents. Additional copies will be furnished upon request at the cost of reproduction."

SC-2.04 *Commencement of Contract Times; Notice to Proceed*

In Paragraph 2.04 **REMOVE** "; Notice to Proceed"

In Paragraph 2.04.A. **REPLACE** the Paragraph with the following language: "The Contract Times will commence to run on the Effective Date of the Agreement."

SC-2.06 *Progress Schedule*

In Paragraph 2.06.A. following "minimum," **ADD** "milestones, contract time, stages of work,".

SC-2.07 *Preliminary Conference*

In Paragraph 2.07.A. **REPLACE** "20" with "7".

SC-3.02 *Standards, Specifications, Codes, Laws and Regulations*

ADD the following new paragraphs immediately after Paragraph 3.02.B:

"C. Compliance with Laws and Permits. All permits and licenses which are required to construct, install and/or operate Buyer's facility or equipment, to use the Equipment, or to manage and dispose of any wastes and residues resulting from Buyer's use of equipment, Buyer is responsible for compliance with all laws and regulations applicable to the storage, use, handling, installation, maintenance, removal, registration and labeling of all Equipment after delivery of the Equipment, as well as for the proper management and disposal of all wastes and residues."

SC-3.04 *Amending and Clarifying Contract Documents*

REPLACE Paragraphs 3.04 C with the following: "The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Goods and Special Services may be authorized by a Field Order."

SC-4.02 Insurance

ADD the following new paragraphs immediately after Paragraph 4.02.E:

F. Seller shall purchase and maintain such liability and other insurance as is appropriate for the furnishing of Goods and Special Services and as will provide protection from claims set forth below which may arise out of or result from Seller's furnishing of the Goods or Special Services and Seller's other obligations under the Contract Documents, whether the furnishing of Goods and Special Services or other obligations are to be performed by Seller, any subcontractor or supplier, or by anyone directly or indirectly employed by any of them to furnish the Goods and Special Services, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Seller's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Seller's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained: (i) by any person as a result of an offense directly or indirectly related to the employment of such person by Seller, or (ii) by any other person for any other reason;

5. claims for damages, other than to the Goods, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

G. The policies of insurance so required by this Paragraph 4.02 to be purchased and maintained shall:

1. with respect to insurance required by Paragraphs SC-4.02.F.3 through SC-4.02.F.6 inclusive, include as additional insureds (subject to any customary exclusion in respect of professional liability) Buyer, Engineer, their consultants, all of whom shall be listed as additional insureds, but only in respect of work performed by or on behalf of the named insured, and only to the extent that the additional insured is held liable for the negligence or other culpability of Seller, and include coverage for the respective officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby. Coverage under Seller's policy does not extend to liability arising out of the additional insured's own negligence;

2. include at least the specific coverages and be written for the limits of liability provided below or required by Laws or Regulations, whichever is greater;

3. include completed operations insurance;

4. include contractual liability insurance covering Seller's indemnity obligations under Paragraphs 5.09 and 12.02.

5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least thirty days prior written notice has been given to Buyer and Seller and to each other additional insured identified in these Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Seller pursuant to Paragraph SC-4.02.I will so provide);

6. remain in effect at least until final payment and at all times thereafter when Seller may be correcting, removing, or replacing non-conforming Goods in accordance with Paragraph 8.03;

7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment (and Seller shall furnish Buyer and each other additional insured identified in these Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Buyer and any such additional insured of continuation of such insurance at final payment and one year thereafter); and

H. The limits of liability for the insurance required by Paragraph SC-4.02.F shall provide coverage for the following amounts or greater where required by Laws and Regulations:

1. Workers' Compensation, and related coverages under Paragraphs SC-4.02.F.1 and F.2:

a. State:	Statutory
b. Applicable Federal (e.g., Longshoreman's):	Statutory
c. Employer's Liability:	$1,000,000

2. Seller's General Liability under Paragraphs SC-4.02.F.3 through F.6 which shall include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of Seller:

a. General Aggregate	$5,000,000
b. Products - Completed 1) Operations Aggregate	$5,000,000
c. Personal and Advertising 1) Injury	$5,000,000
2) Each Occurrence (Bodily Injury and Property Damage)	$5,000,000

d. Property Damage liability insurance will provide Explosion, Collapse, and Underground coverages where applicable.

3. Automobile Liability under Paragraph SC-4.02.F.6:

a. Bodily Injury: 1) Each person	$5,000,000
2) Each Accident	$5,000,000
b. Property Damage: 1) Each Accident	$5,000,000
Or 2) Combined Single Limit of	$5,000,000

4. Professional Liability (if the Special Services include professional services):

Each Claim	$1,000,000
Annual Aggregate	$2,000,000

I. Seller shall deliver to Buyer, with copies to each additional insured identified in these Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Buyer or any other additional insured) which Seller is required to purchase and maintain.

J. If Buyer has any objection to the coverage afforded by or other provisions of the insurance required to be purchased and maintained on the basis of non-conformance with the Contract Documents, Buyer shall notify Seller in writing within 3 days after receipt of the certificates or other evidence required by Paragraph SC-4.02.E. Seller shall provide such additional information in respect to insurance as Buyer shall reasonably request.

SC-5.02 *Labor, Material and Equipment*

In Paragraph 5.02.B.1. **REPLACE** the Paragraph with the following language: "new, current, and of good quality; legacy, and older variants of newer product shall not be included.

SC-5.05 *Taxes*

ADD a new paragraph immediately after Paragraph 5.05.A:

B. Buyer is exempt from payment of sales and compensating use taxes of the State of Georgia and of cities and counties thereof on all materials and equipment to be incorporated into the Project facilities.

1. Buyer will furnish the required certificates of tax exemption to Seller with respect to materials and equipment to be incorporated into the Project facilities.

2. Buyer's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Seller, or to supplies or materials not incorporated into the Project facilities.

3. The Contract Price does not include the cost of sales or compensating use taxes to the extent such are exempted by this paragraph.

SC-5.06 *Shop Drawings and Samples*

DELETE Paragraph 5.06 D 1. in its entirety **AND INSERT** the following in its place:

"1. Engineer will review with reasonable promptness Shop Drawings and Samples. The review of a separate item as such will not indicate review of the assembly in which the item functions. The Seller's stamp of approval on any Shop Drawing or sample shall constitute a representation to the Owner and the Engineer that the Seller has either determined and

verified all quantities, dimensions, field construction criteria, materials, catalogue numbers and similar data or the Seller assumes full responsibility for doing so, and that the Seller has reviewed or coordinated each Shop Drawing or Sample with the requirements of the Work and the Contract Documents."

SC-5.08 *Seller's Warranties and Guarantees*

In Paragraph 5.08.A **REPLACE** the paragraph in its entirety with the following:

A. Seller warrants and guarantees to Buyer that the title to the Goods conveyed shall be proper, its transfer rightful, and free from any security interest, lien, or other encumbrance upon acceptance of delivery. Seller shall defend, indemnify, and hold Buyer harmless against any liens, claims, or demands contesting or affecting title of the Goods conveyed.

ADD new paragraphs immediately after Paragraph 5.05.D:

E. Buyer shall promptly notify Seller of any breach of Seller's warranties or guarantees. Any claim for breach of these warranties must be promptly notified in writing, and Buyer shall make the defective item available to the Seller, or the claim will be void. Seller's sole responsibility and Buyer's exclusive remedy arising out of or relating to the Equipment or Services or any breach of these warranties is limited to repair or (at Seller's option) replacement of defective items of Equipment, and re-performance of defective Services. Buyer shall make maintenance and operation records available to the Seller upon request during the warranty period.

F. Seller makes no implied warranties under this Contract. The foregoing warranties and remedies are in lieu of and exclude all other warranties and remedies, statutory, express or implied, including any warranty of merchantability or of fitness for a particular purpose.

SC-5.09 *Indemnification*

In Paragraph 5.09.A **INSERT** "of third-parties" after "(other than the Goods themselves)".

SC-6.02 *Delivery*

In Paragraph 6.02.A. **REPLACE** the paragraph in its entirety with the following:

A. Seller shall deliver the Goods F.O.B. the Point of Destination in accordance with the Contract Times set forth in the Agreement, or other date agreed to by Buyer and Seller. If any part of the Equipment cannot be delivered to the site on the date agreed upon between the Buyer and the Seller due to any cause not attributable to Seller, Seller may ship such equipment to suitable storage location agreed upon between the Buyer and the Seller which meets or exceeds contract document requirements. If such Equipment is placed in storage, then (i) title and risk of loss shall thereupon pass to Buyer if it had not already passed; (ii) any amounts otherwise payable to Seller upon delivery or shipment shall be payable upon presentation of Buyer's invoice(s); (iii) all expenses incurred by Seller, such as for preparation for and placement into storage, handling, inspection, preservation, insurance, storage, removal charges and any taxes shall be payable by Buyer upon submission of Seller's invoice(s).

In Paragraph 6.02.B. **REPLACE** the paragraph in its entirety with the following:

B. Seller shall provide written notice to Buyer at least 14 days before shipment of the manner of shipment and the anticipated delivery date. The notice shall also include any instructions concerning special equipment or services required at the Point of Destination to unload and care for the Goods. Seller shall also require the carrier to give Buyer and Engineer at least 48 hours notice by telephone prior to the anticipated time of delivery.

SC-6.03 Risk of Loss

In Paragraph 6.03.A. **REPLACE** "Risk of loss" with "Title, risk of loss,".

SC-7.01 *Changes in the Goods and Special Services*

In the Paragraph 7.01 B **REPLACE** the paragraph in its entirety with the following:

B. If Seller concludes that a Work Change Directive issued by Buyer affects the Contract Price or Contract Times, then Seller shall notify Buyer within 5 days after Seller has received the Work Change Directive, and submit written supporting data to Buyer within 3 days after such receipt. If Seller fails to notify Buyer within 5 days, Seller waives any Claim for such adjustment. If Buyer and Seller are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 9.06.

SC-7.02 *Changing Contract Price or Contract Times*

In the third sentence of Paragraph 7.02 C. **REPLACE** "15" with "5".

SC-8.01 *Inspections and Testing*

ADD Paragraph 8.01B.4.

"4. The Seller shall have personnel on site at the time of delivery to verify the acceptance and the satisfactory condition of the equipment provided to the Owner. A written statement shall be provided to Owner confirming the inspection of satisfactory Goods upon arrival."

REPLACE Paragraph 8.01C.1. with: "After all of the Goods have been incorporated into the Project, tested in accordance with such testing requirements as are specified, are functioning as indicated, and all Special Services are performed, the Project has been completed and is ready for final inspection, Buyer and Engineer will make a final inspection."

SC-8.03 Correction Period

In the Paragraph 8.03.A **REPLACE** "or the date of final payment "with "or 24 months from the date of final equipment delivery, whichever occurs first".

In the Paragraph 8.03.A **REMOVE** "Laws or Regulations or by".

SC-9.04 *Rejecting Non-Conforming Goods and Special Services*

In both occurrences in Paragraph 9.04 A. REPLACE the word in between "Goods" and "Special Services" with "and/or".

SC-10.01 *Applications for Progress Payments*

REPLACE Paragraphs 10.01 A.1. and A.2. in their entirety with the following:

1. The first Application for Payment will be submitted after significant progress has been made on Design Assistance and Shop Drawing Preparation.

2. The second Application for Payment will be submitted after 90% completion of Design Assistance and Shop Drawing Preparation.

3. The third Application for Payment will be submitted after Engineer's review and approval of all Shop Drawings and Samples Submittals.

4. The fourth Application for Payment will be submitted after receipt of the Goods has been acknowledged in accordance with Paragraph 8.01.B and will be accompanied by a bill of sale, invoice, or other documentation reasonably satisfactory to Buyer warranting that Buyer has rightfully received good title to the Goods from Seller and that, upon payment, the Goods will be free and clear of all liens. Such documentation will include releases and waivers from all parties with viable lien rights.

5. Subsequent Applications for Payment will be submitted after subsequent portions of the work have been completed, such as submission of Operations and Maintenance Manuals, Installation of Goods, Testing, Training, and placement into Operation.

SC-10.02 Review of *Applications for Progress Payments*

REPLACE Paragraphs 10.02 in its entirety with the following:

A. Engineer will, within ten days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Buyer, or return the Application to Seller indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Seller may make the necessary corrections and resubmit the Application.

1. Engineer's recommendation of payment requested in the first Application for Payment will constitute a representation by Engineer, based on Engineer's review of the Application for Payment and the accompanying data, that significant progress on Design Assistance and Shop Drawing Preparation have been reviewed and approved as required by the Contract Documents and Seller is entitled to payment of the amount recommended.

2. Engineer's recommendation of payment requested in the second Application for Payment will constitute a representation by Engineer, based on Engineer's review of the Application for Payment and the accompanying data, that the 90% completion of

Design Assistance and Shop Drawing Preparation have been reviewed and approved as required by the Contract Documents and Seller is entitled to payment of the amount recommended.

3. Engineer's recommendation of payment requested in the third Application for Payment will constitute a representation by Engineer, based on Engineer's review of the Application for Payment and the accompanying data, that the Shop Drawings and Samples have been reviewed and approved as required by the Contract Documents and Seller is entitled to payment of the amount recommended.

4. Engineer's recommendation of payment requested in the fourth Application for Payment submitted upon Buyer's acknowledgment of receipt of the Goods will constitute a representation by Engineer, based on Engineer's review of the Application for Payment and the accompanying data Seller is entitled to payment of the amount recommended. Such recommendation will not constitute a representation that Engineer has made a final inspection of the Goods, that the Goods are free from non-conformities, acceptable or in conformance with the Contract Documents, that Engineer has made any investigation as to Buyer's title to the Goods, that exhaustive or continuous inspections have been made to check the quality or the quantity of the Goods beyond the responsibilities specifically assigned to Engineer in the Contract Documents or that there may not be other matters or issues between the parties that might entitle Seller to additional payments by Buyer or Buyer to withhold payment to Seller.

5. Engineer's recommendation of payment requested in the subsequent Applications for Payment will constitute a representation by Engineer, based on Engineer's review of the Application for Payment and the accompanying data, that the Work and/or Services have been performed and/or provided in an acceptable manner and in conformance with the Contract Documents as required by the Contract Documents and Seller is entitled to payment of the amount recommended.

6. Engineer may refuse to recommend that all or any part of a progress payment be made, or Engineer may nullify all or any part of any payment previously recommended if, in Engineer's opinion, such recommendation would be incorrect or if on the basis of subsequently discovered evidence or subsequent inspections or tests Engineer considers such refusal or nullification necessary to protect Buyer from loss because the Contract Price has been reduced, Goods are found to be non-conforming, or Seller has failed to furnish acceptable Special Services.

SC-12.01 Intellectual Property and License Fees

REPLACE Paragraphs 12.01.B in its entirety with the following.

B. In the event of suit or threat of suit for intellectual property infringement, Buyer will promptly notify Seller of receiving notice thereof. Seller is to grant to Buyer a non-exclusive, non-terminable, royalty free license to use the intellectual property embedded in design or data delivered to and paid for by the Buyer, for the purposes of owning, financing, using, operating and maintaining the relevant Equipment at the Project site.

SC-12.05 *Electronic Data*

To Paragraph 12.05 **ADD** Paragraph 12.05 D.

"D. Electronic Data in the following formats may be provided by Buyer to Seller or by Seller to Buyer when approved in writing by Engineer: AutoCAD and pdf."

PERFORMANCE BOND
FOR PROCUREMENT CONTRACTS

Any singular reference to Seller, Surety, Buyer, or other party shall be considered plural where applicable.

SELLER (Name and Address):
ZENON Environmental Corporation
3239 Dundas Street West
Oakville, Ontario L6M 4B2
Canada

SURETY (Name and Address of Principal Place of Business):
Federal Insurance Company
202B Halls Mill Road
Whitehouse Station, NJ 08889-3454

BUYER (Name and Address):
City of Buford, 2300 Buford Highway Buford, GA 30518

CONTRACT
Effective Date of Agreement: _____
Amount: **$989,000.00 based on Base Bid Plus Allowance:** Design Assistance and Shop Drawing Preparation, Manufacturing of Goods, Pre-Installation Meeting, Start-Up and Training, Field Testing and Allowance for Spare Parts.

Description (Name and Location): **Water Plant Membrane Filtration System Buford, GA**

BOND
Date (Not earlier than Contract Date): _____
Bond Number: K15491565
Amount: **$989,000.00 based on Base Bid Plus Allowance:** Design Assistance and Shop Drawing Preparation, Manufacturing of Goods, Pre-Installation Meeting, Start-Up and Training, Field Testing, and Allowance for Spare Parts.

Surety and Seller, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

Seller as Principal

ZENON Environmental Corporation
Company: (Corp. Seal)

Signature:

Name and Title: DAVID BRIGHAM - COMMERCIAL DIRECTOR

Surety

Federal Insurance Company
Company: (Corp. Seal)

Signature:

Name and Title: Mariya Leonidov, Attorney-In-Fact
(Attach Power of Attorney)
Address: 48 South Service Road, Melville, NY 11747
Telephone Number: (631) 577-0581

(Space is provided below for signatures of additional parties, if required.)

Seller as Principal		**Surety**	
Company:	(Corp. Seal)	Company:	(Corp. Seal)
Signature:		Signature:	
Name and Title:		Name and Title:	
		Address:	
		Telephone Number:	

1. Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to Buyer for the performance of the Contract, which is incorporated herein by reference. For purposes of this bond, Buyer means Buyer's assigns, if and when Buyer has assigned the Contract.

2. If Seller performs the Contract, Surety and Seller have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no Buyer Default, Surety's obligation under this Bond shall arise after:

   3.1. Buyer has notified Seller and Surety pursuant to Paragraph 10 that Buyer is considering declaring a Seller Default and has requested and attempted to arrange a conference with Seller and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. (If Buyer, Seller, and Surety agree, Seller shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Buyer's right, if any, subsequently to declare a Seller Default); and

   3.2. Buyer has declared a Seller Default and formally terminated Seller's right to complete the Contract. Such Seller Default shall not be declared earlier than 20 days after Seller and Surety have received notice as provided in Paragraph 3.1; and

   3.3. Buyer has agreed to pay the Balance of the Contract Price to:

      a. Surety in accordance with the terms of the Contract;

      b. Another seller selected pursuant to Paragraph 4.3 to perform the Contract.

4. When Buyer has satisfied the conditions of Paragraph 3, Surety shall promptly and at Surety's expense take one of the following actions:

   4.1. Arrange for Seller, with consent of Buyer, to perform and complete the Contract; or

   4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

4.3. Obtain bids or negotiated proposals from qualified sellers acceptable to Buyer for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Buyer and a seller selected with Buyer's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the Bonds issued on the Contract, and pay to Buyer the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by Buyer resulting from Seller Default; or

4.4. Waive its right to perform and complete, arrange for completion, or obtain a new seller, and with reasonable promptness under the circumstances, either:

a. determine the amount for which it may be liable to Buyer and, as soon as practicable after the amount is determined, tender payment therefor to Buyer; or

b. deny liability in whole or in part and notify Buyer citing reasons therefor.

5. If Surety does not proceed as provided in Paragraph 4 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Buyer to Surety demanding that Surety perform its obligations under this Bond, and Buyer shall be entitled to enforce any remedy available to Buyer. If Surety proceeds as provided in paragraph 4.4, and Buyer refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Buyer shall be entitled to enforce any remedy available to Buyer.

6. After Buyer has terminated Seller's right to complete the Contract, and if Surety elects to act under Paragraph 4.1, 4.2, or 4.3, then the responsibilities of Surety to Buyer shall not be greater than those of Seller under the Contract, and the responsibilities of Buyer to Surety shall not be greater than those of Buyer under the Contract. To a limit of the amount of this Bond, but subject to commitment by Buyer of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

6.1. the responsibilities of Seller for correction or replacement of defective Goods and Special Services and completion of the Contract;

6.2. Additional legal, design professional, and delay costs resulting from Seller's Default, and resulting from the actions of or failure to act of Surety under Paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Seller.

7. Surety shall not be liable to Buyer or others for obligations of Seller that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Buyer or its heirs, executors, administrators, successors, or assigns.

8. Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location of the Point of Destination, and shall be instituted within two years after Seller Default or within two years after Seller ceased working or within two years after Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to Surety, Buyer or Seller shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Point of Destination, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

    12.1. *Balance of the Contract Price:* The total amount payable by Buyer to Seller under the Contract after all proper adjustments have been made, including allowance to Seller of any amounts received or to be received by Buyer in settlement of insurance or other Claims for damages to which Seller is entitled, reduced by all valid and proper payments made to or on behalf of Seller under the Contract.

    12.2. *Contract:* The agreement between Buyer and Seller identified on the signature page, including all Contract Documents and changes thereto.

    12.3. *Seller Default:* Failure of Seller, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

    12.4. *Buyer Default:* Failure of Buyer, which has neither been remedied nor waived, to pay Seller as required by the Contract or to perform and complete or comply with the other terms thereof.

13. Modifications to this Bond Form: (If none, so state.) _____.

PAYMENT BOND
FOR PROCUREMENT CONTRACTS

Any singular reference to Seller, Surety, Buyer or other party shall be considered plural where applicable.

SELLER (Name and Address):
ZENON Environmental Corporation
3239 Dundas Street West
Oakville, Ontario L6M 4B2
Canada

SURETY (Name and Address of Principal Place of Business):

Federal Insurance Company
202B Halls Mill Road
Whitehouse Station, NJ 08889-3454

BUYER (Name and Address):
City of Buford, 2300 Buford Highway Buford, GA 30518

CONTRACT

Effective Date of Agreement: _____

Amount: **$989,000.00 based on Base Bid Plus Allowance:** Design Assistance and Shop Drawing Preparation, Manufacturing of Goods, Pre-Installation Meeting, Start-Up and Training, Field Testing, and Allowance for Spare Parts.

Description (Name and Location): **Water Plant Membrane Filtration System**
Buford, GA

BOND

Date (Not earlier than Contract Date):

Bond Number: K15491565

Amount: **$989,000.00 based on Base Bid Plus Allowance:** Design Assistance and Shop Drawing Preparation, Manufacturing of Goods, Pre-Installation Meeting, Start-Up and Training, Field Testing, and Allowance for Spare Parts.

Surety and Seller, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

Seller as Principal

ZENON Environmental Corporation

Company: (Corp. Seal)

Signature:

Name and Title: DAVID BINGHAM, COMMERCIAL DIRECTOR

Surety

Federal Insurance Company

Company: (Corp. Seal)

Signature:

Name and Title: Mariya Leonidov, Attorney-In-Fact
(Attach Power of Attorney)

Address: 48 South Service Road, Melville NY 11747

Telephone Number: (631) 577-0581

(Space is provided below for signatures of additional parties, if required.)

Seller as Principal		**Surety**	
Company:	(Corp. Seal)	Company:	(Corp. Seal)
Signature:		Signature:	
Name and Title:		Name and Title:	
		Address:	
		Telephone Number:	

1. Seller and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to Buyer to pay for labor, materials and equipment furnished for use in the performance of the Contract, which is incorporated herein by reference. For purposes of this bond, Buyer means Buyer's assigns, if and when Buyer has assigned the Contract.

2. With respect to Buyer, this obligation shall be null and void if Seller:

   2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

   2.2. Defends, indemnifies and holds harmless Buyer from all claims, demands, liens or suits by any person or entity who furnished labor, materials or equipment for use in the performance of the Contract, provided Buyer has promptly notified Seller and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens or suits and tendered defense of such claims, demands, liens or suits to Seller and Surety, and provided there is no Buyer Default.

3. With respect to Claimants, this obligation shall be null and void if Seller promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

   4.1. Claimants who are employed by or have a direct contract with Seller have given notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Buyer stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

   4.2. Claimants who do not have a direct contract with Seller:

      a. Have furnished written notice to Seller and sent a copy, or notice thereof, to Buyer, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was done or performed; and

      b. Have either received a rejection in whole or in part from Seller or not received within 30 days of furnishing the above notice any communication from Seller by which Seller had indicated the claim will be paid directly or indirectly; and

      c. Not having been paid within the above 30 days, have sent a written notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Buyer stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Seller.

5. If a notice required by Paragraph 4 is given by Buyer to Seller or to Surety, that is sufficient compliance.

6. Reserved.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Buyer to Seller under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any Performance Bond. By Seller furnishing and Buyer accepting this Bond, they agree that all funds earned by Seller in the performance of the Contract are dedicated to satisfy obligations of Seller and Surety under this Bond, subject to Buyer's priority to use the funds for the completion of the furnishing the Goods and Special Services.

9. Surety shall not be liable to Buyer, Claimants or others for obligations of Seller that are unrelated to the Contract. Buyer shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders, and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Goods relevant to the claim are located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Buyer or Seller shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Buyer or Seller, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Seller shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. Definitions

    15.1 *Claimant:* An individual or entity having a direct contract with Seller or with a Subcontractor of Seller to furnish labor, materials or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Contract, architectural and engineering services required for furnishing the Goods and Special Services by Seller and Seller's Subcontractors, and all other items for

which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.

15.2. *Contract:* The agreement between Buyer and Seller identified on the signature page, including all Contract Documents and changes thereto.

15.3. *Buyer Default:* Failure of Buyer, which has neither been remedied nor waived, to pay Seller as required by the Contract or to perform and complete or comply with the other terms thereof.

16. Modifications to this Bond Form: (If none, so state.) _____.

CHUBB

Power of Attorney

Federal Insurance Company | Vigilant Insurance Company | Pacific Indemnity Company

Know All by These Presents, That **FEDERAL INSURANCE COMPANY,** an Indiana corporation, **VIGILANT INSURANCE COMPANY,** a New York corporation, and **PACIFIC INDEMNITY COMPANY,** a Wisconsin corporation, do each hereby constitute and appoint Annette Audinot, Theresa Giraldo, Terry Ann Gonzales-Selman, Mariya Leonidov, Robert P. McDonough, William G. Morrissey, Vincent Moy, Migdalia Otero, Francesca Papa and Glenn Pelletiere of New York, New York----------

each as their true and lawful Attorney-in-Fact to execute under such designation in their names and to affix their corporate seals to and deliver for and on their behalf as surety thereon or otherwise, bonds and undertakings and other writings obligatory in the nature thereof (other than bail bonds) given or executed in the course of business, and any instruments amending or altering the same, and consents to the modification or alteration of any instrument referred to in said bonds or obligations.

In Witness Whereof, said **FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY,** and **PACIFIC INDEMNITY COMPANY** have each executed and attested these presents and affixed their corporate seals on this **7th** day of **January, 2019.**

Dawn M. Chloros, Assistant Secretary

Stephen M. Haney, Vice President

STATE OF NEW JERSEY

County of Hunterdon ss.

On this **7th** day of **January, 2019,** before me, a Notary Public of New Jersey, personally came Dawn M. Chloros, to me known to be Assistant Secretary of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros, being by me duly sworn, did depose and say that she is Assistant Secretary of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY and knows the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that she signed said Power of Attorney as Assistant Secretary of said Companies by like authority; and that she is acquainted with Stephen M. Haney, and knows him to be Vice President of said Companies; and that the signature of Stephen M. Haney, subscribed to said Power of Attorney is in the genuine handwriting of Stephen M. Haney, and was thereto subscribed by authority of said Companies and in deponent's presence.

Notarial Seal

KATHERINE J. ADELAAR
NOTARY PUBLIC OF NEW JERSEY
No. 2316865
Commission Expires July 16, 2019

Notary Public

CERTIFICATION

Resolutions adopted by the Boards of Directors of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY on August 30, 2016:

"RESOLVED, that the following authorizations relate to the execution, for and on behalf of the Company, of bonds, undertakings, recognizances, contracts and other written commitments of the Company entered into in the ordinary course of business (each a "Written Commitment"):

(1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.

(2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.

(3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

FURTHER RESOLVED, that the foregoing Resolution shall not be deemed to be an exclusive statement of the powers and authority of officers, employees and other persons to act for and on behalf of the Company, and such Resolution shall not limit or otherwise affect the exercise of any such power or authority otherwise validly granted or vested."

I, Dawn M. Chloros, Assistant Secretary of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, and PACIFIC INDEMNITY COMPANY (the "Companies") do hereby certify that

(i) the foregoing Resolutions adopted by the Board of Directors of the Companies are true, correct and in full force and effect,
(ii) the foregoing Power of Attorney is true, correct and in full force and effect.

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this

Dawn M. Chloros, Assistant Secretary

IN THE EVENT YOU WISH TO VERIFY THE AUTHENTICITY OF THIS BOND OR NOTIFY US OF ANY OTHER MATTER, PLEASE CONTACT US AT:
Telephone (908) 903-3493 Fax (908) 903-3656 e-mail: surety@chubb.com

FEDERAL INSURANCE COMPANY

STATEMENT OF ASSETS, LIABILITIES AND SURPLUS TO POLICYHOLDERS

Statutory Basis

DECEMBER 31, 2018

(In thousands)

ASSETS		*LIABILITIES AND SURPLUS TO POLICYHOLDERS*	
Cash and Short Term Investments	$ (360,335)	Outstanding Losses and Loss Expenses	$ 6,523,482
United States Government, State and Municipal Bonds	5,738,426	Reinsurance Payable on Losses and Expenses	1,490,981
Other Bonds	3,916,616	Unearned Premiums	1,914,190
Stocks	100,774	Ceded Reinsurance Premiums Payable	405,271
Other Invested Assets	959,127	Other Liabilities	565,865
TOTAL INVESTMENTS	10,354,608	TOTAL LIABILITIES	10,899,789
Investments in Affiliates:		Capital Stock	20,980
Great Northern Ins. Co.	384,987	Paid-In Surplus	2,711,474
Vigilant Ins. Co.	333,743	Unassigned Funds	2,057,388
Chubb Indemnity Ins. Co.	176,202		
Chubb National Ins. Co.	176,647	SURPLUS TO POLICYHOLDERS	4,789,842
Chubb European Inv. Holdings, SLP	120,469		
Other Affiliates	99,299		
Premiums Receivable	1,281,368		
Other Assets	2,762,308		
TOTAL ADMITTED ASSETS	$ 15,689,631	TOTAL LIABILITIES AND SURPLUS	$ 15,689,631

Investments are valued in accordance with requirements of the National Association of Insurance Commissioners, At December 31, 2018, investments with a carrying value of $566,806,856 were deposited with government authorities as required by law.

STATE OF PENNSYLVANIA

COUNTY OF PHILADELPHIA

John Taylor, being duly sworn, says that he is Senior Vice President of Federal Insurance Company and that to the best of his knowledge and belief the foregoing is a true and correct statement of the said Company's financial condition as of the 31 st day of December, 2018.

Sworn before me this March 19, 2019

Senior Vice President

Notary Public

August 8, 2019
My commission expires

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Diane Wright, Notary Public
City of Philadelphia, Philadelphia County
My Commission Expires Aug. 8, 2019
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

Water Technologies & Solutions

Shawn Hourtovenko
Project Manager

3239 Dundas Street W.,
Oakville, Ontario
Canada

T +1 (647) 504-7100

October 20, 2020

Subject: City of Buford, GA Water Plant Membrane Filtration System; Change Order 01; CIP Tank/System Upgrade

Dear Ms. Northrop,

As a result of our discussions and per your request, Suez is pleased to provide a proposal as follows for the proposed scope changes. Suez will provide the engineering, labour and materials to perform the scope changes described herein, subject to the provisions, assumptions and conditions stated below:

CIP Tank/System Upgrade

CIP upgrade to improve the WTP schedule flexibility, provide greater redundancy, and have a dedicated heating tank.

ITEM	QTY	Change	Tag / Sheet
1	2	Temperature Transmitter and thermowell	22-TT/TW-701 22-TT/TW-701-B
2	2	1.5" Hand Valve	22-HV-721 22-HV-701-B
3	2	2" Hand Valve	22-HV-720 22-HV-706-B
4	2	Level Indicating Transmitter	22-LIT-721 22-LIT-701-B
5	2	6" Spring Automated Butterfly Valve	22-FV-722-A/B
6	1	6" Double Acting Automated Butterfly Valve	22-FV-707-B
7	7	4" Double Acting Automated Butterfly Valve	22-FV-711-A/B 22-FV-710-B 22-FV-712-A/B 22-FV-903-B 22-FV-708-B

ITEM	QTY	Change	Tag / Sheet
8	2	4" Magmeters	22-FIT-701-B 22-FIT-901-B
9	5	0.5" Pressure safety valve	23-PSV-105/305/605/705/805-B
10	5	0.5" Check valve	23-CV-105/305/605/705/805-B
11	5	0.5" Spring actuated ball valve	23-FV-105/305/605/705/805-B
12	5	0.5" Ball valve	23-HV-105/305/605/705/805-B
13	1	pH/Chlorine Analyzer Panel	DS-108 Sheet 2 of 2
14	1	Additional I/O Rack (Add No. 41 I/Os)	
15		Engineering & Commissioning Labour	

TOTAL PRCE = $40,500 USD

Impacts

ALL IMPACTS CONTAINED HEREIN APPLY ONLY TO SUEZ SCOPE OF WORK. IT IS THE CUSTOMER'S RESPONSIBILITY TO EVALUATE IMPACT(S) TO THE CUSTOMER'S SCOPE OF WORK.

Effect on Schedule

None

Effect on Contract Guarantees

None

Effect on Warranty

None

Other Impacts

a) Drawings – Suez has incorporated these items in our drawing/engineering package.

Except as changed herein, all terms and conditions of the contract remain in full force and effect.

This proposal is intended to be binding only upon confirmation of a document signed by all parties.

By signature of all Parties below, this proposal is accepted and binding and forms part of the agreement number 170110.00. The pricing is valid for 30 days.

Accepted by:

Title: Project Manager

Suez WTS

Date 11-04-2020

Shawn Hourtovenko
Project Manager

Accepted by:

Michael D Moffitt

Title: Chairman

Keck & Wood, Inc.
On behalf of the City of Buford

Date 11-04-2020

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EXHIBIT B

PRE-PURCHASED EQUIPMENT
MEMBRANE FILTRATION SYSTEM
TECHNICAL DOCUMENTS
BUFORD WATER WORKS REPLACEMENT

For The

CITY OF BUFORD, GEORGIA

April 14, 2021

THIS EXHIBIT IS AVAILABLE IN ELECTRONIC FORMAT UPON REQUEST TO THE ENGINEER

Prepared by
KECK & WOOD, INC.
3090 Premiere Parkway, Suite 200
Duluth, GA 30097
Ph. (678) 417-4000