CONTRACT DOCUMENTS
FOR THE CONSTRUCTION OF THE

WASTEWATER TREATMENT PLANT IMPROVEMENTS

CITY OF WHITE HOUSE
TENNESSEE

VOLUME 3 OF 5
SPECIFICATIONS

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PROJECT No. 708498

SEPTEMBER 2020

BID DOCUMENTS

CITY OF WHITE HOUSE
TENNESSEE

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

WASTEWATER TREATMENT PLANT IMPROVEMENTS

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JACOBS

SEPTEMBER 2020

Project No. 708498 Copy No.____

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SECTION 31 09 17
DYNAMIC PILE TESTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Pile Integrity Tests (PITs) are required for all of the proposed ground improvement using Rigid Inclusions (RIs). Please refer to specification Section 31 63 20, Ground Improvement With Rigid Inclusions, for details.

B. The testing agency performing PITs will be responsible for testing and assessing the integrity and condition of the RI.

C. Additional PITs shall be performed on every defective RI that is fixed by the Contractor, and on every new RI that is installed with the purpose of replacing a defective RI pile. The test shall be performed at no additional cost to the Owner.

D. The Contractor will hire a qualified testing agency to perform PITs. The Contractor shall provide access and clear the top of the piles from any debris to facilitate testing. This will require cleaning and grinding to provide adequate surface for testing. The Contractor shall provide access at no additional cost to the Owner.

E. PITs shall be performed between 7 and 21 days from the date of rigid inclusion installation. Rigid inclusions shall have a minimum grout compressive strength of 3,000 psi prior to PIT.

F. The Contractor shall allow adequate schedule for performance of the PITs and for the results to become available, before backfilling or before concrete pour of the slabs or pile caps can take place. All PITs shall be completed and accepted by the Engineer prior to pouring any slabs or pile caps on top of the piles.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): D5882-07, Standard Test Method for Low-Strain Impact Integrity Testing of Deep Foundations.

1.03 DEFINITIONS

A. Low-strain Dynamic Testing (LSDT): Test on test piles, production piles, and rigid inclusions selected by Engineer for quality control check of pile defects using low strain wave trace measurements. Test consists of checking the body of the pile for a uniform cross-section with no necking or contractions or other defects using low strain dynamic testing procedures.

B. Production Piles: Piles incorporated into the Work, using a uniform selection of materials and workmanship, and which are determined acceptable by Engineer based on observation and pile test results.

C. Test Piles: Piles constructed of same materials and workmanship, and installed as specified for production piles at locations other than for production pile locations.

1.04 SUBMITTALS

A. Informational Submittals:

1. Qualifications: Testing agency and testing instrumentation installer.
2. Test equipment description and layout.
3. Test procedures.
4. Test record documents.
5. Report with complete interpretation of PIT results.

1.05 QUALIFICATIONS

A. Testing Agency: Independent, certified, and at least 5 years' experience in similar testing including installing instrumentation, performing testing, monitoring specified testing, analyzing data.

B. The field testing shall be performed by an experienced technician with at least 3 years of experience in pile integrity testing. The interpretation of the records, however, requires extensive experience by a graduated engineer with at least 5 years of experience in pile integrity testing.

C. List of Pre-approved PIT Testing Agencies:

1. Geotechnology Inc.
2. GRL Engineers, Inc.
3. D.W. Kozera Inc.
4. Olson Engineering, Inc.
5. Approved Alternate.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEST PROCEDURES

A. Minimum (i) test descriptions, (ii) forms, and (iii) checklists to be used to control and document each required test.

B. Describe specific test to be performed.

C. Provide space(s) after each test description for Contractor, Engineer, and testing agency to certify that successful testing, in accordance referenced standards, has been completed.

D. Engineer's acceptance required prior to commencement of respective testing.

3.02 RECORD DATA

A. Record for each pile or rigid inclusion tested, include minimum:

1. LSDT Report: In accordance with referenced standard for test performed. Submit report to the Engineer to provide the final test results and integrity evaluation within 4 working days after performing the field test.
2. Installation record.
3. RI length.
4. Unusual occurrence(s) during installation.

3.03 TEST RECORD DOCUMENTS

A. Make available to Engineer at Site.

B. List of RIs to be tested.

C. Updated versions of documentation required for testing.

D. Certifications of calibration.

E. Testing record data.

3.04 LOW STRAIN DYNAMIC TESTING

A. Testing Equipment:

1. Provide a Pile Integrity Tester that uses low strain wave measurements such as manufactured by Pile Dynamics Inc., Cleveland, OH. Provide other ancillary equipment including power source, hammers, gauges, cables, necessary to conduct the low strain dynamic testing.
2. Contractor shall assist the testing agency by providing electrical 110-volt, 60-Hz power source with adequate extension cords to reach the test pile and production piles selected for PIT.

B. Testing:

1. Perform PITs in accordance to ASTM D5882-07.
2. Conform to generally accepted procedures as set forth by industry standards.
3. Perform tests on Rigid inclusions selected by Engineer, as defined in Article, Description. Production rigid inclusions for PITs will be selected by the Engineer after installation.
4. The pile head shall be free from water, dirt or other debris for PIT. The concrete at the pile top surface must be relatively smooth with sufficient space for both attachment of the motion sensing device and hammer impact area.
5. If requested by Engineer, perform Pile Integrity Test Wave Analysis Program (PITWAP) analysis.

3.05 DAMAGED, MISPLACED, OR OTHERWISE REJECTED PILES

A. Rigid inclusions found damaged, necked, defective or otherwise unfit for use that are located at production pile locations shall be fixed or replaced in kind by the Contractor at no additional cost to the Owner. The Contractor shall submit a remediation plan, for any defective rigid inclusion, to the Engineer for approval.

END OF SECTION

SECTION 31 09 18
STATIC PILE TESTING

PART 1 GENERAL

1.01 WORK INCLUDED

A. The Work included herein consists of conducting static load testing at locations shown on the Drawings or as specified, at their design elevation. This section shall cover static testing of continuous-flight auger (CFA) piles and rigid inclusions. The Contractor shall furnish all materials, instrumentation, equipment, and labor to conduct the static load test. The Contractor is responsible for conducting the test under the supervision of the Engineer of Record and/or independent testing agency.

B. Load tests for rigid inclusions can be performed in axial compression in accordance to ASTM D1143. Refer to specification Section 31 63 20, Ground Improvement With Rigid Inclusions for static load test requirements for rigid inclusions.

C. The test pile shall not be in a production pile location, and shall be performed prior to installation of the production piles. The Contractor shall not begin installation of production piles or rigid inclusions before static pile load test results are reviewed and approved by the Engineer of Record, and the Engineer of Record provides production piles final tip elevation.

D. The Contractor shall allow 2 weeks in the schedule for the Engineer of Record to review and approve the static load test results, and provide the final production piles tip elevations. The 2-week review period begins from the date the Contractor submits the static load test results and any other documentation necessary to complete the review to the Engineer of Record.

E. Pile integrity testing shall be performed on all test piles or test rigid inclusions prior to static load testing, in accordance with Section 31 09 17, Dynamic Pile Testing.

F. The Contractor shall submit test results data, including calibration of all instrumentation to the Engineer of Record within 3 days after static load test completion. The Engineer of Record will verify if the test pile has adequate load capacity, based on static pile load test results. The Engineer of Record will provide the Contractor final tip elevations based on static load testing results.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D1143, Standard Test Method for Piles Under Static Axial Compressive Load.
   b. D3689, Standard Test Method for Deep Foundations Under Static Axial Tensile Load.

1.03 DEFINITIONS

A. Design Load (DL): Allowable axial pile capacity as shown on the Drawings.

B. Load Test: Axial load tests, witnessed by Engineer on test piles at locations selected by Engineer for test loading.

C. Plunging Failure: 3 inches of movement with no increase in load.

D. Production Piles: Piles incorporated into the Work, using a uniform selection of materials and workmanship, and which are determined acceptable by Engineer based on observation and pile test results.

E. Test Piles: Piles constructed of same materials and workmanship, and installed as specified for production piles at locations other than for production pile locations.

1.04 SUBMITTALS

A. Action Submittals: Load transfer assembly design including shop drawings and calculations to be signed and sealed by a professional engineer registered in the State of Tennessee.

B. Informational Submittals:

1. Qualifications: Testing agency and testing instrumentation installer.
2. Load test procedures.
3. Load System: Detailed method for providing load beam reactions for test pile including reference beam, dial setups, and strain gauge installation.
4. Certifications of Calibration:
   a. Provide for pressure gauges, hydraulic jack, and load cells to be used during load test. Calibrate as a unit each jacking system to be used during static load tests, including gauges for measuring load, and pressure, and dial gauges for measuring deformation.

b. Provide strain gauges and strain read-out unit.
c. Submit at least 14 days prior to commencement of testing.

5. Detailed installation method for strain gauges.
6. Load test record data.
7. Test record documents.
8. Daily log and installation record of test pile and reaction piles (if used) in accordance with Section 31 63 20, Ground Improvement With Rigid Inclusions.
9. PIT results for test pile in accordance with Section 31 09 17, Dynamic Pile Integrity Testing.

1.05 QUALIFICATIONS

A. Testing Agency: Independent, certified, and at least 5 years experience in similar testing including installing instrumentation, performing testing, monitoring specified testing, analyzing data.

B. Testing Instrumentation Installer: At least 3 years' experience in installation of the test pile instrumentation.

1.06 INSTRUMENTATION PREINSTALLATION MEETING

A. Discussion to include details and scheduling of instrumentation installation, test procedures, and monitoring and driving test piles.

B. Attended by Contractor, testing agency, pile installation personnel, and Engineer, before starting Work specified under this section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 LOAD TEST PROCEDURES

A. Minimum (i) test descriptions, (ii) forms, and (iii) checklists to be used to control and document each required load test.

B. Describe specific test to be performed.

C. Provide space(s) after each test description for Contractor, Engineer, and testing agency, to certify that successful testing, in accordance with referenced standards, has been completed.

D. Engineer's acceptance required prior to commencement of respective testing.

3.02 LOAD TEST RECORD DATA

A. Record for each pile tested, include minimum:

1. Report: In accordance with referenced standard for load test performed.
2. Schedule of loading.
3. Method of load application.
4. Method of measuring loads.
5. Log-time for each load increment.
6. Load versus settlement.
7. Settlement versus time.
8. Creep settlement versus load.
9. Load Limit: Based on Davisson criteria.
10. Strain Gauges Data: Measured for each applied load interval.

3.03 TEST RECORD DOCUMENTS

A. Test Procedures: Engineer accepted versions of load increments and durations, certified versions, and while testing is in progress, daily updated version.

B. List of piles to be tested.

C. Certifications of calibration.

D. Load test record data.

3.04 AXIAL LOAD TEST EQUIPMENT

A. Apparatus: ASTM D1143, Section 3.4 (compression), ASTM D3689, Section 6 (tensile), capable of applying incremental static loads.

B. Calibrated Load Cell:

1. ASTM D1143, Section 3.2.3.
2. Calibrated Capacity: 1.2 times specified test load.
3. Spherical bearing plate.
4. Digital readout.

C. Hydraulic jacks shall be equipped with spherical bearing plate(s) and shall be aligned to avoid eccentric loading.

D. Pile Movement Measuring Apparatus: ASTM D1143, Section 4, except:

1. Dial Gauges: Minimum of four, with 4-inch travel.
2. Precision: 0.001 inch.

3. Furnish materials necessary for proper attachment and monitoring of test pile.
4. Provide gauge blocks to increase dial gauge travel an additional 4 inches.

E. Strain Gauges: Furnish load transfer assembly so that strain gauge wires can exit through the top of the test pile.

F. Furnish load frame, reaction Kentledge/ballast, connections, and all other materials necessary to set up and execute the static pile load test as specified.

G. Furnish materials for shielding load test equipment from sun, wind, and precipitation as specified in ASTM D1143.

3.05 LOAD TESTING

A. Provide 14 days prior notice to Engineer prior to performing the test.

B. Perform static load test a minimum of 7 days after installation of the test pile or rigid inclusion.

C. Install complete load system to satisfactorily perform each required pile loading test. Erect load frame for both compression and tension testing.

D. Conduct testing in presence of Engineer and only after Engineer's acceptance of load testing and reaction Kentledge and frame.

E. Construction operations producing discernible vibrations shall not be performed within 100 feet of pile test in progress.

F. The Contractor shall monitor the reaction frame piles for uplift or compression movement.

3.06 LOAD TESTING

A. Test Load: All components of the test load reaction frame assembly, including reaction beam, cross beams, bearing plates, reaction piles/anchors or weighted box or platform, and hydraulic jack, shall be designed to withstand and capable of testing to 400 percent of the DL specified in the Contract Drawings.

B. Just prior to loading test pile, establish elevation of pile tops.

C. Perform survey reads on the test pile and reference beam at least twice during each load increment as follows:

1. At 2 minutes after new load is applied.
2. Just prior to load increment increase.

D. Perform in general accordance with ASTM D1143 (compression), ASTM D3689 (tension), as modified herein.

E. Test Method (Rigid Inclusions): Refer to Specification 31 63 20, Ground Improvement With Rigid Inclusions, Part 3, Article Rigid Inclusion Construction, subparagraph M for load intervals and hold times.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SUBMITTALS

A. Action Submittals: Drawings clearly showing clearing, grubbing, and stripping limits.

1.03 QUALITY ASSURANCE

A. Obtain Engineer’s approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 1 acre.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation Excluding Trenches: 5 feet beyond top of cut slopes.
2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
3. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping 2 feet beyond toe of permanent fill.
4. Waste Disposal:
   a. Clearing: 5 feet beyond perimeter.
   b. Scalping and Stripping: Not required.
   c. Grubbing: Around perimeter as necessary for neat finished appearance.
5. Structures: 15 feet outside of new structures.
6. Roadways: Clearing , grubbing , scalping, and stripping 30 feet from roadway.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing to within 6 inches of ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

A. Grub areas within limits shown or specified.

3.05 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite.
2. Debris may be buried in designated onsite disposal areas to minimum depth of 3 feet below final grade. In lieu of onsite burial, dispose of debris offsite.
3. Burning of debris onsite will not be allowed.
4. When onsite burning is not prohibited by federal, state, or local authorities, debris may be burned onsite. Control burning to prevent fire from spreading.
5. Dispose of unburned and noncombustible debris offsite.
6. Unburned and noncombustible debris may be buried in designated onsite disposal areas to a minimum depth of 3 feet below existing grade. In lieu of onsite burial, dispose of debris offsite.
7. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
8. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).
   b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

F. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 02 41 00, Demolition; 31 10 00, Site Clearing; and 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under Earthfill: Compact upper 6 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D698, and to within 3% of optimum moisture.

B. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures follow recommendations outlined in “Report of Geotechnical Exploration Services Wastewater Treatment Plant Expansion” dated October 24, 2018 prepared by TTL.

3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. Proof-roll subgrade with equipment specified in Article Compaction to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact, or
2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

B. Rock Excavation:

1. General: Removal of solid material which by actual demonstration cannot, in Engineer's opinion, be reasonably loosened or ripped by single-tooth, hydraulically operated ripper mounted on crawler tractor in good condition and rated at minimum 410 flywheel horsepower; and which must be systematically drilled and blasted or broken by power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means prior to removal.
2. Trench: Removal of solid material which by actual demonstration cannot, in Engineer's opinion, be reasonably excavated with minimum 135-horsepower backhoe in good condition and equipped with manufacturer's standard boom, two rippers, and rock points or similar approved equipment; and which must be systematically drilled and blasted or broken by power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means prior to removal.
3. Term "rock excavation" indicates removal of solid material, as specified above, and does not necessarily correspond to "rock" as implied by names of geologic formations.
4. Removal of boulders larger than 1/2 cubic yard will be classified as rock excavation, if drilling and blasting or breaking them apart with power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means is both necessary and actually used for their removal.

1.02 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, Detailing:
   a. Methods and sequencing of excavation.
   b. Proposed locations of stockpiled excavated material.
   c. Proposed onsite and offsite spoil disposal sites.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.05 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, Demolition, prior to excavating.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

C. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Engineer.

C. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.04 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

A. Semicircular, trapezoidal, or 90-degree-V.

B. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

3.05 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.06 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.07 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Dispose of debris resulting from removal of underground facilities as specified in Section 02 41 00, Demolition, for demolition debris.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

SECTION 31 23 16.01
BORROW EXCAVATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittal: Borrow Pit Plan, detailing development, operation, and reclamation of each pit.

1.02 WEATHER LIMITATIONS

A. Except as approved by Engineer, do not operate borrow pits when ground is frozen or when borrow is too wet to achieve required compaction.

1.03 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, Demolition, prior to borrow pit development.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to borrow pit development.

C. Install and operate dewatering systems, specified in Section 31 23 19.01, Dewatering.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 BORROW PIT OPERATION

A. Review Borrow Pit Plan with Engineer prior to excavating from borrow pits. Obtain Engineer’s acceptance of deviations from Borrow Pit Plan prior to their implementation.

B. Always keep borrow pits neat and orderly, and work them in systematic manner. Continuously keep borrow pits graded to drain, and take necessary precautions to control erosion and prevent offsite sediment releases.

C. Do not excavate more borrow material than required for Work. Leave surplus material in place.

D. Limit excavation at borrow pits to depth which will permit completed area to drain to surrounding area after completion of Work.

3.02 OBSTRUCTIONS

A. Remove or protect as specified in Section 01 50 00, Construction Facilities and Temporary Controls, Article Protection of Work and Property.

3.03 RECLAMATION

A. Grade borrow pits and replace topsoil, as specified in Section 31 23 23, Fill and Backfill, to drain without ponding surface water and to blend graded surfaces neatly with surrounding terrain at completion of borrow operations.

B. Final Slopes:

1. Maximum: Two horizontal to one vertical.
2. Minimum: 5 percent.

C. Do not use borrow pits for disposal, unless otherwise specified or shown.

END OF SECTION

SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Water control plan.
2. Discharge permits.
3. Inflow Measurements: Submit weekly record.

1.02 WATER CONTROL PLAN

A. As a minimum, include:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of each system.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components.

B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. Remove and control water during periods when necessary to properly accomplish Work.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
3. To relieve artesian pressures and resultant uplift of excavation bottom.

C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

D. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

E. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.04 MONITORING FLOWS

A. Monitor volume of water pumped per calendar day from excavations, as Work progresses. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Engineer.

3.05 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.06 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Geosynthetics: Geotextiles, geogrids, or geomembranes.

H. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources offsite, suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Samples:
   a. Imported material taken at source.

B. Informational Submittals:

1. Manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete**.** Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-in-Place Concrete.

D. Backfill around buried tanks only after tank is set in position, securely anchored, and ready to be backfilled.

E. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 EARTHFILL

A. Excavated material from required excavations and designated borrow sites, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.

2.02 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.03 SAND

A. Free from clay, organic matter, or other deleterious material.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

2.04 GRANULAR DRAIN MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

2.05 GRANULAR FILTER MATERIAL

A. Clean, hard, durable gravel, free from foreign materials and washed.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
3/8 inch	100
No. 4	90-100
No. 8	75-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 200	0-3

2.06 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.07 BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.08 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

B. Uniformly graded from coarse to fine.

C. Free from excessive dirt and other organic material.

D. Maximum 2-1/2-inch particle size.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D698.

B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 6-inch maximum thickness and compact each lift to minimum of 90 percent relative density.

C. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 95 percent.

3.03 FILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

1. Allow for 6-inch thickness of topsoil where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to minimum 95 percent relative compaction as determined in accordance with ASTM D698, Method.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

A. Gradation:

1. One sample from each **7**50 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. Granular Fill**:** One test per lift per 2,500 square feet plan area.
2. Base Course Rock: As specified in Section 32 11 23, Aggregate Base Courses.
3. Foundation Stabilization Rock: One test per lift per 2,500 square feet plan area

3.05 SAND BLANKET OVER VAPOR RETARDER

A. Place sand in manner that avoids damage to underlying vapor retarder.

B. Moisten sand and thoroughly compact it with a vibratory plate compactor.

3.06 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base Courses.

3.07 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Granular fill.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
    a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
    b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
    a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
    b. Steep Slopes (Steeper than 3:1):
        1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
        2) Backfilling overexcavated areas is prohibited, unless in Engineer’s opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.08 PLACING FILL OVER GEOSYNTHETICS

A. General:

1. Place fill over geosynthetics with sufficient care so as not to damage them.
2. Place fill only by back dumping and spreading only.
3. Dump fill only on previously placed fill.
4. While operating equipment, avoid sharp turns, sudden starts or stops that could damage geosynthetics.

B. Hauling: Operate hauling equipment on minimum of 3 feet of covering.

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:

1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's descriptive literature for marking tapes and tracer wire.
2. Samples:
   a. Trench stabilization material.
   b. Bedding and pipe zone material.
   c. Granular drain.
   d. Granular backfill.
   e. Earth backfill.
   f. Sand(s).
   g. Geotextile.

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. As specified in Section 31 32 19.16, Geotextile.

2.02 MARKING TAPE

A. Nondetectable:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: 6 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Mutual Industries; Non-detectable Tape.
   c. Presco; Non-detectable Tape.
   d. Or approved equal.

B. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 6 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.
   d. Or approved equal.

C. Color: In accordance with APWA Uniform Color Code.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.03 TRACER WIRE

A. Material: Minimum 12-gauge solid copper or copper jacket with a steel core, with high-density polyethylene (HDPE) or high-molecular weight polyethylene (HMWPE) insulation suitable for direct bury.

B. Splices: Use wire nut or lug suitable for direct burial as recommended by tracer wire manufacturer.

C. Manufacturers:

1. Copperhead Industries, LLC.
2. Performance Wire & Cable Inc.
3. Pro-line Safety Products Company.
4. Or approved equal.

2.04 TRENCH STABILIZATION MATERIAL

A. Granular Backfill:

1. Clean gravel or crushed rock, reasonably well-graded from coarse to fine.
2. Maximum Particle Size: 1 inch.

2.05 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
4. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
5. Perforated Pipe: Granular drain material.
6. Conduit and Direct-Buried Cable:
    a. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
    b. Individual Particles: Free of sharp edges.
    c. Maximum Size Particle: Pass a No. 4 sieve.
    d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.06 GRANULAR DRAIN MATERIAL

A. Gradation: ASTM C117 and ASTM C136.

Sieve Size	Percent Passing By Weight
3 inches	100
1-1/2 inches	95-100
3/4 inch	65-95

Sieve Size	Percent Passing By Weight
No. 4	35-55
No. 16	15-45
No. 200	4-15

2.07 EARTH BACKFILL

A. Soil, loam, or other excavated material suitable for use as backfill.

B. Free from roots or organic matter, refuse, boulders and material larger than 1/2 cubic foot, or other deleterious materials.

2.08 PROCESSED EARTH BACKFILL

A. Class A Backfill: Earth backfill, meeting the following additional requirement.

1. Cohesionless, free-draining material with 100 percent passing 3-inch sieve, at least 70 percent passing 1-1/2-inch sieve, and less than 15 percent passing No. 200 sieve.

2.09 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.

B. Materials:

1. Cement: ASTM C150/C150M, Type I or Type II.
2. Aggregate: ASTM C33/C33M, Size 7.
3. Fly Ash (Pozzolan): Class F or Class C fly ash in accordance with ASTM C618, except as modified herein:
   a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
   b. Test in accordance with ASTM C1012/C1012M to verify sulfate resistance is acceptable.
4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.10 CONCRETE BACKFILL

A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete**.**

B. Mix: ASTM C94/C94M, Option A.

1. Cement: ASTM C150/C150M, Type I or Type II.
2. Coarse Aggregate Size: 3/4 inch.
3. Design for Minimum Compressive Strength at 28 Days: 3,000 psi.

2.11 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.12 TOPSOIL

A. As specified in Section 32 91 13, Soil Preparation.

2.13 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Earth backfill, including specified class.
2. Trench stabilization material.
3. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 GEOTEXTILE INSTALLATION

A. Where shown and as specified in Section 31 32 19.16, Geotextile, except as follows:

1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
2. Anchor geotextile trench walls prior to placing trench stabilization or bedding material.
3. Provide 24-inch minimum overlap at joints.

3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.05 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: As follows, except increase depths listed by 2 inches in areas of rock excavation:

1. Pipe 15 Inches and Smaller: 4 inches.
2. Pipe 18 Inches to 36 Inches: 6 inches.

3. Pipe 42 Inches and Larger: 8 inches.
4. Conduit: 3 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.06 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor.

3.07 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping, on top of last lift of pipe zone material. Coordinate with piping installation drawings.

1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.
2. Nondetectable Marking Tape: Install with metallic piping.

3.08 TRACER WIRE INSTALLATION AND TESTING

A. Install tracer wire continuously along centerline of nonmetallic buried piping.

B. Attach wire to top of pipe using tape at maximum of 10-foot intervals. In areas where depth of cover is excessive for allowing detection of tracer wire with electronic pipe locator, install tracer wire within pipe backfill directly above pipe centerline at a minimum depth of 3 feet.

C. Install splices in accordance with manufacturer's instructions for direct bury applications. Tie ends of wire to be joined in a knot as required to reduce tension on splice.

D. Bring tracer wire to surface at each valve box, curb box, vault, air valve, blowoff valve, hydrant, and pipeline marker. Tracer wire shall be brought to surface at least every 1,000 feet. If distance between pipe appurtenances exceeds 1,000 feet, install valve box to allow access to tracer wire. Coil enough excess tracer wire at each appurtenance to extend wire 12 inches above ground.

E. Test continuity of tracer wire using electronic pipe locator in presence of Engineer prior to paving.

3.09 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.

6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Class A Backfill:

1. Place in lifts not exceeding thickness of 9 inches.
2. Mechanically compact each lift to a minimum of 95 percent relative compaction.

C. Class A Backfill:

1. Place in lifts of suitable thickness.
2. Mechanically compact each lift prior to placing succeeding lifts.
3. Determine proper lift thickness, type of compaction equipment, method to use, and amount of compaction necessary to prevent settlement.

D. Class C Backfill:

1. Backfill with earth backfill.
2. Leave trench with backfill material neatly mounded across the entire trench width, but not more than 6 inches above the adjacent ground surface.
3. In lawn, garden, or similar type areas, maintain trench level with the existing adjacent grade.
4. At Other Locations:
   a. Estimate and provide amount of backfill material required so that after normal settlement, settled surface will match adjacent ground surface.
   b. Neatly windrow material over trench, and remove excess.
   c. Correct excess or deficiency of backfill material apparent after settlement and within correction period by regrading, and disposing of excess material or adding additional material where deficient.
5. Compact Class C backfill as a substitute for Class D backfill under the following conditions:
   a. In cases where 2 feet or less of nongranular overburden exists, and where balance of material for full depth of trench is, in Engineer's opinion, suitable for backfill under improved streets and where Class D backfill is shown or indicated.
   b. Compact as specified for Class D backfill.

E. Concrete Backfill:

1. Place above bedding.
2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
3. Do not allow dirt or foreign material to become mixed with concrete during placement.

4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

F. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.

3.10 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.11 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16, Asphalt Paving.

E. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

F. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.12 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   b. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. C150, Standard Specification for Portland Cement.
   d. C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.02 DEFINITIONS

A. Refer to applicable definitions in Section 31 23 23, Fill and Backfill.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Description and location of proposed sources of riprap bedding and riprap.

B. Informational Submittals:

1. Certified Test Results:
   a. Riprap Bedding:
      1) Gradation.
      2) Abrasion resistance.
   b. Riprap:
      1) Gradation.
      2) Abrasion resistance.
      3) Bulk density.
2. Trip tickets showing source, type, and weight of each load of material delivered to Site.

1.04 QUALITY ASSURANCE

A. Riprap Source: Quarry that has produced riprap and has performed satisfactorily on other projects for at least 5 years.

B. Site Visit: Make arrangements for Engineer to visit quarry site to observe materials proposed for riprap and riprap bedding.

1.05 SCHEDULING AND SEQUENCING

A. Complete subgrade preparation as specified in Section 31 23 13, Subgrade Preparation, and geotextile installation as specified in Section 31 32 19.16, Geotextile, prior to placing riprap.

PART 2 PRODUCTS

2.01 AGGREGATE RIPRAP BEDDING

A. Gravel with Cobbles or Crushed Rock with Cobble-Sized Pieces:

1. Gradation, as determined in accordance with ASTM C136:
   a. Well-graded from coarse to fine.
   b. All pieces pass a 6-inch square opening.
   c. Minimum 85 percent by weight passes 4-inch square opening.
   d. Minimum 10 percent by weight passes No. 4 U.S. standard sieve.
2. Abrasion Resistance: Maximum 35 percent wear when tested in accordance with ASTM C535.

B. Free of roots and other organic or deleterious matter.

C. Onsite material from excavations or designated borrow sources that meets or is processed to meet requirements specified above may be used as riprap bedding in lieu of importing material.

2.02 GEOTEXTILE RIPRAP BEDDING

A. Bedding geotextile as specified in Section 31 32 19.16, Geotextile.

2.03 RIPRAP

A. Hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.

B. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.

C. Abrasion Resistance: Maximum 35 percent wear as determined in accordance with ASTM C535.

D. Bulk Density: Minimum 160 pounds per dry cubic foot.

E. Gradation: Smaller pieces shall generally fill voids between larger pieces without either excess or deficiency of one or more sizes of stone.

Class	Thickness (Inches)	Weight (Pounds)	% Greater Than
I	12	150 100 50 25	0 to 5 30 75 90
II	18	250 150 50 25	0 to 5 30 75 90
III	24	800 400 200 25	0 to 5 30 75 90
IV	30	1,600 800 400 50	0 to 5 30 75 90
V	36	2,700 1,600 800 100	0 to 5 30 75 90

2.04 CONCRETE GROUT

A. Portland cement concrete as specified in Section 03 30 00, Cast-in-Place Concrete, having a 28-day compressive strength of 3,000 psi.

2.05 CONCRETE GROUT

A. Mix: ASTM C94/C94M, Option A.

1. Cement: ASTM C150, Type I.
2. Coarse Aggregate Size: 1 inch.
3. Design for Minimum Compressive Strength at 28 Days: 2,500 psi.

PART 3 EXECUTION

3.01 PLACING RIPRAP

A. Place riprap over geotextile to thickness shown.

B. No mechanical compaction of riprap is required; however, work riprap bedding as necessary to distribute it and to eliminate detrimental voids. Avoid overworking or long pushes that result in segregation of particle sizes.

C. Grade surface of riprap bedding free from irregularities and to tolerances of 0.2 feet from established grade.

D. Place and grade riprap in a manner that avoids subgrade disturbance and displacement or damage to geotextile. Do not push riprap bedding down slope. If wrinkles form in geotextile as riprap bedding is placed, correct them as specified in Section 31 32 19.16, Geotextile.

E. Place riprap on geotextile without puncturing or damaging geotextile. If accidentally damaged, repair geotextile prior to proceeding.

3.02 GROUTING RIPRAP

A. Remove dirt and foreign substances from surfaces of riprap and then moisten.

B. Deposit grout by means of chutes, tubes, or buckets, or place by means of pneumatic equipment or other mechanical methods. Place grout in a continuous operation for any day’s run at any one location.

C. Limit flow distance of grout along slope to less than 10 feet.

D. Spade and rod grout into place with suitable spades, trowels, or other approved means immediately after depositing grout. Depths of grout shall be approximately 1/2 the thickness of the riprap.

E. Following placement of grout, thoroughly brush rocks so top surfaces are exposed. Outer rocks shall project 1/3 to 1/4 their diameter above grout surface. Brushing shall follow closely behind rodding such that grout shall not be in place more than 1 hour before brushing.

F. Once brushing of area is complete, no worker or load will be permitted on surface for period of at least 24 hours, or longer if so required by Engineer.

G. Cure grout as provided in Section 03 30 00, Cast-in-Place Concrete.

END OF SECTION

SECTION 31 63 20
GROUND IMPROVEMENT WITH RIGID INCLUSIONS

PART 1 GENERAL

1.01 SCOPE

A. The work shall consist of designing, furnishing, installing, monitoring and testing of rigid inclusions as designated on the project drawings and as specified herein. The piers shall be constructed by either augering a shaft or driving a hollow mandrel to the design depth and vertically ramming lifts of aggregate or an aggregate/cement mixture using the specially designed tamper head and high-energy impact densification equipment to create the compacted aggregate pier or rigid inclusion pier. The pier elements shall be in a columnar-type configuration and shall be used to produce an intermediate foundation system. The installation shall include the hauling, stockpiling, removal, and disposal of excavation spoils resulting from the installation process.

1.02 APPROVED INSTALLERS

A. The installer shall have the following minimum qualifications:

1. A minimum of 5 years experience with Rigid Inclusions.
2. Successfully completed at least 50 projects with Rigid Inclusion or Aggregate Piers.
3. General Liability Coverage of at least $10 million.
4. Professional Liability of at least $3 million.
5. Bonding capability commensurate with project size.

B. Pre-Approved Installers:

1. Hayward Baker.
2. Geopier Foundation Company.
3. Alternate installers to be approved by Engineer.

1.03 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. ASTM International (ASTM):
   a. D448, Standard Classification for Sizes of Aggregates for Road and Bridge Construction.

b. D1143/D1143M, 07e1 Standard Test Methods for Deep Foundations Under Static Axial Compressive Load.
c. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
d. D1194 Spread Footing Load Test.
e. C31 Standard Practice for Making and Curing Cement Test Specimens in the Field.
f. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

1.04 DEFINITIONS

A. Demonstration Rigid Inclusions: Rigid inclusions installed at non-production locations. These rigid inclusions will be installed to verify the installation technique, to assist in selecting location of load tests, develop installation criteria, and to identify installation sequence. For each additional different rig brought to the Site for installation of rigid inclusions, additional demonstration rigid inclusions shall be installed to assess the rig's capabilities.

B. Rigid Inclusions: Vertical grout columns that are used for ground improvement and installed under the structure to transfer the load to a competent bearing layer. The purpose of the rigid inclusions is to provide ground improvement to support foundations and floor slabs.

1.05 SUBMITTALS

A. Design Shop Drawings: Shall include plan locations of all rigid inclusions, diameter, installation procedure, and sequence of construction with sufficient details including transitions areas, planned cut off and tip elevations, material, and mix design. The shop drawings shall also detail excavation process and installation sequence where rigid inclusions are adjacent to existing foundations.

B. Design Calculations: The Installer shall submit design calculations and construction drawings prepared by the Pier Designer for review and approval by the Owner or Owner's Engineer. All plans shall be sealed by a Professional Engineer in the State of Tennessee.

C. The Contractor shall submit a load testing program to verify the design. The submittal shall be submitted a minimum of 10 days prior to installation of the test rigid inclusions and shall include the following:

1. Two static load tests performed on rigid inclusions in accordance with Section 31 09 18, Static Load Testing. The locations of the test piles will be selected by the Engineer.

2. The Contractor shall accommodate in its schedule the time required for performing the load test and for evaluating test results and issuing the installation criteria by the Engineer.
3. Design calculations for the load test reaction piles including diameter, type, reinforcement, depth as well as the reaction frame and beams. All details and supporting calculations shall be submitted for review by the Engineer. All shop drawings and supporting calculations shall be signed and sealed by a professional engineer registered in the State of Tennessee.
4. Calibration records load cells, hydraulic jacks, pumps, and pressure gauges should be submitted at least 7 days prior to performing the load testing.
5. The Contractor shall submit a complete load test report, containing all results of installation and testing, after completion of the test program. The report shall be prepared and sealed by a qualified professional engineer registered in the State of Tennessee. The Engineer shall evaluate results of load tests and the demonstration rigid inclusions logs and shall issue the final tip elevations and installation criteria for the production rigid inclusions within 14 days from receipt of the load test report. No rigid inclusions shall be installed at production locations until after issuance of this report.

D. Work Plan: The Contractor shall submit to the Engineer, for review and approval, details of the equipment, sequence, and method of installation. The plan shall include a detailed quality control plan and explain how the plan complies with requirements of the Project safety plan.

E. Qualifications: Documentation of the Contractor’s qualifications shall show that they have been engaged in successful installation of deep ground improvements for at least 5 years and constructed a minimum of 10 similar projects of similar scope utilizing the deep ground improvement method proposed. A list of previous projects including name, description, relative size and contact person with phone number shall be provided. Resumes of Contractor’s site superintendent and/or foreman shall also be provided.

F. Production records, including:

1. All recordable information versus penetration depth, including applied torque, applied static down pressure (crowd pressure), advance rate (penetration speed), grout pressure and grout volume.
2. As-built plans for the installed rigid inclusions based on actual locations and tip elevations, shall also be submitted.
3. Documentation of laboratory and field testing of grout and other imported materials to the Site.

1.06 DESIGN REQUIREMENTS

A. Rigid Inclusion Pier Design Capacity: The capacity of individual rigid inclusions shall be the lesser of the geotechnical and structural capacity as defined below:

1. Geotechnical Requirements: The geotechnical capacity shall be calculated using Meyerhof bearing capacity method. Shaft capacity shall not be considered in fill materials. Shaft resistance may be considered when the pier extends a minimum 5 feet into a competent soils stratum. For piers where the shaft extends a minimum of five feet into the bearing stratum or extends through multiple soils strata below an unsuitable layer, a unit friction value should be computed for each layer and the total shaft resistance should be taken as the summation of the individual layers.
2. Structural Requirements: The structural capacity of the pier used for design shall not exceed 0.3 by f'c, where f'c equals the 28-day compressive strength of the cement/aggregate mixture as sampled on site and confirmed by QC compressive strength testing per ASTM C39.

B. Load Transfer Platform Design: Design calculations and design details shall be provided to determine the thickness and lateral extent needed for an aggregate load transfer layer to transfer the load from the concrete footing, slab or wall or embankment fill, to the rigid inclusion element.

C. Maximum Allowable Bearing Pressure for footings supported by Rigid Inclusions equals 2,500 psf.

D. Estimated Long Term Settlement for Footings maximum equals 1 inch.

E. Estimated Long Term Differential Settlement of Adjacent Footings maximum equals 0.5 inch.

PART 2 PRODUCTS

2.01 GRANULAR BACKFILL

A. In accordance with Section 31 23 23, Fill and Backfill.

2.02 CEMENT

A. Cement used in Rigid Inclusion Piers shall meet the requirements for Type I or Type II Portland cement per ASTM C150.

PART 3 EXECUTION

3.01 EQUIPMENT

A. The Contractor shall use machines or combinations of machines and equipment that are in good working condition, are safe to operate, and will produce the results specified herein.

B. The Contractor shall use equipment that is capable of advancing the rigid inclusions through the subsurface materials efficiently and timely to meet the Project schedule.

C. The equipment shall be of sufficient size and capacity, and be capable of installing rigid inclusions to the minimum tip elevation shown in the plans or that required per the load test, whichever is deeper.

D. Rigid inclusion equipment must be equipped with installation monitoring capabilities including, as a minimum, the following: a) applied torque, b) applied static down pressure (crowd), c) advance rate (penetration speed), d) grout pressure, and e) grout volume.

E. The equipment shall be capable of installing rigid inclusions in the presence of dense granular soils and very stiff to hard fine-grained soils.

3.02 SITE PREPARATION

A. The Contractor shall inspect the Site prior to the start of its operation to verify the depth ground improvements can be constructed using the proposed equipment.

B. Any overexcavation and backfill required to access the Site and operate the rigid inclusion rigs is incidental to the rigid inclusions installation and no additional payment or time will be granted.

3.03 RIGID INCLUSION CONSTRUCTION

A. Evaluate Site surface and subsurface conditions and assess any need for working platforms. Such platforms, preparatory work, and material needed is considered part of means and methods and no additional payment or time will be granted toward such Work.

B. Install a total of 5 demonstration rigid inclusions at non-production locations throughout the Site(s). The minimum number of demonstration rigid inclusions per structure are listed below:

Structure	Minimum Number of Demonstration Rigid Inclusions
Bioreactor	2
Clarifier	1
Filter / UV Structure	1
Grit Structure	1

C. Demonstration rigid inclusions are necessary to assess any variation in soil conditions and select the rigid inclusions locations that will be load tested and to be used in development of production rigid inclusion installation criteria. These demonstration rigid inclusions shall be installed before the load tests and before installation of production rigid inclusions.

D. Perform a total of two load tests prior to the start of rigid inclusion production. The load test location shall be provided by the Engineer based on the review of demonstration rigid inclusions installation logs. Note that a minimum of one load test will be performed in either the area of the proposed Bioreactor. The other load test will be selected in either the area of the proposed UV Disinfection Building, Maintenance Building, or Alum Storage Tank adjacent to the existing Chemical Building. The Contractor shall perform load tests prior to commencement of any production rigid inclusions in the areas stated above.

E. The Contractor shall provide the installation logs for the demonstration and test rigid inclusions for the review of the Engineer within 1 day after the completion of the rigid inclusion installation. The Engineer shall provide the location of the load tests within 7 calendar days after receiving all the demonstration rigid inclusion installation logs for a specific area.

F. The load test results shall be signed and sealed by the Contractor's professional engineer and submitted to the Engineer for review and acceptance. No payment shall be made for load tests that were unsatisfactorily performed as determined by the Contractor or the Engineer.

G. No production rigid inclusions shall be installed until the load testing for that specific area has been completed, including completion of requirements of Article Submittals paragraph B in this Specification.

H. Layout and Tolerances:

1. Surveying: Prior to installation of the rigid inclusions, each rigid inclusion location shall be surveyed by an approved surveyor paid for by the Contractor. The Contractor shall provide all survey layouts, maintain utility clearances and provide any required coordination with the Owner prior to the start of construction. The location of each rigid inclusion shall be marked using a numbered utility flag.
2. Plan Position: The center of the completed rigid inclusion shall be within 3 inches of the plan location.
3. Verticality: The axis of the completed rigid inclusion shall not deviate more than 2 percent from vertical rigid inclusions. The verticality of the mast of the rig shall be checked by the operator before start of the installation for each rigid inclusion. The operator shall indicate on the daily drilling log for each rigid inclusion that verticality was within tolerance by checking the appropriate box on the installation log.
4. Diameter: The completed rigid inclusion diameter shall not deviate more than 10 percent from the plan diameter.

I. Rejection: Rigid inclusions improperly located or installed beyond the maximum allowable tolerances or reported to be defective as a result of pile integrity testing, shall be abandoned and replaced with new rigid inclusions unless the Contractor and the Contractor's designer propose a remedial measure which is mutually agreeable to the Contractor and the Engineer, either of which will be done at no additional cost to the Owner.

J. Schedule: The Contractor shall mobilize and maintain sufficient equipment, materials, and personnel to complete the Work in accordance with Project milestones and shall coordinate operations with all other aspects of the Project.

K. Installation Sequence: The Contractor shall install the rigid inclusions in accordance with the sequence detailed in the approved work plan. If adjacent rigid inclusions are observed to be influenced by the installation of a neighboring rigid inclusion, the installation sequence shall be modified to prevent disturbance of rigid inclusions. Any required modifications to the sequence, or mitigation of rigid inclusions deemed unusable due to disturbance, shall be completed by the Contractor at no additional cost to the Owner.

L. Depth: Rigid inclusions shall be installed from the existing ground surface and extend to the minimum tip elevation, or deeper as required to found the rigid inclusions in a suitable bearing stratum, as determined by the Engineer.

M. Obstructions: Subsurface obstructions may include but are not limited to boulders, timbers, concrete, bricks, utility lines, foundations, slabs, etc. that prevent rigid inclusions to be installed to the required depth. If obstructions are encountered during installation of a rigid inclusion that cannot be penetrated with reasonable effort, one or more of the following procedures will be used:

1. Position the rigid inclusion a short distance away from the original position in consultation with and approval of the Engineer.
2. Pre-drill the obstruction.
3. Install additional rigid inclusions to bridge over the obstruction.
4. Perform other removal or relocation operations.

N. Any change made to the design or rigid inclusion layout because of obstructions shall be evaluated by the Contractor and approved by the Engineer. The Contractor shall provide to the Engineer as-built submittal no later than 7 calendar days after the modification has been performed on-site. This submittal shall be stamped by the registered professional engineer responsible to the Contractor and having stamped the design submittals. All elements that are abandoned due to obstructions or equipment malfunction shall be completely backfilled with grout.

O. Cut-off Elevation: Rigid inclusions shall be cutoff to the bottom elevation of the granular backfill layer for the planned slab or footing, or slightly higher to allow any required trimming or removal of low-strength material at the butt of the rigid inclusion. The cut-off elevation of each rigid inclusion shall be established by the Contractor with an accuracy of plus or minus 0.1 foot.

P. Protection of Rigid Inclusions: Rigid inclusion installation, construction of the overlying granular drainage layer, and new structures shall be performed in such a way as to prevent damage to the rigid inclusions or disturbance of soil between rigid inclusions.

Q. Load Testing: Following a cure time to achieve the design strength, perform axial load tests on the test rigid inclusions. The testing shall be in accordance with Section 31 09 18, Static Pile Testing, with the following loading protocol:

1. Apply the load in increments of approximately 20 percent of the design load up to 150 percent of the design load.
2. Maintain the applied load at each increment for 5 minutes during loading and unloading, except at 100 and 150 percent of the design load. Record the deformation and strain two minutes after applying the test load and just prior to applying the next load increment.

3. At 100 and 150 percent of the design load, hold the load for at least 10 minutes. Deformation readings shall be recorded at 1, 2, 4, 6 and 10 minutes. If the average deformation between 1 and 10 minutes increases by more than 0.04 inch, hold the load for 60 minutes and record the deformation every 10 minutes.
4. After completing the required hold time at 150 percent of design load, unload the pile in increments of 25 percent of design load until the alignment load is reached.
5. Continue testing by reloading the test pile at increments equal to 25 percent of the design load until plunging failure occurs or a maximum load of 200 percent of design load is reached, whichever occurs first. During this reload cycle, hold each load increment for 2.5 minutes.
6. Unload in increments of 50 percent of design load until the alignment load is reached.

R. Disposal of Excavation Spoils: Stockpile all spoil material, including any topsoil and spoils generated by rigid inclusion installation, at the locations designated on the soil erosion plan. Handling and disposal of spoils are incidental to the Work and at no additional cost to the Owner.

3.04 FIELD QUALITY CONTROL

A. Section 01 45 16.13, Contractor Quality Control, specifies the general requirements for the Contractor's quality control (CQC) program.

B. The following describes the minimum inspection and testing required in the CQC plan and program for the Work of this section and is for CQC only. Implementation of the CQC program does not relieve the Contractor from the responsibility to provide the Work in accordance with the Contract Documents, applicable codes, regulations, and governing authorities. The CQC plan and program shall include, but not be limited to, the following testing and inspection elements. These elements are provided only as a minimum starting point for the Contractor to use to generate its complete CQC program.

3.05 QUALITY CONTROL: SUPERVISION, INSPECTION AND RECORDS

A. The Contractor must have an onsite field engineer to manage all QC activities on the Project including grout sampling and testing at frequencies defined by Contractor in the design submittal and approved by the Engineer. Monitoring, recording of data and evaluation of load tests, and inspection and recording of data for production rigid inclusion construction, and subgrade preparation shall be done under the direct supervision of a professional engineer registered in the State of Ohio on the staff of the Contractor or a subconsultant to the Contractor. The professional engineer shall have supervised a minimum of five similar deep-ground improvement projects.

B. Records:

1. An accurate record shall be kept by the Contractor for all rigid inclusions as installed. The record shall indicate the rigid inclusion location, length, cut-off elevation, date and time of construction, and other pertinent installation details as indicated in the design submittal and approved by the Engineer. The Contractor shall immediately report any unusual conditions encountered during installation. Any corrective measures shall also be recorded. Daily records shall be signed by the Contractor' superintendent and by the inspector. A complete tabulation of all records pertaining to approved rigid inclusion installation shall be certified by the Contractor's professional engineer and shall be delivered to the Engineer no later than 14 days after the completion of the rigid inclusion work. All testing and inspection documents shall be reviewed and approved by the Contractor's professional engineer certifying the rigid inclusions will be suitable for support of the design loads.
2. The Contractor shall provide on a daily basis pertinent installation data as defined in the design submittal and approved by the Engineer. These documents shall be prepared continuously as the production progresses and shall be submitted to the Engineer no later than 1 working day after the installation of a rigid inclusion. The Contractor shall ensure the Engineer has complete access at all times to data for the rigid inclusion installation, as required.
3. Concrete/Grout: Conduct strength testing in accordance with Section 31 63 16, Auger Cast Grout Piles. At a minimum, prepare a set of four test cylinders or cubes for each 50 cubic yards of grout placed or a minimum of two sets of four cubes per day (whichever is greater). One cube from each set shall be tested for strength at 1, 2, 7, and 28 days. Certified strength tests shall be provided to Engineer for acceptance.
4. Pile Integrity Testing (PIT): PIT shall be performed on all the inclusions used for load test and approximately 5 percent of the rigid inclusions. The PIT shall be performed in accordance with Section 31 09 17, Dynamic Pile Testing. Production elements selected for the PIT shall be at the discretion of the Engineer based on daily records indicating likelihood of anomalies in the inclusions.
5. The PIT shall be performed by a firm qualified to do such testing. Documentation of the firm's qualifications shall show that it has successfully performed PIT testing for at least 5 years, and for a minimum of five similar projects. A list of previous projects including name, description, number of tests performed, and contact person with phone number shall be provided.

6. The firm performing PIT will be responsible for testing and assessing the integrity and condition of the pile, including but not limited to significant reductions in pile cross-sectional area (necking) or pile material strength/stiffness above the pile toe. In addition, the firm performing PIT shall confirm the pile lengths where clear pile toe reflection is obtained or state to which pile length the test appears to be conclusive.
7. The PIT submittal shall include:
    a. A record of each rigid inclusion tested.
    b. Low-strain Dynamic Testing (LSDT) Report: In accordance with referenced standard for test performed.
    c. Installation record.
    d. Pile length.
    e. Unusual occurrence(s) during installation.
    f. Submit report with complete interpretation of PIT results to the Engineer within 48 hours of test completion.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
   b. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   c. C117, Standard Method of Test for Materials Finer Than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C131, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   e. C183, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   f. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).
   g. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft^3 (2700 kN-m/m^3)).
   h. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   i. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   j. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   k. D2844, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   l. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
   m. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   n. D5195, Standard Test Methods for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.
   o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.

D. Gravel Surfacing: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.

E. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

PART 2 PRODUCTS

2.01 BASE COURSE

A. Mineral aggregate base Type Grade D conforming to the requirements of Section 303 of Tennessee Department of Transportation (TDOT) Standard Specifications for Road and Bridge Construction.

2.02 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials on soft, muddy, subgrade.

3.02 EQUIPMENT

A. In accordance with the requirements of Section 303 of Tennessee Department of Transportation (TDOT) Standard Specifications for Road and Bridge Construction.

B. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 ROLLING AND COMPACTION

A. In accordance with the requirements of Section 303 of Tennessee Department of Transportation (TDOT) Standard Specifications for Road and Bridge Construction.

B. Commence rolling at outer edges and continue toward center; do not roll center of road first.

C. Apply water as needed to obtain specified densities.

D. Place and compact each lift to the required density before succeeding lift is placed.

E. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

F. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.05 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.06 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Provide testing laboratory at least 2 hours advance notification prior to testing.
2. Show proof that areas meet specified requirements before identifying density test locations.
3. Refer to Table 2 for minimum sampling and testing requirements for aggregate base course and surfacing.

Table 2
Minimum Sampling and Testing Requirements

Property	Test Method	Frequency	Sampling Point
Gradation	ASTM C117and ASTM C183	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	ASTM D698, Method D	One test for every aggregate grading produced	Production output or stockpile

Table 2 Minimum Sampling and Testing Requirements			
Property	**Test Method**	**Frequency**	**Sampling Point**
In-Place Density and Moisture Content	ASTM D5195, ASTM D6938, and ASTM D2216 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

3.07 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   d. M140, Standard Specification for Emulsified Asphalt.
   e. M156, Standard Specification for Requirements for Mixing Plants for Hot-mixed, Hot-laid Bituminous Paving Mixes.
   f. M208, Standard Specification for Cationic Emulsified Asphalt.
   g. R35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.
   h. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
   i. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA).
   k. T245, Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus.
   l. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA) by Means of Hveem Apparatus.
   m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
   n. T283, Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage.
   o. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate.

p. T312, Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of a Superpave Gyratory Compactor.

2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.
3. ASTM International (ASTM):
   a. D75, Standard Method of Test for Sampling of Aggregates.
   b. D140, Standard Method of Test for Sampling Bituminous Materials.
   c. D979, Standard Method of Test for Sampling Bituminous Paving Mixtures.
   d. D2041, Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   e. D2489, Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures.
   f. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   g. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   h. D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
   i. E329 REV A, Standard Specification for Agencies Engaged in Construction Inspection Testing, or Special Inspection.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.

C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.

D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.

E. Reclaimed asphalt pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.

F. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.

G. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.

1.03 DESIGN REQUIREMENTS

A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of Tennessee Department of Transportation (TDOT) Standard Specifications for Road and Bridge Construction, latest revision.

1.04 SUBMITTALS

A. Informational Submittals:

1. TDOT approved mix design:
   a. Submit minimum of 15 days prior to start of production.
2. Test Report for Asphalt Cement:
   a. Submit minimum 10 days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following materials:
   a. Aggregate: Gradation, source test results as defined in this section.
   b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
   c. Prime Coat: Type and grade of asphalt.
   d. Tack Coat: Type and grade of asphalt.
   e. Additives.
   f. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
   a. Mix design.
   b. Asphalt concrete core.
   c. Gradation and asphalt content of uncompacted mix.
   d. Field density.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329 REV A.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F (10 degrees C) or air temperature is lower than 40 degrees F (4 degrees C). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat: Cutback asphalt, in accordance with the requirements of Section 402 of TDOT Standard Specifications for Road and Bridge Construction.

B. Tack Coat:

1. Emulsified Asphalt for Tack Coat or Seal Coat: Conform to Section 403 of TDOT Standard Specifications for Road and Bridge Construction.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Engineer.
2. Source Changes:
   a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
   b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Engineer to confirm that properties are in compliance with design criteria.
   c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Asphalt Concrete: Grade E as specified in Section 411 of the TDOT Standard Specifications for Road and Bridge Construction.

C. Asphalt Binder Course: Grade BM-2 as specified in Section 307 of the TDOT Standard Specifications for Road and Bridge Construction.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:

1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

A. In accordance with applicable sections of TDOT Standard Specifications for Road and Bridge Construction, latest edition.

3.04 PREPARATION

A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Remove existing material to a minimum depth of 1 inch (25 millimeters).
3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with the TDOT Standard Specifications for Road and Bridge Construction.

B. Pavement Mix:

1. Prior to Paving:
   a. Sweep primed surface free of dirt, dust, or other foreign matter.
   b. Patch holes in primed surface with asphalt concrete pavement mix.
   c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in one single lift.
3. Compacted Lift Thickness:
   a. Minimum: Twice maximum aggregate size, but in no case less than 1 inch (25 millimeters).
   b. Maximum: 4 inches (100 millimeters).
4. Total Compacted Thickness: As shown.
5. Sequence placement so that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
   a. Offset edge of each layer a minimum of 6 inches (150 millimeters) so joints are not directly over those in underlying layer.
   b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
   c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 6 inches (150 millimeters) on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.

C. Compaction:

1. Roll until roller marks are eliminated and minimum percent compaction as stated in the Standard Specifications.
2. Joint Compaction:
   a. Place top or wearing layer as continuously as possible**.**
   b. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
   c. Cut away waste material and lay new mix against fresh cut.

D. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
   a. Uniform texture, smooth, and uniform to crown and grade.
   b. Maximum Deviation: 1/8 inch (3 millimeter) from lower edge of a 12-foot (3.6-meter) straightedge, measured continuously parallel and at right angle to centerline.
   c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.
3. Transverse Slope Maximum Deviation: (1/4 inch (6 millimeters) in 12 feet (3.6 meters) from rate of slope shown.
4. Finished Grade:
   a. Maximum Deviation: 0.02 foot (6 millimeters) from grade shown.

3.06 PAVEMENT OVERLAY

A. Preparation:

1. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.
2. Surface Depressions: Fill with asphalt concrete mix, and thoroughly compact.
3. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.
4. Portland Cement Concrete Joints: Remove joint filler to minimum 1/2 inch (12 millimeters) below surface.

B. Application:

1. Tack Coat: As specified in this section.
2. Place and compact asphalt concrete as specified in Article Pavement Application.

3. Place first layer to include widening of pavement and leveling of irregularities in surface of existing pavement.
4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 2 inches (50 millimeters).
5. Actual compacted thickness of intermittent areas of 120 square yards (100 square meters) or less may exceed 2 inches (50 millimeters), but not 4 inches (100 millimeters).
6. Final wearing layer shall be of uniform thickness, and meet grade and cross-section as shown.

3.07 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 3 inches (75 millimeters) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 pounds per linear inch to 300 pounds per linear inch (350 Newtons per linear centimeter to 525 Newtons per linear centimeter). Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least one-half the roller width. Progress toward center of patch overlapping each preceding track by at least one-half width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.

2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch (6 millimeters) or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.08 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 500 tons (400 mg) of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons (900 mg) or once every 8 hours, whichever is greater.
2. Density Tests: Once every 500 tons (450 mg) of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M237, Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete.
   b. M247, Standard Specification for Glass Beads Used in Traffic Paint.
   c. M248, Standard Specification for Ready-Mixed White and Yellow Traffic Paints.
   d. M249, Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
2. ASTM International (ASTM): D4280, Standard Specification Extended Life Type, Nonplowable, Prismatic, Raised, Retroreflective Pavement Markers.
3. Federal Specifications (FS):
   a. A-A-2886A, Paint, Traffic, Solvent Based.
   b. TT-B-1325C, Beads (Glass Spheres); Retroreflective.

1.02 DEFINITIONS

A. Standard Specifications: Tennessee Department of Transportation (TDOT) Standard Specifications for Road and Bridge Construction.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Paint.
      2) Thermoplastic material.

PART 2 PRODUCTS

2.01 GENERAL

A. All products shall be in accordance with Section 603 of the TDOT Standard Specifications.

2.02 PAINT

A. Color: White or yellow.

B. Traffic paint in accordance with Section 603 of the TDOT Standard Specifications.

C. Homogeneous, easily stirred to smooth consistency, with no hard settlement or other objectionable characteristics during storage period of 6 months.

PART 3 EXECUTION

3.01 GENERAL

A. Surface Preparation, Application, and Protection: In accordance with Section 610 of the TDOT Standard Specifications.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod, or sprig) and continue for a period of 8 weeks after all planting under this section is completed.

B. Satisfactory Stand: Grass that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

A. Action Submittals: Product labels/data sheets.

B. Informational Submittals:

1. Seed: Certification of seed analysis, germination rate, and inoculation:
   a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
      1) Name and address of laboratory.
      2) Date of test.
      3) Lot number for each seed specified.
      4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
   b. Mixtures: Proportions of each kind of seed.
2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.
3. Certification of sod; include source and harvest date of sod, and sod seed mix.
4. Certification of sprig type and name.
5. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Sod:

1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.
2. Harvest and deliver sod only after laying bed is prepared for sodding.
3. Roll or stack to prevent yellowing.
4. Deliver and lay within 24 hours of harvesting.
5. Keep moist and covered to protect from drying from time of harvesting until laid.

C. Sprigs:

1. Cut and deliver only after planting area is prepared for planting.
2. Deliver and plant within 24 hours of harvesting.
3. Keep moist and covered to protect from drying from time of cutting until planted.

D. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

A. Complete Work under this section within 5 days following completion of soil preparation.

B. Notify Engineer at least 3 days in advance of:

1. Each material delivery.
2. Start of planting activity.

C. Planting Season: March 15 and September 15.

1.06 MAINTENANCE SERVICE

A. Contractor: Perform maintenance operations during maintenance period to include:

1. Watering: Keep surface moist.
2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
3. Mulch: Replace wherever and whenever washed or blown away.
4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
5. Fence: Repair and maintain until satisfactory stand of grass is established.
6. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
7. Reseed/replant during next planting season if scheduled end of maintenance period falls after September 15.
8. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.

B. Application Rates: Determined by soil analysis results.

C. Mix:

1. Nitrogen: 10.
2. Phosphoric Acid: 10.
3. Potash: 10.

2.02 SEED

A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.

B. Summer Seed Mix: Turf type tall fescue.

1. Rebel II.
2. Or approved equal.

C. Winter Protective Seed: Annual ryegrass.

2.03 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

2.04 HYDROSEEDING MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

2.05 NETTING

A. Jute:

1. Heavy-duty, twisted, weighing 1 pound per square yard.
2. Openings Between Strands: Approximately 1-inch square.

B. Plastic:

1. Extruded Polypropylene: 20 mils.
2. Opening Between Strands: 1 inch by 2 inch.

C. Matting:

1. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.
2. Manufacturers and Products:
   a. Akzo Industries, Asheville, NC; Curlex mat.
   b. North American Green, Evansville, IN; S150 blanket.
   c. Or approved equal.

2.06 TACKIFIER

A. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.

1. Capable of hydrating in water, and to readily blend with other slurry materials.
2. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.
3. Manufacturers and Products:
   a. Chevron Asphalt Co.; CSS 1.
   b. Terra; Tack AR.
   c. J Tack; Reclamare.
   d. Or approved equal.

2.07 WEED BARRIER

A. 6 mils (0.006-inch) black polyethylene sheet.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer’s instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

3.03 SEEDING

A. Start within 2 days of preparation completion.

B. Hydroseed slopes steeper than 3H:1V. Flatter slopes may be mechanically seeded.

C. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipacter or roller.

1. Sow seed at uniform rate of 5 pounds per 1,000 square feet.
2. Use Brillion type seeder.
3. Broadcasting will be allowed only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20 percent.
4. Roll with ring roller to cover seed, and water with fine spray.

D. Hydroseeding:

1. Apply on moist soil, only after free surface water has drained away.
2. Prevent drift and displacement of mixture into other areas.
3. Upon application, allow absorption and percolation of moisture into ground.
4. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

E. Cover Crop Seeding: Apply seed at rate of 120 pounds per acre to areas that are bare or incomplete after September 15.

F. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre.

G. Netting: Immediately after mulching, place over mulched areas with slopes steeper than 3:1, in accordance with manufacturer's instructions. Locate strips parallel to slope and completely cover seeded areas.

H. Tackifier: Apply over mulched areas with slopes steeper than 4:1 at rate of 5 gallons per 1,000 square feet in accordance with the manufacturers recommended requirements.

I. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 FIELD QUALITY CONTROL

A. 8 weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

END OF SECTION

SECTION 33 05 13
MANHOLES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A536, Standard Specification for Ductile Iron Castings.
   e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   j. C150/C150M, Standard Specification for Portland Cement.
   k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
   p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.
   q. C1311, Standard Specification for Solvent Release Sealants.

r. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings including details of construction, reinforcing and joints, anchors, lifting, erection inserts, and other items cast into members.
2. Product Data:
   a. Concrete mix design.
   b. Manhole frame to structure seals.
   c. Manhole frame to structure anchor bolt.
   d. Rubber gaskets and sealants.
   e. External joint wrap.

B. Informational Submittals:

1. Experience Record:
   a. Precast concrete production capabilities.
   b. Evidence of current PCI plant certification.
2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
3. Test Reports: Precast manufacturer’s concrete test cylinders.
4. Manufacturer’s recommended installation instructions.
5. Field quality control report.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years’ experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials of Construction and Service Conditions:

1. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.
2. Gaskets: Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
   a. Sanitary sewage.
   b. Corrosion or rotting under wet or dry conditions.
   c. Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
   d. Biological environment in soils and sanitary sewers.
   e. Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
   f. Temperature ranges, variations, and gradients in construction area.
   g. Variations in moisture conditions and humidity.
   h. Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
   i. Vibrations because of traffic loading.
   j. Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.
3. Materials shall be compatible with each other and manhole materials.
4. Designed to provide a 20-year service life.

B. Structures shall meet requirements of ASTM C478, this specification and the following:

1. Concrete:
   a. Cement: Meet requirements of ASTM C150/C150M.
   b. Compressive Strength:
      1) Minimum 4,000 psi.
      2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.
2. Reinforcement: Grade 60, unless otherwise specified.
3. Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.
4. Floor: below pipe to provide clearance for grouting channels.

5. Joint:
    a. Form joint contact services with machined castings.
    b. Surfaces shall be parallel with nominal 1/16-inch clearing and tongue equipped with recess for installation of O-ring rubber gasket.
6. Gasket: Meet requirements of ASTM C443.

2.02 PRECAST MANHOLES

A. Riser Sections:

1. Fabricate in accordance with ASTM C478.
2. Diameter: Minimum 48 inches.
3. Wall Thickness: Minimum 4 inches or 1/12 times inside diameter, whichever is greater.
4. Top and bottom surfaces shall be parallel.
5. Joints: Tongue-and-groove.

B. Cone Sections:

1. Eccentric.
2. Same wall thickness and reinforcement as riser section.
3. Top and bottom surfaces shall be parallel.

C. Base Sections and Base Slab:

1. Base slab integral with sidewalls.
2. Fabricate in accordance with ASTM C478.

D. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.
2. Fabricate in accordance with ASTM C478.

E. Joint Seal Manufacturers and Products:

1. Butyl Gaskets:
    a. Hamilton Kent, Sparks, NV; Kent-Seal No. 2.
    b. Henry Company, Houston, TX; Ram-Nek.
    c. Trelleborg Engineered Solutions, Park Hills, MO; NPC Bidco C-56.
    d. Or approved equal.
2. Confined Plastic or Rubber O-Ring:
    a. As recommended by precasting manufacturer.
    b. Meet requirements of ASTM C443.

3. External Wrap:
    a. Sealing Systems, Inc., Loretto, MN; Gator Wrap.
    b. Henry Company, Houston, TX; RU116 Rubr-Nek External Joint Wrap.
    c. Trelleborg Engineered Solutions, Park Hills, MO; NPC External Joint Wrap.
    d. Cretex Specialty Products, Waukesha, WI; Cretex Wrap.
    e. Or approved equal.

2.03 MANHOLE FRAMES AND COVER

A. Castings:

1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
2. Cast Iron: ASTM A48/A48M Class 35B.
3. Ductile Iron: ASTM A536, Grade 60-40-12.
4. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Cover: With the word SEWER in 2-inch raised letters.

2.04 MANHOLE FRAME CONNECTION TO STRUCTURE

A. Butyl Sealant:

1. Conform to ASTM C1311, or AASHTO M198 and ASTM C990.
2. Trowelable or cartridge applied.
3. Manufacturers and Products:
    a. Tremco Commercial Sealants and Waterproofing, Beachwood, OH; Tremco Butyl Sealant.
    b. Bostik, Middleton, MA; Chem-Calk 300.
    c. Press-Seal Gasket Company, Fort Wayne, IN; EZ-Stik #3.
    d. Or approved equal.

B. External Wrap:

1. Meet requirements of ASTM C923.
2. Construct of high quality rubber that will provide flexible watertight seal around joint.
3. Thickness: Minimum 60 mils.
4. Consist of a top and bottom section and be sealed to structure, frame top, and bottom with mastic as applicable.
5. Length: Extend from manhole frame and extension ring to cone section.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.

7. Manufacturers and Products:
    a. Sealing Systems, Inc., Loretto, MN; Infi-Shield.
    b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
    c. Cretex Specialty Products, Waukesha, WI; X-85 Seal.
    d. Or approved equal.

C. Internal Wrap or Sealing Membrane:

1. Meet requirements of ASTM C923.
2. Minimum internal thickness of 3/16 inch or as recommended by manufacturer for installation climate.
3. Designed for application and have a demonstrated history of accommodating differential expansion between frame and concrete.
4. Width: Minimum 8 inches.
5. Expansive type wraps shall be fabricated of high quality rubber or urethane.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
7. Wrap shall not restrict access to manhole.
8. Manufacturers and Products:
    a. Sealing Systems, Inc., Loretto, MN; Flex-Seal Utility Sealant.
    b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
    c. Cretex Specialty Products, Waukesha, WI; Internal Manhole Chimney Seal.
    d. Or approved equal.

D. Frame to Structure Anchor Bolts:

1. 3/4-inch-diameter HAS stainless steel bolts; minimum 6-5/8-inch embedment.
2. Manufacturer and Product: Hilti; HVA Capsules Adhesive Anchoring System.
3. Or approved equal.

2.05 MORTAR

A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

B. Admixtures: May be included; do not exceed the following percentages of weight of cement:

1. Hydrated Lime: 10 percent.
2. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.06 BACKFILL AROUND AND UNDER MANHOLE

A. Structural fill as specified in Section 31 23 23, Fill and Backfill.

2.07 FLEXIBLE JOINTS FOR SEALING PIPES IN MANHOLE

A. Manufacturers and Products:

1. NPC, Inc., Milford, New Hampshire; Kor-N-Seal flexible rubber boot with stainless steel accessories.
2. A-LOK Products, Inc., Tullytown, PA; Z-LOK XP or A-LOK flexible connectors.
3. Or approved equal.

2.08 SOURCE QUALITY CONTROL

A. Prior to delivery of precast manhole sections to Site, yard permeability tests may be required at point of manufacture. Engineer or Owner will select precast sections not to exceed 5 percent of the total project quantity to test from material which is to be supplied to Project. Test specimens shall be mat tested and meet permeability test requirements of ASTM C14.

B. Concrete Testing: Test two concrete test cylinders for each manhole. Compressive strength shall be tested in accordance with ASTM C31/C31M, ASTM C39/C39M, and ASTM C192/C192M.

C. Inspection:

1. Material Quality:
   a. Manufacturing process and finished sections shall be subject to inspection and approval by Owner and Engineer.
      1) Inspections may take place at manufacturer's plant, at Site after delivery, or at both.
      2) Sections not meeting requirements of this Specification or that are determined to have defects which may affect durability of structure are subject to rejection.
      3) Sections rejected after delivery shall be removed and replaced.
      4) Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
      5) If structure cannot be repaired it shall be removed and replaced entirely at Contractor's expense.
2. At the time of inspection the sections will be carefully examined for compliance with ASTM C478 and with manufacturer's drawings. Sections will be inspected for general appearance, dimensions, scratch strength, blisters, cracks, roughness, and soundness. Surface shall be dense and close textured.
3. Imperfections may be repaired, subject to approval of Engineer, after demonstration by manufacturer that strong and permanent repairs result.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to installation inspect materials:

1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Backfill: As specified in Section 31 23 23, Fill and Backfill.

3.03 INSTALLATION OF PRECAST MANHOLES

A. Concrete Base:

1. Precast:
   a. Place on compacted structural fill.
   b. Properly locate, ensure firm bearing throughout, and plumb first section.
2. Cast-in-Place:
   a. Invert: Minimum 8 inches below lowest connecting pipe.
   b. First section of manhole shall be cast in concrete base.

B. Sections:

1. Inspect precast manhole sections to be joined.
2. Clean ends of sections to be joined.
3. Do not use sections with chips or cracks in tongue.

C. Preformed Plastic Gaskets or Rubber O-Ring:

1. Use only pipe primer furnished by gasket manufacturer.
2. Install gasket material in accordance with manufacturer's instructions.
3. Completed Manhole: Rigid and watertight.

D. External Joint Wraps: Install in accordance with manufacturer's instructions.

E. Extensions:

1. Provide on manholes in streets or other locations where change in existing grade may be likely.
2. Install to height not exceeding 12 inches.
3. Lay grade rings in mortar with sides plumb and tops level.
4. Seal joints with mortar as specified for sections and make watertight.

3.04 MANHOLE INVERT

A. Construct with smooth transitions to ensure unobstructed flow through manhole. Remove sharp edges or rough sections that tend to obstruct flow.

B. Where full section of pipe is laid through manhole, break out top section and cover exposed edge of pipe completely with mortar. Trowel mortar surfaces smooth.

3.05 MANHOLE FRAMES AND COVERS

A. Install concrete grade rings as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.

C. Anchor frame to manhole with specified bolts.

D. Install interior manhole frame to structure seals in accordance with manufacturer's instructions. Seal shall cover grade rings.

3.06 MANHOLE PIPING

A. Drop Assembly: See Drawings for detail of installation requirements.

B. Flexible Joints:

1. Provide in pipe not more than 1-1/2 feet from manhole walls.
2. Where last joint of pipe is between 1-1/2 feet and 6 feet from manhole wall, provide flexible joint in manhole wall.

C. Stubouts for Future Connections:

1. Provide same type and class of pipe as specified for use in service connection, lateral, main, or trunk sewer construction. Where there are two different classes of pipe at manhole use higher strength pipe.
2. Grout pipe in precast walls or manhole base to provide watertight seal or use flexible joints as specified herein.
3. Maximum Length: 1-1/2 feet outside manhole wall.
4. Construct invert channels as shown. Unless otherwise approved by Engineer, match inside top elevation of service connection pipe to inside top elevation of outlet pipe.
5. Test Plugs:
   a. Install rubber-gasketed plugs in end of stubouts with gasket joints similar to sewer pipe being used.
   b. Plugs shall withstand internal or external pressures without leakage.
   c. Adequately brace plugs against hydrostatic or air test pressures.

D. Permanent Plugs: Clean interior contact surfaces of pipes to be cut off or abandoned as shown, and construct plug as follows:

1. Pipe 18 Inches or Less in Diameter: Concrete plug in end, minimum 2 feet long.

2. Pipe 20 Inches and Larger: Concrete plug in end, minimum 4 feet long.
3. Plugs shall be watertight and capable of withstanding internal and external pressures without leakage.

3.07 MANHOLES OVER EXISTING PIPING

A. Maintain flow through existing pipelines at all times.

B. Concrete Pipe: Apply bonding agent on surfaces in contact with concrete.

C. Construct base under existing piping.

D. Construct manhole as detailed in Drawings.

E. Apply minimum of two complete wraps of hydrophilic waterstop centered on pipe in wall.

F. Place a minimum of 24 inches of concrete around each pipe penetration outside manhole against undisturbed soil or compacted aggregate unless otherwise detailed.

G. Grout channel through manhole.

H. Saw cut out or demolish existing pipe within new manhole using method approved by Engineer.

I. Protect new concrete or grout for 7 days after placing concrete.

3.08 CONNECTIONS TO EXISTING MANHOLES

A. Core manhole bases and grouting as necessary.

B. Seal pipe in manhole using flexible connector.

C. Regrout to provide smooth flow into and through manholes.

D. Provide diversion facilities and perform work necessary to maintain flow during connection.

3.09 FIELD QUALITY CONTROL

A. Hydrostatic Testing:

1. When, in Engineer’s opinion, groundwater table is too low to permit visual detection of infiltration leaks, hydrostatically test all manholes.
2. Procedure: Plug inlets and outlets and fill manhole with water to height determined by Engineer.

3. Manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into pipe walls to take place.
4. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above invert.
5. Repair manholes that do not meet leakage test, or do not meet specified requirements from visual inspection.

END OF SECTION

SECTION 33 13 00
DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. B300, Hypochlorites.
   b. B301, Liquid Chlorine.
   c. B302, Ammonium Sulfate.
   d. B303, Sodium Chlorite.
   e. C651, Disinfecting Water Mains.
   f. C652, Disinfection of Water Storage Facilities.
   g. C653, Disinfection of Water Treatment Plants.
2. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
3. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this Specification.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where Samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
7. Method of disposal for highly chlorinated disinfecting water.
8. Certified Bacteriological Test Results:
   a. Facility tested is free from coliform bacteria contamination.
   b. Forward results directly to Engineer.

1.03 SEQUENCING

A. Commence disinfection after completion of following:

1. Completion and acceptance of internal painting of system(s).
2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable.

B. Owner will supply potable quality water. Contractor shall convey in disinfected pipelines or containers.

PART 3 EXECUTION

3.01 GENERAL

A. Conform to AWWA C651 for pipes and pipelines**,** except as modified in these Specifications.

B. Contractor’s Equipment:

1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.

C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
2. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

D. Prior to application of disinfectants, clean pipelines of loose and suspended material.

E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 TURBIDITY

A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

3.03 PIPING AND PIPELINES

A. Cleaning:

1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
2. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
3. Flush pipe through flushing branches and remove branches after flushing is completed.

B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.04 DISPOSAL OF CHLORINATED WATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.

B. See appendix of AWWA C651 for acceptable neutralization methods.

3.05 TESTING

A. Collection of Samples:

1. Coordinate activities to allow Samples to be taken in accordance with this Specification.
2. Provide valves at sampling points.
3. Provide access to sampling points.

B. Test Equipment:

1. Clean containers and equipment used in sampling and make sure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from Owner.

C. Chlorine Concentration Sampling and Analysis:

1. Collect and analyze Samples in accordance with AWWA standards.
2. Analysis to be performed by an independent test laboratory selected by Owner**.** Samples will be analyzed using amperometric titration method for free chlorine as described in latest edition of Standard Methods for Examination of Water and Wastewater.

D. After pipelines have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies.

1. Collect Samples in accordance with applicable AWWA Standard.
2. Analyze Samples for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.
3. Obtain and analyze a minimum of two Samples on each of 2 consecutive days from every 1,000 feet of pipeline by standard procedures outlined by state and local regulatory agencies.
4. Sampling points shall be representative and accepted by Engineer.

E. Turbidity Sampling and Analysis:

1. After pipelines have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to turbidity limitations for public drinking water supplies. Turbidity shall not exceed 0.3 NTU.
2. If turbidity is in excess of the limit, dispose of the water in accordance with this Specification and applicable regulations, take action to remove source of turbidity, refill system, and retest.

F. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION

SECTION 33 41 01
STORM DRAIN PIPING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M36M, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
   b. M190M, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
   c. M196M, Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm) for Water and Other Liquids.
   b. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   c. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
3. ASTM International (ASTM):
   a. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   b. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   g. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   h. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
   i. C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
   j. C595, Standard Specification for Blended Hydraulic Cements.

k. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
l. C655, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe.
m. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
n. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
o. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
p. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
q. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
r. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
s. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.02 SUBMITTALS

A. Informational Submittals: Manufacturer’s Certification of Compliance.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in the Data Sheets following “End of Section.”

2.02 SERVICE AND DRAIN CONNECTIONS

A. Pipe and fittings for individual service connection shall be of one type of material throughout.

B. Polyvinyl chloride pipe.

C. Residential Service: 4 inches.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.
2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.
3. Pipe invert may deviate from line or grade up to 1/2 inch for line and 1/4 inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.
4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.
5. Prevent entry of foreign material into gasketed joints.
6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

B. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

C. Service Connections:

1. Minimum Slope: 1/4 inch per foot.
2. Markers:
   a. Paint the top portion of the marker immediately after its installation with first-quality white, quick-drying enamel.
   b. If marker is broken or knocked out of vertical alignment during backfilling operation, reopen trench and place marker in accordance with Sewer Service Connection Details shown on Drawings.
3. Disconnecting and Reconnecting Existing Service Connections:
   a. Locate the existing service connections prior to constructing the tee in the new sewerline.
   b. Disconnect existing service connections from existing sewers to be abandoned and reconnect them to the new sewers.

D. Square-End Underdrains: Cover top and sides of the joints with a strip of asphalt-saturated 30-pound roofing felt.

E. Perforated Underdrain: Lay with open joints and with perforations down.

3.02 PRESSURE TESTING

A. As specified in Section 40 80 01, Process Piping Leakage Testing.

3.03 REPAIR AND RETESTING

A. Sections of pipe not meeting the pressure test requirements shall be replaced or have individual joints tested and sealed.

B. Following repairs, sections shall be retested as specified.

3.04 SEWER CLEANING

A. Prior to final acceptance and final manhole-to-manhole inspection of the sewer system by Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.

B. Upon Engineer's final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

END OF SECTION

SECTION 33 41 01.03 POLYVINYL CHLORIDE (PVC)	
Item	**Description**
Pipe: 15-inch diameter and under	ASTM D3034: Standard dimension ratio less than 35, except that the cell classification shall be 12454-B or 12454-C as defined in ASTM D1784.
Pipe: 18- through 24-inch diameter	ASTM F679: Standard dimension ratio less than 35, except that the cell classification shall be 12454-C as defined in ASTM D1784.
Ribbed Profile Pipe: 18- through 36-inch diameter	ASTM F794: Minimum stiffness of 46 psi when tested in accordance with ASTM D2412, except that the cell classification shall be 12454-C as defined in ASTM D1784.
Joints	ASTM D3212 rubber gasketed.
Gaskets	ASTM F477. Lubricants: As approved by manufacturer.
Fittings	PVC, gasketed. Provide plug when service piping is not required.
Plugs	Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
Source Quality Control Testing	In accordance with specified ASTM.

END OF SECTION

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Pipe	ASTM C76, Wall B, class as shown. Mark each joint with pipe class. Rotating packer or platform not allowed.
Cement	ASTM C150, Type II, or ASTM C150, Type I, with fly ash; maximum 12 percent Tricalcium Aluminate, or ASTM C595 Rev A, Type IP, with fly ash; Cement: ASTM C150. Minimum 564 pounds per cubic yard without fly ash. Minimum 479 pounds per cubic yard with fly ash.
Ratio: Water to Cementitious Materials	Not over 0.49.
Fly Ash	ASTM C618, Class C or Class F, Tables 1 and 2 modified as follows: Loss on Ignition: Maximum 3 percent Water Requirement: Maximum 100 percent of control Ratio Percent CaO/Fe_2O_3: Maximum 1.5 or test cement fly ash mix in accordance with ASTM C1012. Mix: Equal to or better than ASTM C150, Type II cement. 85 pounds per cubic yard minimum, 160 pounds per cubic yard maximum. Test: ASTM C311 and ASTM C618.
Joints	ASTM C443 Rev A. Captive gasket in groove.
Rubber Gaskets	ASTM C443.
Tee Fittings	Reinforced concrete, rubber gasketed. Provide plug when service piping is not required.
Plugs	Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
Circumferential Reinforcement	Not closer than 1 inch to inside surface of pipe. Area of outer circular reinforcing cage not less than 75 percent of inner cage.
Elliptical Reinforcement	Not allowed.

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Source Quality Control Testing	Load Bearing 0.01-inch Crack, Compressive Strength and Absorption: ASTM C655. Load Bearing Ultimate: ASTM C655. Permeability: ASTM C497. Voids: Longitudinally sawcut one pipe from each 100 lengths of pipe manufactured in half with saw that will not damage the concrete or reinforcing steel. Inspect for voids adjacent to circumferential bars. Voids will be considered continuous if a 1/16-inch diameter pin can be inserted 1/4-inch deep. If voids exist adjacent to more than 10 percent of the circumferential bars, two additional pipes shall be tested. If either of the two pipes fail, the entire 100 lengths will be rejected.

END OF SECTION

SECTION 33 44 13.13
CATCH BASINS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Welding Society (AWS): Code for Welding in Building Construction.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   f. C478, Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.

PART 2 PRODUCTS

2.01 CONCRETE

A. Type: Ready-mixed, conforming to ASTM C94/C94M, Alternate 2.

B. Compressive Field Strength: Not less than 2,500 psi at 28 days.

C. Maximum Size of Aggregate: 1-1/2 inch.

D. Slump: Between 2 inches and 4 inches.

E. Assumed Field Strength: 85 percent of strength of laboratory-cured cylinders.

2.02 FORMS

A. Exposed Surfaces: Plywood.

B. Other Surfaces: Steel, matched boards, plywood, or other acceptable material.

1. Trench walls, large rock, and earth are not acceptable form material.

C. Form vertical surfaces.

D. Provide fillets on re-entrant angles.

2.03 REINFORCING STEEL

A. Conform to ASTM A615/A615M, Grade 60, deformed bars.

2.04 PRECAST UNITS

A. Conform to ASTM C478. Submit details of proposed units to Engineer for review.

B. Concrete Risers for Extensions: 6 inches high maximum and of same quality as sections.

1. Confirm acceptability of risers with Engineer before installation.

2.05 MORTAR

A. Standard premixed mortar conforming to ASTM C387/C387M, Type S, or proportion one part portland cement to two parts clean, well-graded sand which will pass a 1/8-inch screen.

B. Admixtures may be used if not exceeding the following percentages of weight of cement:

1. Hydrated Lime: 10 percent.
2. Diatomaceous Earth or Other Inert Materials: 5 percent.

C. Consistency of Mortar: As required to readily adhere to concrete.

2.06 FRAMES AND GRATES

A. Frames and Grates for Catch Basins and Storm Drain Inlets: Steel conforming to ASTM A36/A36M.

B. Connections: Welded in accordance with requirements of current Code For Welding in Building Construction of the American Welding Society.

2.07 FRAMES AND GRATINGS

A. Frames and Grates for Catch Basins and Storm Drain Inlets: Cast iron conforming to ASTM A48/A48, Class 30.

B. Bearing Surfaces: Clean and provide uniform contact.

C. Castings: Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.

PART 3 EXECUTION

3.01 EXCAVATION AND BACKFILL

A. Excavate as required to accomplish construction. Backfill as specified for adjoining pipe trench.

3.02 CONSTRUCTION OF CATCH BASINS AND INLETS

A. Construct inlets and catch basins at locations shown and in accordance with Drawings. Construct tight and well-braced forms to dimensions and elevations required. Chamfer form corners.

B. Prior to placing concrete, remove water and debris from forms. Moisten forms just prior to placing concrete. Handle concrete from transporting vehicle to forms in a continuous manner as rapidly as practical without segregation or loss of ingredients. Immediately after placing, compact concrete with mechanical vibrator. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

C. Screed top surface of exposed slabs and walls. When initial water has been absorbed, float surfaces with wood float and lightly trowel with steel trowel to smooth finish free from marks or irregularities. Finish exposed edges with steel edging tool. Remove forms and patch defects in concrete with mortar mixed in same proportions as original concrete mix.

D. Use a membrane-forming curing compound to prevent loss of moisture for 7 days. Apply curing compound immediately after removal of forms or finishing of slabs. Protect concrete from damage during curing period.

3.03 PLACING PRECAST UNITS

A. If material in bottom of trench is unsuitable for supporting unit, excavate and backfill to required grade with 3-inch minus, clean, pit-run material. Set units to grade at locations shown.

3.04 EXTENSIONS

A. Install watertight extensions to height determined by Engineer. Lay risers in mortar with sides plumb and tops to grade. Seal joints with mortar, with interior and exterior troweled smooth. Prevent mortar from drying out and cure by applying a curing compound.

3.05 INSTALLATION OF FRAMES AND GRATES

A. Set frames and grates at elevations indicated or as determined in field and in conformance with Drawings.

B. Frames may be cast in, or set in mortar.

3.06 CLEANING

A. Upon completion, clean structure of silt, debris, and foreign matter.

END OF SECTION

SECTION 35 20 16.25
FABRICATED SLIDE GATES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA): C561, Fabricated Stainless Steel Slide Gates.
2. American Water Works Association (AWWA): C562, Fabricated Aluminum Slide Gates.
3. ASTM International (ASTM):
   a. A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
   c. A276, Standard Specification for Stainless Steel Bars and Shapes.
   d. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   e. B209, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
   f. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
4. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

1.02 DEFINITIONS

A. Self-Contained: The arrangement of gate operator, supported by gate frame, such that operating thrust loads are not applied external to the assembly.

B. Slenderness Ratio: The ratio of the maximum unsupported stem length to the stem cross-section radius of gyration.

C. Submersible: The ability to exclude water when submerged under a 20-foot head of fresh water for 24 hours and still maintain electrical integrity.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower, if applicable, of each equipment assembly.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment associated therewith.
   d. Gate operator and stem calculations for each gate and service condition.
   e. Gate opening and closing thrust forces that will be transmitted to the support structure with operator at extreme positions and load.
   f. External utility requirements such as air, water, power, drain, etc., for each component.
   g. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
   h. Power and control wiring diagrams, including terminals and numbers.
   i. Performance Test Procedures.
   j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's written/printed installation instructions.
5. Routine maintenance requirements prior to plant startup.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
7. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
8. Service records for maintenance performed during construction.

1.04 SYSTEM DESCRIPTION

A. Coordinate such that electric motor operators are fully assembled and tested, including motor, at the factory.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

Item	Quantity
Stem collars for all gate stems	One of each different size
Bronze lift nuts	One of each different size
Indicator lights	One dozen
Special tools required to maintain or dismantle	One complete set

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.06 WARRANTY

A. The manufacturer shall provide a full warranty on all parts and labor on the longer of the two following options, 60 months from acceptance by the Owner and beneficial use.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. See supplements to this section for additional product information.

B. The fabricated gates shall be Series 7600 type as manufactured by WACO Products, Inc., Baltimore, Maryland or approved equal. Gates shall be furnished with all necessary accessories and parts for a complete installation and shall be the latest standard product of a manufacturer regularly engaged in the production of equipment of this type. All gates shall be furnished by the same manufacturer. Upward opening gates shall be designated “slide gates” and downward opening gates shall be designated as “weir gates”.

2.02 MATERIALS

A. All gates are to be designed and manufactured to meet or exceed all AWWA C561 “Standard for Fabricated Stainless-Steel Slide Gates” most recent edition, specifications, including those defining head and loading calculations, structural strength and deflection requirements, and material specifications and minimum dimensions.

B. The slide/weir plate shall be fabricated from minimum 5/16-inch thickness stainless steel plate and reinforced as required. Deflection under full design head will be no more than 1/720 of the span width of the gate.

C. Stainless Steel:

1. Plate, Sheet, and Strip: ASTM A240/A240M, Type 316L.
2. Bars and Shapes: ASTM A276, Type 316L.

2.03 PERFORMANCE REQUIREMENTS

A. Leakage shall not exceed 0.05 gallon per minute per foot of gate periphery under either seating or unseating head conditions.

2.04 SLIDE GATES

A. Rising stem type, with assembly styles designated as follows:

1. Style A:
   a. Style A.1: Upward acting type for wall surface mounting on the concrete structures.
   b. Style A.2: Upward acting type for wall surface mounting with embedded base on the concrete structures.
2. Style B: Upward acting type for mounting in channels with concrete embedded frame and invert.
3. Style C: Downward acting weir gate type with invert seal for wall surface mounting on the concrete structures.
4. Style D: Downward acting weir gate type with invert seal for embedded side frame mounting in concrete structures.

B. Guide Frames:

1. The guide frame is fabricated from minimum 5/16-inch thickness stainless steel structural members to resist loads imposed by the design head. Additionally, any self-contained frame will require no additional reinforcing where it extends above the operating floor to support the operator. The guide frame shall be a one-piece formed section without through-holes, reinforced with welded gussets as required to meet loading conditions. Guide frames with bolted or sandwich construction or otherwise requiring through-holes for frame assembly or seal

attachment shall not be allowed. Guide frame shall be of the dual slot type to limit gate plate edge loading in the seated condition.

2. The frame is fabricated to accommodate a one-piece Ultra High Molecular Weight Polyethylene (UHMW) bearing bar/seal. This bearing bar/seal is supplied mounted in the frame to reduce friction and wear between the slide/weir plate and frame faces, as well as to form the side seal seats to prevent leakage.
3. For non-self-contained frames, a fabricated pedestal of the same alloy as the frame shall be mounted on the operating floor or over-hung off of a wall at the operating level by means of a wall bracket. The pedestal and wall bracket where applicable shall be capable of supporting all loads imparted by the operator or actuator.

C. Operator Support Yoke:

1. For self-contained gate operators, attached to the vertical extensions of the guide frames.
2. The bench (yoke) to support the operator will be formed by two back to back structural shapes, angles or channels as loading requires, which are welded or bolted to the guide frame to provide a rigid complete frame assembly.
   Maximum Deflection: The bench shall be capable of supporting all loads imparted by the operator or actuator and shall have a deflection under full design head operation of no more than 1/360 of the span width of the gate.

D. Invert:

1. Slide gate: The frame bottom, or invert, is a flush-bottom design formed by a neoprene block held within a one-piece formed structural frame, or for embedded or surface anchor-mounted applications is sandwiched between two structural members with a welded bottom member to form a seating surface for the edge of the plate bottom and to retain the neoprene. The invert frame shall be welded to the guide frame to form a continuous frame and seal assembly. The flush-bottom design maximizes flow to that of the channel, port, or pipe opening and is required for all gates with the exception of surface anchor-mounted invert frames.
2. Weir gate: UHMW self-adjusting seals are attached to the invert frame which is welded to the guide frame sides across the bottom to form a continuous frame and seal assembly. The frame is mounted so that the gate invert is flush with the channel or port bottom.

E. Seals:

1. All gate side frames, slide gate upper seals, and weir gate invert seals shall prevent leakage using a UHMW bearing bar/seal that requires no adjustment. Seal pressure shall be made constant automatically by means of an integrated round section nitrile member within a continuous extruded slot in the bearing bar/seal. The cord shall exert pressure on the UHMW away from the frame face and compressing the seal against the plate face. Seal systems that require pressure pads, p-seals, j-bulbs, or adjustable wedge systems to seal the gate shall not be permitted.
2. UHMW polymer shall be extruded from black virgin resins with an ultraviolet inhibiting formula and shall have integral flex reliefs. UHMW seals that are saw cut or otherwise machined to shape, or which do not have integral extruded reliefs to prevent flex fatigue shall not be allowed. The bearing bar/seal and cord can be replaced without dismantling or loosening any portion of the frame. Side guide bearing bar/seal shall be held in place by means of the frame construction and shall require no bolts or fastened retainers.
3. Gate seals that de-rate performance as head increases shall not be allowed.
4. P-Bulb or J-Bulb type seals attached to the Disc/mounted to the frame, or any seal that needs replacement in less than 20 years shall not be acceptable. No part of the seal shall protrude into the clear opening.

F. Stems:

1. 1-1/2-inch minimum diameter, ASTM A276, Type 316 stainless steel.
2. Threads: Acme type with RMS surface roughness of 63 microinches or less on the flanks for manually operated gates and 32 microinches or less on the flanks for electrically operated gates. Extend threaded portion of stem 3 inches above operator when gate is in CLOSED position.
3. Ratio of the unsupported stem length to the radius of gyration, both in inches, shall not exceed 200.
4. Stems to withstand in compression, without damage, the thrust equal to at least 2-1/2 times the rated output of the hoisting mechanism, with a 40-pound effort applied to the handwheel or crank.
5. Design electric motor-driven floor stands to withstand at least 1.25 times the output thrust of the motor in the stalled condition.
6. Equip operating stems with, bushed stem guides, mounted on Type 316 stainless steel brackets; adjustable in two directions and spaced so that the L/r ratio does not exceed 200.
7. Connect the stems to the disc plate with a stem nut and bracket, threaded and keyed to the stem and bolted to the disc with bolts in tension.

8. Slide gates having a width greater than twice the height or width greater than 84 inches shall have dual stems. For downward opening weir type gates, locate stems near outside edges of gate. Operators for multiple stems will be linked with flexible couplings and stainless-steel shafts. Dual stem gates can be manually or electrically powered. Dual stem gates wider than 10 feet shall have a center gearbox drive to eliminate differential backlash between the stem drives and weir plate height offset.

G. Stem Covers:

1. Transparent plastic, vented pipe stem cover and cap.
2. Provide with OPEN/CLOSED designators with 1-inch graduations on clear mylar pressure sensitive, adhesive tape, suitable for outdoor application.

H. Manufacturers: WACO Products, Inc. or approved equal.

2.05 GATE OPERATORS

A. Controls:

1. Furnish the following in accordance with operator control styles listed below and specified in Slide Gate Schedule:

Feature	Description
A	Local OPEN/STOP/CLOSE pushbutton station
B	End position limit switches; OPEN and CLOSED position switches shall be normally open contacts that close at the end position; contacts shall be dry and rated for 5 amps, 120V ac.
C	Continuous position output; provide transmitter to generate a 4 mA to 20 mA dc signal to an external loop in direct proportion to gate position; the transmitter shall be factory mounted in a NEMA 250, Type 4 enclosure. Transmitter shall be capable of driving an external load impedance of 350 ohms minimum.
D	LOCAL/REMOTE weatherproof selector switch and provisions for remote OPEN/STOP/CLOSE operation; remote commands will be by way of a four-wire circuit, as shown; motor operator shall impress the voltage required to read these contacts and shall go to the commanded position or stop when in the REMOTE mode. Provide auxiliary contact which closes when LOCAL/REMOTE switch is in REMOTE position.

a. Operator Control Styles:
   1) Style 1: Includes control feature A only.
   2) Style 2: Includes control features A and B.
   3) Style 3: Includes control features A, B, and D.
   4) Style 4: Includes control features A, B, C, and D.

B. General:

1. Components: Withstand a minimum of 250 percent of design torque or thrust at extreme operator positions without damage.
2. Mount at walkway level, 36 inches above floor, unless otherwise indicated or required.
3. Gear train and gate stem sections shall produce a self-locking drive train.
4. Lift Nuts: Internally threaded with cut or cold-rolled Acme threads corresponding to stem threading.
5. Roller Bearings: Ball-thrust or tapered above and below lift nut to support both opening and closing thrusts.
   a. Grease lubrication fittings for bearings.
   b. Input pinions with needle or ball bearings.
6. Lubrication: Furnish rising stem gates with an insert lubricator flange in lift, with grease fitting for greasing stem threads below stem nut.
7. Manual Operator Limit Switches:
   a. Mounted on an angle adjacent to stem and actuated through limit switch wands by stop collar.
   b. Single-pole, double-throw type, with contacts rated 5 amps at 120V ac.
   c. Provide two switches, one for gate full OPEN, and one for gate full CLOSED, where indicated.

C. Dual-Stem Gate Operators:

1. Enclosed, geared floor or bench stands.
2. Interconnect so operators will work as a unit from single point with crank lever or interconnecting electric operator.
3. Interconnecting Shafts:
   a. Stainless steel with flexible couplings at ends.
   b. Diameter sufficient to prevent sagging.
   c. Include flanged coupling to allow precision weir leveling.

D. Type 1, Handwheel-Operated Bench Stands:

1. Direct drive.
2. Sealed, ball thrust, roller or needle bearing type and equipped with bronze lift nut, internally threaded with Acme threads.
3. Furnish mechanical seals at housing penetrations.

4. Handwheel and Baseplate: Cast iron or cast aluminum.
5. Manual Effort: Not to exceed 40 pounds.

E. Type 2, Crank-Operated Bench Stands:

1. Weatherproof housings, mounted on cast aluminum or cast iron base to the top horizontal member of the slide gate frame as described under paragraph Operator Support Yoke.
2. Solid Bronze Lift Nut: Integrally threaded with Acme threads.
3. Ball Thrust or Tapered Roller Bearings:
   a. Locate above and below operating nut flange to support opening and closing thrusts.
   b. Include grease lubrication fittings and input pinions.
4. Manual Crank Effort: Not to exceed 40 pounds.
5. Suitable for portable electric drill operation after removal of handcrank. Furnish one adapting chuck to fit slide gate operator and to fit portable electric drill gate operator.

F. Type 3, Geared Floor Stands:

1. Crank-operated, with weatherproof housings with solid bronze lift nut.
2. Mount on high-strength cast-iron pedestal or base.
3. Maximum manual crank effort to operate gate shall not exceed 40 pounds.
4. Lift Nut: Internally threaded with Acme threads.
5. Furnish ball thrust or tapered roller bearings above and below the lift nut to support both opening and closing thrusts.
   a. Grease lubrication fittings for bearings.
   b. Input pinions with needle or ball bearings.
   c. Mechanical seals at housing penetrations.
6. Suitable for portable electric drill operation after removal of handcrank. Furnish one adapting chuck to fit slide gate operators and to fit portable electric drill gate operators.

G. Type 4, Electric Motor Operators:

1. 28-inch-high steel pedestal or direct yoke-mounted, totally enclosed weatherproof electric drive unit, and a totally enclosed gear box that operates a two-piece, bronze stem nut, which lifts the gate stem.
2. Gears: Heat treated alloy steel, supported throughout by antifriction ball or roller bearings and grease lubricated.
3. Automatic double-acting geared limit switches and double-acting torque switches.
   a. Gear directly to the operating gear train and shall be “in step” at all times, whether in motor or manual operation.

b. Wire geared limit switches internally to stop the motor at the fully OPEN and fully CLOSED positions.
c. Wire torque switches internally so that, in the event of a mechanical overload in either direction, the motor will be stopped.

4. Equip with side mounted handwheel for manual operation.
   a. Include an automatic clutch to positively disengage the handwheel at any time the drive motor control is energized.
   b. Design handwheel operator so that failure of the motorized gearing will not prevent hand operation of the gate.
5. Drive Unit:
   a. TENV, 480-volt, three-phase electric motor as specified in Section 26 20 00, Low-Voltage AC Induction Motors, with integral OPEN/STOP/CLOSE weatherproof pushbuttons, reversing controller, 480/120-volt control power transformer, space heaters in the limit switches and in the control compartments, mechanical dial type position indicator, and transparent plastic pipe stem cover and cap, unless otherwise specifically noted on the Drawings.
   b. Furnish motor enclosure with drainage and breathing holes.
   c. Self-locking, with approximately 12 inches per minute gate travel speed, and a rated running torque equal to 20 percent of the motor starting torque at a rated running time of 15 minutes, without exceeding the allowable NEMA temperature rise for the insulation class used.
6. Operation: Drive the gate to its fully OPEN or CLOSED position when the OPEN or CLOSED pushbutton is depressed momentarily. Motor shall stop in mid-travel when the STOP button is depressed.
7. Manufacturers and Products: Rotork Controls or approved equal. Refer to Section 40 27 02, Process Valves and Operators for detailed requirements.

H. Identification Tagging Requirements:

1. For each gate operator, 1-1/2-inch minimum diameter Type 304 stainless steel tag, bearing the gate tag number shown in the schedule.
2. Attach the tags to the operator by soldered split key rings to that ring and tag cannot be removed. Use block type numbers and letters with 1/4-inch minimum high numbers and letters stamped on and filled with black enamel.

2.06 APPURTENANCES

A. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Anchor Bolts: ASTM A193/A193M, Type 316 stainless steel sized by equipment manufacturer at least 1/2 inch in diameter, or as shown, and as specified in Section 05 50 00, Metal Fabrications.

C. Staff Gauges: For downward acting weir gates. Graduated in 1/4 inches and marked every inch and foot.

1. Manufacturer and Product: Stevens Water Monitoring Equipment; Porcelain Enameled Style C or approved equal.

2.07 SHOP/FACTORY FINISHING

A. Mechanically descale and passivate all weld burn and weld slag in accordance with ASTM A380 to provide uniform finish.

B. Coat all aluminum surfaces in contact with concrete with unthinned bitumastic paint in accordance with Section 09 90 00, Painting and Coating, or insulate with suitable protective neoprene gasket material.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with the manufacturer's written instructions.

B. Disassemble factory assembled gate components before installation.

C. Field mount operators after installing gates.

D. Accurately place anchor bolts using templates furnished by the manufacturer and as specified in Section 05 50 00, Metal Fabrications.

E. Lubricate stems before operating.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each slide gate.

B. Performance Test:

1. Conduct on each slide gate.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Adjust, realign, or modify units and retest if necessary.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for facility startup.
4. 1/2 person-day for post-startup training

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

C. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Slide Gate Schedule.

END OF SECTION

Slide Gate Schedule							
Gate Identification No. and Location	**Assembly Style**	**Wall Opening (width/height inches)**	**Gate Height (inches)**	**Flow Stream**	**Design Operating Head (feet) Seating/Unseating Condition**	**Operator Type/ Control Style**	**Notes**
Headworks	Style A.1			RS	8 Seating	Type 1	Existing to be replaced
Headworks	Style A.1			RS	8 Seating	Type 1	Existing to be replaced
05GTE0501 Bioreactor Influent Weir Gate	Style C	60 / 36	42	SRS	3 Seating	Type 2	Weir Gate
05GTE0502 Bioreactor Influent Weir Gate	Style C	60 / 36	42	SRS	3 Seating	Type 2	Weir Gate
05GTE2501 Bioreactor No. 1 Flow Gate	Style C	144 / 30	36	SE	3 Unseating	Type 4	Weir Gate
05GTE2502 Bioreactor No. 2 Flow Gate	Style C	144 / 30	36	SE	3 Unseating	Type 4	Weir Gate
05GTE2503 Bioreactor No. 1 Re-aeration Basin Bypass Gate	Style C	36 /48	54	SRS	6 Seating	Type 3, w/4 electric operator	Weir Gate
05GTE2504 Bioreactor No. 2 Re-aeration Basin Bypass Gate	Style C	36 /48	54	SRS	6 Seating	Type 3, w/4 electric operator	Weir Gate

Slide Gate Schedule							
Gate Identification No. and Location	**Assembly Style**	**Wall Opening (width/height inches)**	**Gate Height (inches)**	**Flow Stream**	**Design Operating Head (feet) Seating/Unseating Condition**	**Operator Type/ Control Style**	**Notes**
06GTE0101 Clarifier No. 1 Influent Gate	Style C	48 / 48	54	SE	6 Unseating	Type 2	Weir Gate
06GTE0102 Clarifier No. 2 Influent Gate	Style C	48 / 48	54	SE	6 Unseating	Type 2	Weir Gate
06GTE0103 Clarifier No. 3 Influent Gate	Style C	48 / 48	54	SE	6 Unseating	Type 2	Weir Gate
07GTE0101 Filter No. 1 Influent Gate	Style A.1	36 / 44	42	SE	4 Seating	Type 2	Isolation Gate
07GTE0102 Filter No. 2 Influent Gate	Style A.1	36 / 44	42	SE	4 Seating	Type 2	Isolation Gate

Note: Gate disc contains weir openings. See Drawings for configuration and invert elevations.

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger and 4 inches and smaller. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

2. Calculations for each type of pipe support, attachment and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Maintenance information on piping support system.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state where the Work is to be installed.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on Structural General Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural General Drawings.

4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
   a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
   b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.
5. Electrical Conduit Support: Include in design of framing support system.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

A. Clevis: MSS SP 58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.
4. Or approved equal.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.
3. Or approved equal.

C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.
3. Or approved equal.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.
3. Or approved equal.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.
3. Or approved equal.

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.
3. Or approved equal.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches or approved equal.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).
5. Or approved equal.

2.04 PIPE SADDLES

A. Provide 90-degree to120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Figure 2000 or approved equal.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
   b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.
   c. Or approved equal.
3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
   b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.
   c. Or approved equal.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer’s allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).
6. Or approved equal.

2.06 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer’s recommendations.
2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.
4. Or approved equal.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.
3. Or approved equal.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base or approved equal.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89 or approved equal.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches or approved equal.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.
3. Or approved equal.

2.10 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.
3. Or approved equal.

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B or approved equal.

2.12 SEISMIC RESTRAINTS

A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.

B. Manufacturers:

1. Mason Industries.
2. B-Line.
3. Anvil.
4. Or approved equal.

2.13 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer and Products:
   a. B-Line; B1999 Vibra Cushion.
   b. B-Line; Iso Pipe, Isolation Tape.
   c. Or approved equal.

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
   a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
   b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.
   c. Or approved equal.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
   a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.
   c. Or approved equal.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger or approved equal.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
   c. Or approved equal.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.
   c. Or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and "J" hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
   a. Saddle Supports:
      1) Pedestal Type, elbow and flange.
      2) Provide minimum 1-1/2-inch grout beneath baseplate.
   b. Floor Mounted Channel Supports:
      1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
      2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
      3) Attach pipe to channel with clips or pipe clamps.
   c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.
4. Insulated Pipe:
   a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
   b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
   c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
   a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).

b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

2. Steel Beams: I-beam clamp or welded attachments.
3. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
4. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
5. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. Table 1: Nonchemical Areas.
2. Table 2: Chemical Areas.

END OF SECTION

Table 1
Nonchemical Areas

Exposure Conditions	Support Material
Office Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Shops and Warehouse Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Pipe Galleries	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Headworks	Stainless steel or FRP
Process Areas: High Humidity or Hydrogen sulfide	Stainless steel or FRP
Process Areas: Wetted or Submerged	Stainless steel or FRP

Notes:

1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

Table 2 Chemical Areas		
Exposure Conditions	**Support for Direct Exposure**	**Support for Remote Exposure**
Alum	FRP	Precoated steel
Aqua Ammonia	Stainless steel	Precoated steel
Coagulants	FRP	Precoated steel or galvanized steel
Ferric Chloride	FRP	Precoated steel
Ferric Sulfate	FRP	Precoated steel
Hydrofluorosilic Acid	FRP	Precoated steel
Lime	Stainless steel, FRP, precoated steel	Stainless steel, FRP, precoated steel
Methanol	Galvanized steel	Galvanized steel
Polymers	FRP	Precoated steel
Potassium Permanganate	Precoated steel	Precoated steel
Powdered Activated Carbon	Precoated steel	Precoated steel
Sodium Carbonate	Stainless steel	Precoated steel
Sodium Hydroxide	Stainless steel	Precoated steel
Sodium Hypochlorite	FRP	Precoated steel
Sulfuric Acid	Stainless steel	Precoated steel

Notes:

1. Direct exposure includes entire area within containment area; area within 20 feet horizontal and 10 feet vertical of chemical pumps or chemical mixing stations; or as specified.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.
5. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

SECTION 40 05 33
PIPE HEAT TRACING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Factory Mutual.
2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. Underwriters Laboratories, Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.
3. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN REQUIREMENTS

A. Design Heating Load:

1. Heating load to be calculated based upon a 50 degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 40 42 13, Process Piping Insulation, pipe as specified in Section 40 27 00, Process Piping—General, and shall include a 10 percent safety factor.
2. Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

2.02 ELECTRICAL HEATING TAPE

A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

B. UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

C. Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

E. Service Voltage: As indicated by branch circuits provided for heat tracing on the Drawings.

F. Manufacturers and Products:

1. Raychem; BTV-CR.
2. Thermon; BSX.
3. Nelson; CL1-J1 or L1-J1.
4. Or approved equal.

2.03 CONNECTION SYSTEM

A. Rating: NEMA 250, Type 4 and Factory Mutual approved.

B. Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

C. Manufacturers and Products:

1. Power Connection Kit:
   a. Raychem; JBS-100.
   b. Thermon; PCA-1-SR or DP-L.
   c. Nelson; PLT-BC.
   d. Or approved equal.
2. Splice Kit:
   a. Raychem; S-150.
   b. Thermon; PCS-1-SR.
   c. Nelson; PLT-BS.
   d. Or approved equal.
3. Tee Kit:
   a. Raychem; T-100.
   b. Thermon; DS-S.
   c. Nelson; PLT-BY.
   d. Or approved equal.
4. End Seal Kit:
   a. Raychem; E-150.
   b. Thermon; DE-S.

c. Nelson; LT-ME.
d. Or approved equal.

5. Lighted End Seal Kit:
   a. Raychem; E-100-L.
   b. Thermon; DLS.
   c. Nelson; LT-L.
   d. Or approved equal.

2.04 SECURING TAPE

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
   a. Raychem; AT-180.
   b. Thermon; AL-20P.
   c. Nelson; AT-50.
   d. Or approved equal.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
   a. Raychem; GS54 or GT66.
   b. Thermon; PF-1.
   c. Nelson; GT-6 or GT-60.
   d. Or approved equal.

2.05 PIPE MOUNTED THERMOSTAT

A. Type: Fixed, nonadjustable, set at 40 degrees F.

B. Sensor: Fluid-filled with 3-foot capillary.

C. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.

D. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-F5.
2. Thermon; E4X-1.
3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
4. Thermon; E7-25325 for hazardous areas.
5. Or approved equal.

2.06 AMBIENT THERMOSTAT

A. Type: Adjustable setting (15 to 140 degrees F).

B. Sensor: Fluid-filled probe.

C. Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.

D. Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-1A.
2. Thermon; B4X-15140.
3. Raychem; DigiTrace Model AMC-1H for hazardous areas.
4. Thermon; B7-15140 for hazardous areas.
5. Or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install in accordance with the manufacturer’s instructions and recommended practices.
2. Provide insulation as specified in Section 40 42 13, Process Piping Insulation, over all pipe heat tracing.
3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.

B. Electrical Heating Tape:

1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. Derate heating tape capacity when installed on plastic piping.

4. Install on services as follows:

Service	Piping Material	Placement	Location
W3	CLDI	All Above Ground Piping	UV Structure
W3	COP	All Exposed Above Grade Piping	Grit
W3	SST	All Exposed Seal Water Piping	Grit
W1	COP	All Exposed, Exterior W1 Piping at Eyewash	Alum Facility
BW		Exposed Instrument Taps	Disc Filter Facility
SSM	PVC	2” Exposed Piping at Scum Pit	Clarifiers

5. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:

1. Install in accordance with manufacturer's instructions and as approved by Engineer.
2. For each group of heat traced circuit, install one ambient thermostat.

3.02 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION

SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   f. B16.9, Factory-Made Wrought Buttwelding Fittings.
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
   i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
   l. B16.25, Buttwelding Ends.
   m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   n. B31.1, Power Piping.
   o. B31.3, Process Piping.
   p. B31.9, Building Services Piping.
   q. B36.10M, Welded and Seamless Wrought Steel Pipe.
5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.

6. American Water Works Association (AWWA):
    a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
    b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
    c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
    d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
    e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
    f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
    g. C153/A21.53, Ductile-Iron Compact Fittings.
    h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
    i. C606, Grooved and Shouldered Joints.
7. American Welding Society (AWS):
    a. Brazing Handbook.
    b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
    c. D1.1/D1.1M, Structural Welding Code - Steel.
    d. QC1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
    a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
    b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
    d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
    e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
    f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
    g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
    h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
    j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
    k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.

l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
n. A197/A197M, Standard Specification for Cupola Malleable Iron.
o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
r. A276, Standard Specification for Stainless Steel Bars and Shapes.
s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
aa. A536, Standard Specification for Ductile Iron Castings.
bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
hh. B32, Standard Specification for Solder Metal.
ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
jj. B61, Standard Specification for Steam or Valve Bronze Castings.
kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
ll. B75/B75M, Standard Specification for Seamless Copper Tube.
mm. B88, Standard Specification for Seamless Copper Water Tube.
nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
ww. D1330, Standard Specification for Rubber Sheet Gaskets.
xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.
aaa. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

bbb. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ccc. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
ddd. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
eee. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
ggg. D2996, Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
hhh. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
iii. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
jjj. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
kkk. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
lll. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
mmm. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
nnn. F436, Standard Specification for Hardened Steel Washers.
ooo. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
ppp. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
qqq. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
rrr. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
sss. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ttt. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

9. FM Global (FM).
10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.

11. NSF International (NSF):
    a. ANSI 61: Drinking Water System Components - Health Effects.
    b. ANSI 372: Drinking Water System Components - Lead Content.
12. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
13. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 DEFINITIONS

A. Submerged or Wetted: Zone below elevation of liquid surface or within 2 feet above top of liquid surface.

1.03 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
    a. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code.
3. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
4. Thrust Restraints:
    a. Design for test pressure shown in Piping Schedule.
    b. Allowable Soil Pressure: 1,000 pounds per square foot.
    c. Low Pressure Pipelines:
        1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
        2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
    a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.

b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.

2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
6. Pipe Corrosion Protection: Product data.
7. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer's Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements
   a. Pipe and fittings.
   b. Factory applied resins and coatings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fittings: Manufacturer's product data sheets for gaskets including torqueing requirements and bolt tightening procedures.
4. Qualifications:
   a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
   b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
   c. Welders:
      1) Continuity log for welders and welding operators.
      2) Welder qualification test records conducted by Contractor or manufacturer.
5. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
6. Nondestructive inspection and testing procedures.
7. Test logs.
8. Pipe coating applicator certification.
9. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
10. H: CWI inspection records and NDE test records.

11. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection , Observation, and Testing.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
   b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
   e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
4. Contractor's CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.

B. Quality Assurance: Provide services of Special inspection to be provided by Owner and performed by independent inspection and testing agency for welding operations.

1. Note, the presence of Owner's Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

A. As specified on Piping Data Sheet(s) located at the end of this section as Supplement.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.03 JOINTS

A. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

B. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

C. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than:
   a. 3 degrees for sizes through 12 inches.
   b. 2 degrees for sizes 14 inches through 16 inches.
   c. 1.5 degrees for sizes 18 inches through 24 inches.
   d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

D. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
   a. Pipeline Products Corp.
   b. Fernco Joint Sealer Co.
   c. Or approved equal.

E. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
4. Gaskets as specified on Data Sheet.

2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.05 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

B. Polyethylene Encasement (Bagging):

1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 1 inch wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.

C. Insulating Flanges, Couplings, and Unions:

1. Materials:
   a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
   b. Galvanically compatible with piping.
   c. Resistant for intended exposure, operating temperatures, and products in pipeline.
2. Union Type, 2 Inches and Smaller:
   a. Screwed or solder-joint.
   b. O-ring sealed with molded and bonded insulation to body.
3. Flange Type, 2-1/2 Inches and Larger:
   a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   b. Bolt insulating sleeves shall be provided full length between insulating washers.
   c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
   d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
   e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
4. Flange Insulating Kits:
   a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
   b. Insulating Sleeves: Full-length mylar.
   c. Insulating Washers: High-strength phenolic.
   d. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
      1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
      2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.
5. Manufacturers and Products:
   a. Dielectric Flanges and Unions:
      1) PSI, Houston, TX.
      2) Advance Products and Systems, Lafayette, LA.
      3) Or approved equal.
   b. Insulating Couplings:
      1) Dresser; STAB-39.
      2) Baker Coupling Company, Inc.; Series 216.
      3) Or approved equal.

2.06 THRUST BLOCKS

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.07 THRUST TIES

A. Steel Pipe: Joint harness as specified in Section 40 27 01, Process Piping Specialties.

B. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

2.08 FABRICATION

A. Mark each pipe length on outside with the following:

1. Size or diameter and class.
2. Manufacturer's identification and pipe serial number.
3. Location number on laying drawing.
4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.09 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.03 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B: B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Keep paper record of which welder welded each joint.

C. Pipe End Preparation:

1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ASME B16.25.

D. Surfaces:

1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.

F. Climatic Conditions:

1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Quality: Meet requirements of governing welding codes.

3.04 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
6. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
7. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
8. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
9. Manufacturer: Same as pipe manufacturer

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

F. Brazed Joints for Refrigerant Piping:

1. Braze copper piping with silver solder complying with AWS A5.8/A5.8M.
2. Construct joints according to AWS Brazing Handbook, Chapter Pipe and Tube.
3. Inside of tubing and fittings shall be free of flux.
4. Clean parts to be joined with emery cloth and keep hot until solder has penetrated the full depth of the fitting and extra flux has been expelled.
5. Cool joints in air and remove flame marks and traces of flux.
6. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel the air.
7. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

G. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

H. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

I. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

J. High-Density Polyethylene Piping:

1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.
2. Perform butt-fusion in accordance with pipe manufacturer's recommendations as to equipment and technique.
3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1 inch(es) from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.06 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes:
   a. Provide flexible mechanical compression joints for pressure pipe.
   b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.
2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.

7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
   a. Shorter pipe lengths.
   b. Special mitered joints.
   c. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC or HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line , Except PVC, CPVC or HDPE: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch(es).
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
2. Buried: Wrap with polyethylene bagging.
3. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.

B. Copper Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.
2. Buried:
   a. Pipe: None
   b. Joints: None

C. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

D. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
   b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
2. Buried:
   a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
   b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
   c. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.

E. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer’s instructions.

F. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

G. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Cathodically protected piping penetration to buildings and watertight structures.
   c. Submerged to unsubmerged metallic piping connections and Connections to existing metallic pipe.
   d. Where required for electrically insulated connection.
2. Pipe Installation:
   a. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.
   b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
   c. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.09 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Steel Pipe: Attach with joint harness specified in Section 40 27 01, Process Piping Specialties.
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

D. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.11 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.12 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines only where shown.

3.13 INSULATION

A. See Section 40 42 13, Process Piping Insulation.

3.14 HEAT TRACING

A. See Section 40 05 33, Pipe Heat Tracing.

3.15 DISINFECTION

A. See Section 33 13 00, Disinfecting of Water Utility Distribution Facilities.

3.16 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.17 PIPE IDENTIFICATION

A. As specified in Section 31 23 23.15, Trench Backfill and 09 90 00, Painting and Coating.

3.18 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified required by the Engineer.

B. Minimum Duties of Welding Inspector:

1. Job material verification and storage.
2. Qualification of welders.
3. Certify conformance with approved welding procedures.
4. Maintenance of records and preparation of reports in a timely manner.
5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:

1. Perform examinations in accordance with Piping Code ASME B31.3 for Normal Fluid Service.
2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.
4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.19 CLEANING

A. Following assembly and testing, and prior to disinfection, if required, and final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris plant process air, natural gas, and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. Immediately after cleaning service piping, dry to minus 40 degrees F dew point with dry compressed instrument air or compressed commercial grade nitrogen.

D. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

E. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

F. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.20 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Piping Schedule Legend.
2. Piping Schedule.
3. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar and Ceramic-Lined Ductile Iron Pipe and Fittings
40 27 00.03	Carbon Steel Pipe and Fittings—General Service
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.11	Chlorinated Polyvinyl Chloride(CPVC Pipe and Fittings
40 27 00.13	Copper and Copper Alloy Pipe Tubing and Fittings

END OF SECTION

PIPING SCHEDULE LEGEND

SERVICE

A	Air
AHP	Air-High Pressure
AL	Liquid Aluminum Sulfate
ALP	Air-Low Pressure
BWD	Backwash Drain
DR	Drain
FE	Tilter Effluent
GR	Grit
ML	Mixed Liquor
OF	Overflow
RD	Roof Drain
SD	Storm Drain
SE	Secondary Effluent
SRS	Screened Raw Sewage
SS	Sanitary Sewer
V	Vents
W1	Water-Potable
W2	Water-Non-Potable
W3	Water- Plant Utility

EXPOSURE

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

CELDI	Ceramic Epoxy Lined Ductile Iron
CLDI	Cement-Lined Ductile Iron

CMP	Corrugated Metal Pipe
COP	Copper
CPVC	Chlorinated PVC
DI	Ductile Iron
FRPX	Fiberglass Reinforced Plastic Pipe Type (X = 1 to 3)
GLDI	Glass-Lined Ductile Iron
GSP	Galvanized Steel Pipe
HDPE	High-Density Polyethylene
PCCP	Prestressed Concrete Cylinder Pipe
PSTL	PVDF-Lined Steel
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene Fluoride
RCP	Reinforced Concrete Pipe
RSTL	Rubber-Lined Steel
SST	Stainless Steel
STL	Steel
VC	Vitrified Clay Pipe
WS	Fabricated Welded Steel

JOINT TYPE

FL	Flanged
GR	Grooved
HU	Hub and spigot
PRJ	Proprietary Restrained
RM	Restrained Mechanical
S	Screwed
W	Welded (including solvent and fusion)

PRESSURE TEST

G	Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
H	Hydrostatic
I	In Service

P	Pneumatic
PC	Test per Uniform Plumbing Code
NA	Not Applicable

Piping Schedule									
Service	**Size(s) (In.)[1]**	**Exposure**	**Piping Material**	**Specification Section**	**Joint Type**	**Lining/ Coating[2]**	**Test Pressure and Type (psig-x), x = Type indicated in Legend**	**Pipe Label**	**Remarks**
AL	1/2	EXP	HDPE	22 10 01.08	W	None	100 – H	AL	Use DR 13.5 pipe
AL	½ - 4	EXP	PVC	40 27 00.10	W	None	100 - H	AL	
ALP	6-8”	EXP	SST	40 27 00.20	W, FL	None	15 - P	None - ALP	
BWD	6-8	SUB	CELDI	40 27 00.01	FL	Ceramic Epoxy	G	BWD	
BWD	8	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	G	BWD	
DR	2	EXP	PVC	20 27 00.13	W	None	G	DR	
DR	ALL	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	G	DR	
FE	All	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	75 - H	FE	
FE	ALL	EXP	CELDI	40 27 00.01	FL	Ceramic Epoxy	75 - H	FE	
GR	4	EXP	CELDI	40 27 00.01	FL	Ceramic Epoxy	50 - H	GR	
ML	All	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	75 - H	ML	
OF	6	EXP	CELDI	40 27 00.01	FL	Ceramic Epoxy	10 - H	OF	
RAS	ALL	BUR	CEL;DI	40 27 00.01	PRJ	Ceramic Epoxy	150 - H	RAS	
RAS	ALL	EXP	CELDI	40 27 00.01	FL	Ceramic Epoxy	150 – H	RAS	
SE	18	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	75 - H	SE	
SRS	18-24	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	150 -H	SRS	
SSM	2	BUR	PVC	40 27 00.10	W	None	50 – H	SSM	

Piping Schedule									
Service	**Size(s) (In.)[1]**	**Exposure**	**Piping Material**	**Specification Section**	**Joint Type**	**Lining/ Coating[2]**	**Test Pressure and Type (psig-x), x = Type indicated in Legend**	**Pipe Label**	**Remarks**
AL	1/2	EXP	HDPE	22 10 01.08	W	None	100 – H	AL	Use DR 13.5 pipe
AL	½ - 4	EXP	PVC	40 27 00.10	W	None	100 - H	AL	
ALP	6-8”	EXP	SST	40 27 00.20	W, FL	None	15 - P	None - ALP	
BWD	6-8	SUB	CELDI	40 27 00.01	FL	Ceramic Epoxy	G	BWD	
BWD	8	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	G	BWD	
DR	2	EXP	PVC	20 27 00.13	W	None	G	DR	
DR	ALL	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	G	DR	
FE	All	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	75 - H	FE	
W1	All	BUR	COP	40 27 00.13	W	None	150 – H		
VENT	2	EXP	PVC	40 27 00.10	W	None	10 - P	VENT	
W3	ALL	BUR	CLDI	40 27 00.01	PRJ	Asphalt Coated Cement	150 – H	W3	
W3	All	BUR	COP	40 27 00.13.	W	None	150-H	W3	
WAS	All	BUR	CELDI	10 27 00.01	PRJ	Ceramic Epoxy	75 – H	WAS	
WAS	All	EXP	CELDI	10 27 00.01	FL	Ceramic Epoxy	75 – H	WAS	

Piping Schedule									
Service	**Size(s) (In.)[1]**	**Exposure**	**Piping Material**	**Specification Section**	**Joint Type**	**Lining/ Coating[2]**	**Test Pressure and Type (psig-x), x = Type indicated in Legend**	**Pipe Label**	**Remarks**
AL	1/2	EXP	HDPE	22 10 01.08	W	None	100 – H	AL	Use DR 13.5 pipe
AL	½ - 4	EXP	PVC	40 27 00.10	W	None	100 - H	AL	
ALP	6-8”	EXP	SST	40 27 00.20	W, FL	None	15 - P	None - ALP	
BWD	6-8	SUB	CELDI	40 27 00.01	FL	Ceramic Epoxy	G	BWD	
BWD	8	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	G	BWD	
DR	2	EXP	PVC	20 27 00.13	W	None	G	DR	
DR	ALL	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	G	DR	
FE	All	BUR	CELDI	40 27 00.01	PRJ	Ceramic Epoxy	75 - H	FE	

[1]“>” Greater Than“<” Less Than
“<=” Less Than or Equal To
“>=” Greater Than or Equal To
“All” All Sizes

[2]Coating system number as specified in Section 09 90 00, Painting and Coating, and as specified in Article Pipe Corrosion Protection.

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).
Pipe	Buried Liquid Service Using Push-on, Mechanical or Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	Cement-mortar: AWWA C104/A21.4. Ceramic Epoxy: Pipe and fittings to be ceramic-epoxy lined shall not have been previously lined. Surface preparation shall be made to surfaces free of grease, oil, or other substance with abrasive blasting using clean sand or grit abrasive. Lining shall be done within 8 hours of surface preparation and surfaces shall be reblasted if rusting appears before lining. Line with a total dry film thickness of 40 mils of ceramic epoxy. Ceramic epoxy shall be amine-cured Novolac epoxy with 20 percent minimum volume ceramic quartz pigment, Protecto 401 by Induron Coating, “or-equal”, for sewer service. Ceramapure by Induron Coating, “or-equal”, for NSF 61 and potable water service. Lining shall be applied above 40 degrees F ambient temperature and shall not be applied to flange faces. Lining thickness shall be tested using a magnetic film thickness gauge. Lining integrity shall be tested on surfaces with a nondestructive, 2,500-volt dielectric resistance test.

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Fittings	Lined and coated same as pipe. Push-on: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face . Gray cast iron will not be allowed.
Joints	Push-on: 250 psi minimum working pressure, AWWA C110/A21.10 and AWWA C111/A21.11. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: 250 psi minimum working pressure. Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Flange: Dimensions per AWWA C110/A21.10 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. Flanged: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.
Gaskets	General: Gaskets in contact with potable water shall be NSF ANSI 61 certified. Push-on, Mechanical and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Flanged, Water, Sewage and Hot Air Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000. Full face for flat-faced flanges, flat-ring type for raised-face flanges. Blind flanges shall be epoxy-lined in accordance with the system specified above. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	All	Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless. Threaded, and flanged joints:
	Threaded: 1-1/2" & smaller	Standard weight.
Joints	1-1/2" & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.
Fittings	1-1/2" & smaller	Threaded: 150-pound or 300-pound malleable iron, ASTM A197/A197M or ASTM A47/A47M, dimensions in accordance with ASME B16.3. Fire sprinkler fittings to be UL listed. Grooved End: Malleable iron ASTM A47/A47M or ductile iron ASTM A536, grooved ends to accept couplings without field preparation. Victaulic Co.; Anvil International, Inc., Gruvlok.
Branch Connections	1-1/2" & smaller	For Threaded Pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet.
Flanges	1-1/2" & smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face.
Unions	1-1/2" & smaller	Threaded malleable iron, ASTM A197/A197 or ASTM A47/A47M, 150-pound or 300-pound WOG, meeting the requirements of ASME B16.3.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Bolting	All	Flanges: Carbon steel ASTM A307, Grade A hex head bolts; ASTM A563, Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All flanges	Fuel Gas Service: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated 250 degrees F continuous and conforming to ASME B16.21, ASTM D1330, Steam Grade.
Thread Lubricant	1-1/2" & smaller	Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.

END OF SECTION

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2-1/2" & smaller	Schedule 40S: ASTM A312/A312M, Type 304 seamless, pickled and passivated.
	3" thru 6"	Schedule 10S: ASTM A312/A312M, Type 304L, pickled and passivated.
	8" & larger	Schedule 5S: ASTM A312/A312M, Type 304L, pickled and passivated.
Tubing	All	ASTM A269, Type 316 stainless steel, seamless, fully annealed hydraulic tubing, 0.065-inch wall thickness minimum.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting.
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F304 or cast Class 150, ASTM A351/A351M, Grade CF8/304.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP304L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" & larger	Butt-Welded: ASTM A403/A403M, Type 304L pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Branch Connections	1-1/2" & smaller 2" & larger	Tee or reducing tee in conformance with fittings above. Butt-welding tee or reducing tee in accordance with fittings above.
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F304L**,** ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside. Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240/A240M Type 304L “as-welded grade”, conforming to MSS SP 43, wall thickness same as pipe. Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F304, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Bolting	All	Forged Flanges: Type 304 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Van Stone Flanges and anywhere mating flange on equipment is cast iron and gasket is flat ring: Carbon steel ASTM A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All Flanges	Flanged, Water, Hot Air, Fuel Gas and Sewage Services: 1/8 inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Blind Flanges: Gasketed covering entire inside face with gasket cemented to blind flange.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape. Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.

END OF SECTION

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 40 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441/F441M. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded nipples shall be Schedule 80.
Fittings	All	Schedule to Match Pipe Above: Conforming to the requirements of ASTM F439 for socket weld type and Schedule 80 ASTM F437 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Solvent Cement	All	All socket type joints shall be made employing primer and solvent cements that meet or exceed the requirements of ASTM F493 and primers that meet or exceed the requirements of ASTM F656, resistant to the fluid service, and as recommended by the pipe and fitting manufacturer, solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43.
Tubing	Seamless, conforming to ASTM B88 as follows: Oxygen service .....Type K, hard drawn Water (buried) .....Type K, soft or hard temper Water (exposed).....Type L, hard drawn Domestic hot water .....Type L, hard drawn Compressed air service .....Type L, hard drawn Laboratory air service .....Type L, hard drawn Laboratory vacuum service.....Type L, hard drawn Refrigerant service.....Type L, hard drawn P-Trap priming service .....Type L, soft temper Sample line service .....Type L, hard drawn Laboratory gas service .....Type L, hard drawn
Fittings	Oxygen Service: Class 250, ASTM B62 bronze, screwed, dimensions conforming to ASME B16.15 or ASTM B75/B75M wrought copper, socket joint, dimensions conforming to ASME B16.22. Other Services: ASTM B75/B75M commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22.
Flanges	Oxygen Service: Class 150, ASTM B61 bronze, screwed, ASME B16.24 standard. Other Services: Class 150, ASTM B75/B75M commercially pure wrought copper, socket joint, ASME B16.24 standard.
Bolting	Oxygen Service: ASTM A320/A320M, stainless steel Type 304, Grade B8 bolts, copper silicon hex nuts conforming to ASTM B98 Grade A hard and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Other Services: ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
Gaskets	1/16-inch thick nonasbestos compression type, full face, Cranite, John Manville.
Solder	Oxygen Service: Silver brazing alloy, 15 percent silver content, 1,185 degrees F to 1,300 degrees F melting range, conforming to AWS A5.8M/A5.8. Other Services: Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Joints Larger than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder.

END OF SECTION

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
2. Metal Bellows Field Finishing:
   a. Manufacturer’s recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.

b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.
c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09 90 00, Painting and Coating.

3. Chemical Injectors:
   a. Type, size, quantity, materials, and model number of each.
   b. Sketch of each showing major parts, main pipe, and dimensions.
   c. Details and model number of each support system and component.
   d. Details and model of connects (for example, service saddle, weld-o-let).

B. Informational Submittals:

1. Coupling Harness:
   a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
   b. Weld procedure qualifications.
   c. Load proof-testing report of prototype restraint for any size coupling.
2. Basket Strainer:
   a. Manufacturer's written/printed installation instructions.
   b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services..

C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data..

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools for basket strainer:

Item	Quantity
Basket	One for each strainer
Disc seals	One for each strainer
Special tools required to maintain or dismantle	One complete set

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

A. Teflon Bellows Connector:

1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 214.
   b. Resistoflex; No. R6904.
   c. Unisource Manufacturing, Inc.; Style 112.
   d. Proco Products, Inc.; Series 442.
   e. Or approved equal.

B. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and wrap-applied neoprene cover.
3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.

4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
    a. Goodall Rubber Co.; Specification E-1462.
    b. Garlock; Style 204.
    c. Unisource Manufacturing, Inc.; Style 1501.
    d. Proco Products, Inc.; Series 220.
    e. Or approved equal.

C. Metal Bellows Connector:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ANSI 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
    a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
    b. Metraflex; Model MN.
    c. Senior Flexonics Pathway, Inc.; Expansion Joints.
    d. Or approved equal.

D. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Bronze.
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 500 psig at 70 degrees F.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
    a. U.S. Hose Corp.; Series 300.
    b. Anamet Industrial, Inc.
    c. Unisource Manufacturing, Inc.
    d. Proco Products, Inc.
    e. Or approved equal.

E. Closure Collar Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

F. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.
5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
   a. OPW; Kamlock.
   b. Ryan Herco; 1300 Series.
   c. Or approved equal.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:

1. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 38.
      2) Smith-Blair, Inc.; Style 411.
      3) Or approved equal.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 253.
      2) Smith-Blair, Inc.; Style 441.
      3) Or approved equal.

C. Transition Coupling for Steel Pipe:

1. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 162.
   b. Smith-Blair, Inc.; Style 413.
   c. Or approved equal.

D. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.
2. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 913.
      3) Or approved equal.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 912.
      3) Or approved equal.

E. Restrained Flange Adapter:

1. Pressure Rating:
   a. Minimum Working Pressure Rating: Not less than 150 psi.
   b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
2. Thrust Restraint:
   a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
   b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange or approved equal.

F. Restrained Dismantling Joints:

1. Pressure Rating:
   a. Minimum working pressure rating shall not be less than rating of the connecting flange.
   b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.

2. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 131.
   b. Smith Blair, Inc.; Model 975.
   c. Or approved equal.

G. Exposed Metallic Piping Plain End Couplings:

1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, or approved equal.

2.04 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced molded wide arch.
2. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.
3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250 degrees F.
7. Rated Deflection and Pressure:
   a. Lateral Deflection: 3/4 inch, minimum.
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure as follows:

Size (inch)	Deflection (inch)	Pressure (psig)
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.

c. Goodall Rubber Co.; Specification G: E-711.
d. Unisource Manufacturing, Inc.; Series 1500.
e. Proco Products, Inc.; Series 251.
f. Or approved equal.

B. Teflon Bellows:

1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 215.
   b. Resistoflex; No. R6905.
   c. Unisource Manufacturing, Inc.; Style 113.
   d. Proco Products, Inc.; Series 443.
   e. Or approved equal.

C. Metal Bellows:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ASME 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of eight convolutions and minimum axial compression of 3/4 inches.
6. Manufacturers and Products:
   a. U.S. Bellows, Inc.; Universal Tied expansion joint.
   b. Metraflex, Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.
   d. Or approved equal.

D. Copper Pipe Expansion Compensator:

1. Material: Stainless steel bellows with female copper solder joint ends.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model HB.
   b. Hyspan; Model 8510.
   c. Unisource Manufacturing, Inc.; Style EC-FFS.
   d. Or approved equal.

E. Galvanized and Black Steel Pipe Expansion Compensator:

1. Material: All stainless steel.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model H**.**
   b. Hyspan; Model 8503.
   c. Unisource Manufacturing, Inc.; Style EC-MMT.
   d. Or approved equal.

F. Flexible Metal Hose:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
   a. 3 Inches and Larger: Shop fabricated flanged ends to match mating flanges.
   b. 2-1/2 Inches and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 600 psig at 70 degrees F for 12 inches and smaller.
5. Length: Provide hose live-length equal to lengths shown on Drawings.
6. Manufacturer:
   a. U.S. Hose Corp.; Series 401M.
   b. Anamet Industrial, Inc.; BWC21-1.
   c. Or approved equal.

2.05 FLEXIBLE EXPANSION JOINTS

A. Design:

1. Ball and socket type for earth settlement compensation.
2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
3. Assembly shall accommodate up to 4 inches of expansion in length.
4. Ductile iron conforming to AWWA C153/A21.53.
5. Rated for 350 psi.
6. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets.
7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
8. Joint connecting to mechanical joint shall be thrust restrained.

9. Bonding:
    a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
    b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
    c. Bond wires shall be 2 AWG with two 12-inch-long THHN insulated 12 AWG wire pigtails.

B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend or approved equal.

2.06 SEAL WATER HOSE

A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.

2.07 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
    a. Body: Malleable or ductile iron.
    b. Straps: Galvanized steel.
    c. Hex Nuts and Washers: Steel.
    d. Seal: Rubber.
5. Manufacturers and Products:
    a. Smith-Blair; Series 313 or 366.
    b. Dresser; Style 91.
    c. Or approved equal.

B. Nylon-Coated Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Materials:
    a. Body: Nylon-coated iron.
    b. Seal: Buna-N.
    c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315 or 317 or approved equal.

2.08 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: AWWA C110/A21.10 flange

C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle or approved equal.

2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16 inch.
2. Seep Ring:
   a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
   b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
   c. Continuously fillet weld on each side all around.
3. Factory Finish:
   a. Galvanizing:
      1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
      2) Electroplated zinc or cadmium plating is unacceptable.
   b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
2. Provided with end caps for support during concrete placement.
3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal or approved equal.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable or approved equal.

D. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
   a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
   b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening , and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division or approved equal.

2.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable Pipe Data Sheet.
4. Thrust Collars:
   a. Rated for thrust load developed at 250 psi.
   b. Safety Factor: 2, minimum.
   c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
   a. American Cast Iron Pipe Co.
   b. U.S. Pipe and Foundry Co.
   c. Or approved equal.

B. Steel or Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar:
   a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
   b. Continuously fillet welded on each side all around.

2.11 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:

1. Type, size, quantity, and materials as shown on Drawings and Standard Details.
2. Manufacturer: SAF-T-FLO or approved equal.

B. Support System:

1. Stainless steel Unistrut or FRP Aickenstrut.
2. Materials compatible with chemical service and subject to Engineer approval.

C. Connectors: Stainless steel service saddle or weld-o-let, as shown on Drawings.

2.12 MISCELLANEOUS SPECIALTIES

A. Strainers, Water Service, 2 Inches and Smaller:

1. Type: Bronze body, Y-pattern, 200 psi nonshock rated, with screwed gasketed bronze cap.
2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.
3. Manufacturers and Products:
   a. Armstrong International; Inc.; Model F.
   b. Mueller Steam Specialty; Model 351M.
   c. Or approved equal.

B. Strainers, Water Service, 2-1/2 Inches and Larger:

1. Type: Cast iron or ductile iron body, Y-pattern, 175 psi nonshock rated, with flanged gasketed iron cap.
2. Screen: Heavy-gauge Type 316 stainless steel, 0.045-inch perforations.
3. Manufacturer and Product: Armstrong International, Inc.; Model A7FL 125 or approved equal.

C. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals.
2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward or approved equal.

D. Basket Strainer:

1. Service Conditions:
   a. Material Handled: Plant final effluent (No. 3 water).
   b. Temperature of Material Handled: 32 degrees F, minimum to 140 degrees F, maximum.
   c. Specific Gravity of Material Handled.
   d. pH Range of Material Handled: 5 to 9.
   e. Range of Total Suspended Solids: 10 mg/L.
2. Strainer Capacity: 150 gpm, maximum pressure drop shall not exceed 2 psi at 150 gpm.
3. Screen: Capable of removing material larger than 0.01 inch (250 microns)in diameter.
4. Strainer: Single chamber design of cast iron construction with a bolted cover.
5. Process Connections: 125 pound ASME B16.5.
6. Strainer: Double chamber design of stainless steel construction.
7. Permit one basket strainer to be removed for cleaning while other basket is in operation.
8. Inlet and Outlet Valves: Lever operated swing type valve disc with neoprene disc seals.
9. Baskets: Type 304 stainless steel.
10. Wearing parts shall be replaceable without removing strainer from line.
11. Factory Finishing: Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.
12. Manufacturer: S.P. Kinney Engineers, Inc. or approved equal.

E. Water Hose:

1. Furnish four 50-foot lengths of 1-inch and four 50-foot lengths of 1-1/2-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
   a. Goodyear.
   b. Boston.
   c. Or approved equal.

F. Hose Nozzles:

1. Furnish two 1-inch and two 1-1/2-inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.

2. Manufacturers:
   a. Croker.
   b. Elkhart.
   c. Or approved equal.

G. Pump Seal Water Sight Flow Indicators:

1. Bronze body, 3/8-inch, horizontal, ball action with tempered glass.
2. Rated 125 psi with NPT screwed ends.
3. Operate with a minimum flow of 0.25 gpm.
4. Manufacturers and Products:
   a. Eugene Ernst Co.; Series E-57-4.
   b. Jacoby Tarbox Co.
   c. Or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from face of structures; joint may be flush with face.

D. Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes. Wrap complete joint assembly in a double layer of polyethylene encasement, as specified in Section 40 27 00, Process Piping—General.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
   a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
   b. Clean pipe surface before placing closure collars.
   c. Wet nonmetallic pipe thoroughly prior to pouring collars.
   d. Prevent concrete from entering pipe.
   e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
   f. Make entire collar in one placement.
   g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.04 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.
3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.

4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

C. Weld-End Metal Bellows Installation:

1. Field Weld: Stainless steel bellows beveled ends joined to ALP carbon steel piping in accordance with approved welding procedures.
2. Lining:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
   b. Field apply lining to protect bellows and piping from rust at welded joint.
   c. Line both ends inside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot inside length of the carbon steel pipe.
3. Coating:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
   b. Field apply coating to protect bellows and piping from weather and rust at welded joint.
   c. Coat both ends outside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot outside length of the carbon steel pipe.

D. Anchors : Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Plastic Piping: Nylon-coated iron.

3.06 OUTLET/TAPPING SADDLE

A. Install in accordance with manufacturer’s written instructions.

3.07 COUPLINGS

A. General:

1. Install in accordance with manufacturer’s written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Do not remove pipe coating. If damaged, repair before joint is made.

4. Application:
    a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
    b. Concrete Encased Couplings: Flexible coupling.

3.08 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon bellows connector.
2. Copper Piping: Flexible metal hose connector.
3. Compressor and Blower Discharge: Metal bellows connector.
4. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 PIPE SLEEVES

A. Application:

1. As specified in Section 40 27 00, Process Piping—General.
2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.

B. Installation:

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:
    a. Wall pipes with thrust collars.
    b. Provide taps for stud bolts in flanges to be set flush with wall face.
2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
3. Existing Walls: Rotary drilled holes.

4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.11 CHEMICAL INJECTOR SYSTEM

A. Install in accordance with manufacturer's instructions.

3.12 MISCELLANEOUS SPECIALTIES

A. Basket Strainers: Install in accordance with manufacturer's instructions.

1. Field Quality Control:
   a. Conduct test on each basket strainer.
   b. Test valves shall be tested for proper seating, travel, and operation.
2. Manufacturer's Services: Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
3. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
   d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
   e. C509, Resilient-Seated Gate Valves for Water Supply Service.
   f. C510, Double Check Valve Backflow Prevention Assembly.
   g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   k. C542, Electric Motor Actuators for Valves and Slide Gates.
   l. C550, Protective Interior Coatings for Valves and Hydrants.
   m. C606, Grooved and Shouldered Joints.
   n. C800, Underground Service Line Valves and Fittings.

6. ASTM International (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
   e. B61, Standard Specification for Steam or Valve Bronze Castings.
   f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
   g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
   h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
   i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
   j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
   k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
   l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
   n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
9. FM Global (FM).
10. Food and Drug Administration (FDA).
11. International Association of Plumbing and Mechanical Officials (IAPMO).
12. Manufacturers Standardization Society (MSS):
   a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
   b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
   c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   d. SP-88, Diaphragm Valves.
   e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. Underwriters Laboratories (UL).
16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
    b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
    c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
    d. Power and control wiring diagrams, including terminals and numbers.
    e. For each power actuator provided, manufacturer’s standard data sheet, with application specific features and options clearly identified.
    f. Sizing calculations for open-close/throttle and modulating valves.
    g. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
    a. Electric actuators; full compliance with AWWA C542.
    b. Butterfly valves; full compliance with AWWA C504.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Tests and inspection data.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SCHEDULE

A. Additional requirements relative to this section are shown on Electric Actuated Valve Schedule located at the end of this section.

2.03 MATERIALS

A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

B. Valve materials in contact with or intended for drinking water service to meet the following requirements:

1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.
3. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

2.04 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF/ANSI 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
      6) Supply AWWA gate valves with stainless steel bolting.
2. Type V100 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, nonrising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 438, NPT threaded ends.
      2) Stockham; Figure B103, NPT threaded ends.
      3) Crane; Figure 1324, soldered ends.
      4) Stockham; Figure B104, soldered ends.
      5) Or approved equal.
   c. All-bronze, screwed bonnet, packed gland, single solid wedge gate, rising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 2.
   d. Manufacturers and Products:
      1) Crane; Figure 428, NPT threaded ends.
      2) Stockham; Figure B-100, NPT threaded ends.
      3) Crane; Figure 1334, soldered ends.
      4) Stockham; Figure B-108, soldered ends.
      5) Or approved equal.
3. Type V108 Gate Valve 2 Inches to 24 Inches:
   a. Iron body, bronze mounted, flanged ends, solid wedge gate, nonrising bronze stem, Class 125 rated 125 psi SWP, 200 psi CWP for 2 inches through 12 inches and 100 psi SWP, 150 psi CWP for 14 inches through 24 inches.

b. Manufacturers and Products:
   1) Crane; Figure 461.
   2) Stockham; Figure G612.
   3) Or approved equal.

4. Type V122 Gate Valve 3 Inches to 48 Inches for Buried Water Service:
   a. AWWA C500, iron body, bronze mounted, mechanical joint ends, double-disc gate, nonrising bronze stem, 2-inch operating nut, and O-ring sealed stuffing box, working water pressure of 200 psi for 3 inches through 12 inches and 150 psi for 14 inches through 48 inches.
   b. Manufacturers and Products:
      1) M&H Valve Company; Style 67.
      2) Clow Valve Company; AWWA C500.
      3) Or approved equal.
5. Type V128 Gate Valve 4 Inches Through 30 Inches for Buried High Pressure Water Service:
   a. Iron body, bronze mounted, mechanical joint ends, double disc gate, nonrising bronze stem, O-ring sealed stuffing box, 2-inch square wrench nut conforming to AWWA C500, rated 250 psi nonshock cold water.
   b. Manufacturer and Product: M&H; Style 871 or approved equal.
6. Type V130 Resilient Seated Gate Valve 3 Inches to 12 Inches:
   a. Iron body, resilient seat, bronze stem and stem nut, ASME B16.1 Class 125 flanged ends, nonrising stem, in accordance with AWWA C509, minimum design working water pressure 200 psig, full port, fusion-epoxy coated inside and outside per AWWA C550,
   b. Manufacturers and Products:
      1) M&H Valve; AWWA C509.
      2) U.S. Pipe; A-USPO.
      3) Or approved equal.
7. Type V135 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
   a. Ductile iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C515, minimum design working water pressure 200 psig, full port, fusion epoxy coated inside and outside per AWWA C550
   b. Manufacturers and Products:
      1) American Flow Control; Series 2500.
      2) M&H; Style 7000 and C515 Large RW Valves.
      3) Or approved equal.

B. Globe Valves:

1. Type V200 Globe Valve 3 Inches and Smaller:
   a. All-bronze, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T, NPT threaded end.
      2) Crane Co.; Figure 7TF, NPT threaded end.
      3) Milwaukee; Model 1590T, soldered ends.
      4) NIBCO; Figure S-235-Y, soldered ends.
      5) Or approved equal.
2. Type V209 Needle Disc Type Globe Valve 1/8 Inch to 3/4 Inch:
   a. All-bronze, threaded bonnet, packed gland, rising stem, bronze body and stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80.
   b. Manufacturers and Products:
      1) Crane Cat.; No. 89.
      2) Stockham; B-264.
      3) Or approved equal.
3. Type V235 Angle Type Hose Valve 3/4 Inch:
   a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE 1011 and IAPMO code.
   b. Manufacturers and Products:
      1) Acorn; 8126, surface pipe mount valve, bent nose without flange.
      2) Acorn; 8121, surface mount through wall valve, bent nose with flange.
      3) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
      4) Acorn; 8136, pedestal mounted valve located lower than 6 inches, inverted nose.
      5) Or approved equal.
4. Type V236 Globe Style Hose Valve 1 Inch to 3 Inches:
   a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, complies with MSS SP-80, rated 300 WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T.
      2) Crane Co.; Cat. No. 7TF.
      3) Nibco; Figure T-235-Y.
      4) Or approved equal.

C. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
   a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded:
         a) Conbraco Apollo; 70-100.
         b) Nibco; T-580-70.
         c) Or approved equal.
      2) Soldered:
         a) Conbraco Apollo; 70-200.
         b) Nibco; S-580-70.
         c) Or approved equal.
2. Type V302 Actuator Ready Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 71-140.
      2) Milwaukee; 20BSOR-02.
      3) Or approved equal.
3. Type V303 Ball Valve 2 Inches and Smaller for Equipment Air System Shutoff:
   a. Two-piece, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, 125 psig rated, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel locking handle with vinyl grip.
   b. Meets OSHA Regulation 29 CFR Part 1910.147 requirements.
   c. Manufacturers and Products:
      1) Conbraco Apollo; 75-100-41.
      2) Nibco; T-580-70-SV/T-585-70-SV.
      3) Or approved equal.

4. Type V304 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Three-piece, full port, NPT threaded ends, bronze body and end pieces, hard chrome plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150 psi SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded Ends:
         a) Conbraco Apollo; 82-100.
         b) Nibco; T-595-Y.
         c) Stockham; T-395 Series.
         d) Or approved equal.
      2) Solder Ends:
         a) Conbraco Apollo; 82-200.
         b) Nibco; S-595-Y.
         c) Stockham; S-395 Series.
         d) Or approved equal.
5. Type V305 Ball Valve 2 Inches and Smaller for Natural Gas Service:
   a. Two-piece bronze or forged brass body and end piece, NPT threaded ends, hard chrome-plated solid brass ball, RTFE seats and seal, blowout-proof stem, zinc-plated hand lever operator with vinyl grip, UL Listed Guide YRPV for natural/manufactured gas, 600 WOG.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 80-100.
      2) Nibco; T-585-70-UL/T-580-70-UL.
      3) Or approved equal.
6. Type V306 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, NPT threaded ends, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000 psig CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76F-100 Series.
      2) Nibco; T-585-S6-R-66-LL.
      3) Or approved equal.
7. Type V309 Instrument Air Shutoff Valve 1/8 Inch to 3/4 Inch:
   a. Stainless steel body ball valve, nylon handle, tube fitting ends, PTFE seats and seals, panel nut, rated 1,500 psi minimum.

b. Manufacturers and Products:
   1) Swagelok; 40 Series.
   2) Parker Hannifin; B Series.
   3) Or approved equal.

8. Type V330 PVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
      3) Spears; True Union.
      4) Or approved equal.

D. Plug Valves:

1. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
   a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.
   b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
   c. For buried service, provide external epoxy coating.
   d. Operators:
      1) 3-Inch to 4-Inch Valves: Wrench lever manual.
      2) 6-Inch to 12-Inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
   e. Manufacturers and Products:
      1) Pratt; Ballcentric.
      2) DeZurik; Style PEC.
      3) Milliken; Millcentric Series 600.
      4) Or approved equal.

2. Type V406 Eccentric Plug Valve 14 Inches to 20 Inches:
   a. Nonlubricated type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joints ends, unless otherwise shown, plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
   b. Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
   c. For buried service, provide external epoxy coating.
   d. Manufacturers and Products:
      1) Pratt; Ballcentric.
      2) DeZurik; Style PEC.
      3) Milliken; Millcentric Series 600.
      4) Or approved equal.
3. Type V462 Gauge Cock 1/8 Inch to 1/4 Inch:
   a. 1/4-inch bronze body, hexagon end pattern, tee head, male ends, rated 125-pound SWP.
   b. Manufacturer and Product: United Brass Works; Figure 973 or approved equal.
4. Type V464 Corporation Stop 1/2 Inch to 2 Inches:
   a. AWWA C800 type, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads, outlet compression connection or IPS threads to suit connecting pipe, stops 1 inch and smaller rated 100 psi, larger stops rated 80 psi.
   b. Manufacturers and Products:
      1) Ford Meter Box Co.
      2) Mueller Co.
      3) Or approved equal.
5. Type V466 Buried Service Natural Gas Plug Valve 2 Inches and Smaller:
   a. UL Listed, iron body type, rated 125 psi, screwed ends, drilled key head for permanent pinned operating rod.

b. Manufacturers and Products:
   1) DeZurik; Figure 425.
   2) Mueller; (gas) curb stop H-11104.
   3) Or approved equal.

E. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
      4) No travel stops for disc on interior of body.
      5) Self-adjusting V-type or O-ring shaft seals.
      6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
      8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
      9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
      10) Valves to be in full compliance with NSF/ANSI 61.
   b. Non-AWWA butterfly valves to meet the following actuator requirements:
      1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.
2. Type V514 High Performance Butterfly Valve 2 Inches to 36 Inches:
   a. ASME B16.1 Class 150 lugstyle, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, Buna-N seat, PTFE stem packing, stainless steel with RTFE thrust washer.

b. Manufacturers and Products:
   1) Tyco/Keystone; K-Lok Series.
   2) DeZurik; BHP Series.
   3) Or approved equal.

F. Check and Flap Valves:

1. Type V608 Swing Check Valve 2 Inches to 24 Inches:
   a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with bronze seat, stainless steel hinge shaft.
   b. Valves, 2 inches through 12 inches rated 175-pound WWP and 14 inches through 24 inches rated 150-pound WWP. Valves to be fitted with adjustable outside lever and weight.
   c. Manufacturers and Products:
      1) M&H Valve; Style 59, 159, or 259.
      2) Mueller Co.; No. A-2600 Series.
      3) Or approved equal.
2. Type V614 Slanting Disc Check Valve 2 Inches to 60 Inches:
   a. Slanting or tilting disc design, off-center pivot, body ductile iron two-piece design, bronze seat on 55 degree angle, disc bronze or ductile iron, pivot pin and bushing Type 304 stainless steel, Class 125, 150 psi rating, Class 125 flange drilling, bottom mounted buffer cylinder for cushion closing.
   b. Manufacturers and Products:
      1) APCO; Series 800.
      2) Val-Matic; Series 9800.
      3) Or approved equal.
3. Type V617 Wafer Style Check Valve 2 Inches to 36 Inches:
   a. Wafer style, swing check, one-piece body design, full resilient seal in machined body groove. Type 316 stainless steel body, ASME B16.1 Class 150 rating, Type 316 stainless steel disc, Type 316 stainless steel spring and other internals, Buna-N seal, outside lever and weight assembly, and limit switch assembly.
   b. Manufacturers and Products:
      1) Tyco; Prince Figure 800 Series.
      2) Crane; Uni-Chek II.
      3) Or approved equal.
4. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
   a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.

b. Manufacturers and Products:
   1) Nibco; Chemtrol Tru Union.
   2) ASAHI/America.
   3) Spears; True Union.
   4) Or approved equal.

5. Type V690 Flap Gate 6 Inches to 96 Inches:
   a. Cast-iron body and cover, bronze-mounted, flanged frame type, dual pivot-point hinge arms, hinge arms bronze, hinge pins Type 304 stainless steel, seat bronze and impacted into grooves in body and cover flap, lubrication fittings for each pivot, upper and lower pivot adjustment.
   b. Manufacturers and Products:
      1) Rodney Hunt Co.; Series FV-AC or FV-AR.
      2) Hydro Gate; Model 50C or 50.
      3) Or approved equal.
6. Type V694 Check Valve 1 Inch to 48 Inches:
   a. Elastomer type flanged or slip-on as shown on Drawings, round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger, valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition, rated for 50 psi minimum operating pressure; flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced Buna-N.
   b. Manufacturer and Product: Red Valve Co.; Tideflex Check Valve Series TF-1 or 35-1 or approved equal.

G. Self-Regulated Automatic Valves:

1. Type V710 Pressure-Reducing Valve 2-1/2 Inches and Smaller:
   a. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200-psig rated minimum.
   b. Size/Rating: As shown in Valve Schedule.
   c. Manufacturers and Products:
      1) Fisher; Type 75A.
      2) Watts; Series 223.
      3) Or approved equal.
2. Type V740 Air and Vacuum Valve 1/2 Inch to 16 Inches:
   a. 1/2-inch through 3-inch NPT inlets and outlets, 4-inch and larger ASME B16.1 Class 125 flanged inlet with plain outlet and protective hood.
   b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.

c. Manufacturers and Products:
   1) APCO Valve and Primer Corp.; Series 140 or 150.
   2) Val-Matic Valve; Series 100.
   3) Or approved equal.

3. Type V742 Air and Vacuum Valve 1/2 Inch to 16 Inches for Vertical Turbine Service:
   a. Equip 1/2 inch through 3 inches with stainless steel diffuser screen to break up solid water column before coming in contact with float, manufacturer's standard double acting throttling device in outlet for throttling, NPT threaded inlet and outlet.
   b. Equip 4 inches and larger with anti-slam device to throttle flow of water into air valve. Design anti-slam device to permit full, unrestricted flow of air into and out of air valve, but reduce flow area for water to approximately 10 percent. ASME B16.1 Class 125 flanged inlet and NPT threaded outlet.
   c. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
   d. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 141DAT to 146DAT or Series 1904 to 1916.
      2) Val-Matic Valve; Series 100WS to 116WS.
      3) Or approved equal.
4. Type V746 Combination Air Release Valve 1 Inch to 16 Inches:
   a. Suitable for water service, combines operating features of air and vacuum valve and air release valve. Air and vacuum portion to automatically exhaust air during filling of system and allow air to re-enter during draining or when vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system.
   b. Valve single body or dual body, air release valve mounted on air and vacuum valve, isolation valve mounted between the dual valves. 1-inch through 3-inch valves with NPT threaded inlet and outlet, 4-inch and larger valves with ASME B16.1 Class 125 flanged inlet and cover outlet.
   c. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
   d. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 143C to 147C or 1804 to 1816.
      2) Val-Matic Valve; Series 201C to 203C or 104/22 to 116/38.
      3) Or approved equal.

5. Type V750 Sewage Air and Vacuum Valve 2 Inches to 14 Inches:
   a. Suitable for sewage service; automatically exhausts air during system filling and allows air to re-enter during draining or when vacuum occurs.
   b. Rated working pressure of 150 psi, 1-inch through 3-inch valves with NPT threaded inlet and outlet, 4-inch and larger valves with ASME B16.1 Class 125 flanged inlet and threaded cover outlet, built and tested to AWWA C512.
   c. Materials: Cast-iron or ductile iron body and cover, concave or skirted stainless steel float and trim, Buna-N seat.
   d. Sewage air and vacuum valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.
   e. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 401 SAVV to 414 SAVV.
      2) Val-Matic Valve; Series 301 to 306.
      3) Or approved equal.

H. Miscellaneous Valves:

1. Type V915 Mud Valve 4 Inches to 24 Inches:
   a. Cast-iron frame, yoke, and gate; heavy-duty 125-pound flange style, bronze seat, Buna-N seal, non-rising stem, bronze stem and stem nut, 2-inch square operating nut, cast-iron floor box, Type 304 stainless steel extension stem; stem guides spaced for L/R of 200 maximum.
   b. Manufacturers:
      1) Troy Valve.
      2) Trumbull Industries, Inc.
      3) Clow Valve Company.
      4) Or approved equal.
2. Type V920 Hydrostatic Pressure Relief Valve, Floor Type 4 Inches:
   a. Floor type, cast-iron body, grate, and cover, removable cover and strainer, body with integral seep ring, body length as shown on Drawings, neoprene rubber cover seat, epoxy body seat.
   b. Manufacturers and Products:
      1) M&H Valve; Style 147, F-1493.
      2) Clow Valve; Figure F-1493.
      3) Or approved equal.

3. Type V921 Hydrostatic Pressure Relief Valve, Wall Type 4 Inches:
   a. Wall type, flange style frame, cast-iron body and cover, bronze seat body, resilient rubber seat on cover, bronze hinge pins, cast-iron wall pipe with integral seep ring and strainer, length as shown on Drawings.
   b. Manufacturers and Products:
      1) M&H Valve; Style 147, F-1494/F-1496.
      2) Clow Valve; Figure F-1494/F-1496.
      3) Or approved equal.
4. Type V930 Fire Hydrant: (Describe agency standard.)
5. Type V940 Solenoid Valve 1/4 Inch to 2 Inches:
   a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (when de-energized) as indicated on Drawings.
   b. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.
   c. Manufacturers and Products:
      1) ASCO.
      2) Skinner.
      3) Or approved equal.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
   c. Operator self-locking type or equipped with self-locking device.
   d. Position indicator on quarter-turn valves.
   e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator’s threaded steel reach rod with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
   a. Galvanized and painted handwheel.
   b. Cranks on gear type operator.

c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
d. Valve handles to take a padlock, and wheels a chain and padlock.

3. Buried Operator:
   a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
   b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
   c. Buried valves shall have extension stems, bonnets, and valve boxes.

B. Electric Motor Actuators, 480 Volts:

1. General:
   a. Comply with latest version of AWWA C542.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
   c. Controls integral with actuator and fully equipped as specified in AWWA C542.
   d. Stem protection for rising stem valves.
2. Actuator Operation—General:
   a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves, as applicable.
   b. Manual override handwheel.
   c. Valve position indication.
   d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Actuated Valve Schedule.
   e. Nonintrusive Electronic Control: Local controls, diagnostics, and calibration, including limit and torque settings, shall be accomplished nonintrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two minimum.
3. Open-Close(O/C)/Throttling(T) Service:
   a. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
   b. Actuator suitable for throttling operation of valve at intermediate positions.

c. LOCAL-OFF-REMOTE Selector Switch, padlockable in each position:
   1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
   2) Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; valve travel stops when remote STOP contact opens.
   3) Auxiliary contact that closes in REMOTE position.
d. OPEN and CLOSED indicating lights.
e. Integral reversing motor starter with built-in overload protection.

4. Modulating (M) Service:
   a. Size actuators for continuous modulating duty.
   b. Feedback potentiometer, or equivalent, and integral electronic positioner/comparator circuit to maintain valve position.
   c. HAND-OFF-AUTO (Local-Off-Remote) Selector Switch, padlockable in each position:
      1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in HAND (Local) position.
      2) 4 mA to 20 mA dc input signal to control valve in AUTO (Remote) position.
      3) Auxiliary contact that closes in AUTO (Remote) position.
   d. OPEN and CLOSED indicating lights.
   e. Ac motor with solid state reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Controller capable of 1,200 starts per hour.
   f. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
   g. Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.
5. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
   b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   c. Housed in actuator control enclosure.
6. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
7. Manufacturers and Products:
   a. Rotork Controls.
   b. Or approved equal.

2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing valve tag number shown on Drawings.

B. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

C. T-Handled Operating Wrench:

1. Two each galvanized operating wrenches, 4 feet long.
2. Manufacturers and Products:
   a. Mueller; No. A-24610.
   b. Clow No.; F-2520.
   c. Or approved equal.
3. Two each galvanized operating keys for cross handled valves.

D. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

1. Manufacturers and Products:
   a. Pratt.
   b. DeZurik.
   c. Or approved equal.

E. Floor Stand:

1. Nonrising, heavy pattern, indicating type.
2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment. Stem length as required to connect valve operating nut and floor stand.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
   a. Clow; Figure F-5515.
   b. Mueller, Figure A-26426.
   c. Or approved equal.

F. Floor Box:

1. Plain type, for support of nonrising type stem.
2. Complete with solid extension stem, operating nut, and stem guide brackets. Stem length as required to extend valve operating nut to within 3 inches of finish floor.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
   a. Neenah Foundry; R 7506.
   b. Clow; No. F5690.
   c. Or approved equal.

G. Chain Wheel and Guide:

1. Handwheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.
4. Manufacturers and Products:
   a. Clow Corp.; Figure F-5680.
   b. Walworth Co.; Figure 804.
   c. DeZurik Corp.; Series W or LWG.
   d. Or approved equal.

H. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum depth 3 inches, nonlocking type, marked SEWER.
3. Extensions: Cast iron.
4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
6. Manufacturers and Products:
   a. East Jordan Iron Works; Cast-Iron Valve Boxes.
   b. Bingham & Taylor; Cast-Iron Valve Boxes.
   c. Or approved equal.

I. Concrete Valve Box: Designed for traffic loads, sliding type, with minimum of 10-inch ID shaft.

1. Box: High-density, reinforced concrete, minimum depth 12 inches, cast-iron ring seat.

2. Lid: Cast iron, minimum depth 3 inches, marked SEWER.
3. Extensions: Concrete.
4. Manufacturers and Products:
   a. Christy Concrete Products; G Series.
   b. BES Concrete Products; G Series.
   c. Or approved equal.

J. Indicator Post Assembly:

1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
3. Padlockable eye bolt for wrench.
4. Adjustable bury depth. Bury depth as required for valve installation.
5. UL Listed and FM Approved.
6. Manufacturers and Products:
   a. Clow; Style 2945.
   b. Mueller; A-20806.
   c. Or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.

c. Install valves per manufacturer's recommendations.

2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
3. Eccentric Plug Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve as follows:
      1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
      2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
      3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).
4. Butterfly Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
   b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
   c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
   d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
   e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
5. Check Valves:
   a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
   b. Install valve in vertical flow (up) piping only for gas services.
   c. Install swing check valve with shaft in horizontal position.
   d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
6. Solenoid Valves: Install in accordance with manufacturer's instructions.

E. Install 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.

F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

G. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

H. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

I. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

J. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer’s data.

E. Set, verify, and record set pressures for relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are part of this Specification.

1. Slide Gate Schedule.
2. Electric Actuated Valve Schedule.
3. Solenoid Valve Schedule.
4. Self-Regulated Valve Schedule.

END OF SECTION

Slide Gate Schedule							
Gate Identification No. and Location	**Assembly Style**	**Wall Opening (Height/ Width inches)**	**Gate Height (inches)**	**Flow Stream**	**Design Operating Head (feet) Seating/Unseating Condition**	**Operator Type/ Control Style**	**Notes**

Electric Actuated Valve Schedule									
Tag Number	**Valve Type**	**Actuator Power Supply**	**Valve Size (inches)**	**Process Fluid**	**Maximum Operating Flow**	**Maximum ΔP (psi)**	**Service**	**Travel Time (seconds)**	**Control Feature Modifications/supplements**
05FCV 2301	V500	480V, three phase	6	blower air	231 scfm	7.5	M	60	05UU 2301
05FCV 2302	V500	480V, three phase	6	blower air	231 scfm	7.5	M	60	05UU 2302

Solenoid Valve Schedule							
Tag Number	**Valve Type**	**Valve Size (inches)**	**Fluid**	**Maximum Operating Flow**	**Maximum ΔP (psi)**	**Travel Time (seconds)**	**Actuator Type and Control Features**
02FV 5301	V940	1	W3	20	125	<1	fail closed
02FV5901	V940	1	W3	20	125	<1	fail closed
02FV5001	V940	1/2	W3	5	125	<1	fail open
21FV2101	V940	1/2	W3	5	125	<1	fail open
21FV2102	V940	1/2	W3	5	125	<1	fail open
21FV2103	V940	1/2	W3	5	125	<1	fail open
21FV2001	V940	1/2	W3	5	125	<1	fail open
21FV2002	V940	1/2	W3	5	125	<1	fail open
21FV2003	V940	1/2	W3	5	125	<1	fail open

Self-Regulated Valve Schedule							
Tag No.	**type**	**Size (inches)**	**Inlet Pressure (psi)**	**Outlet Pressure (psi)**	**Maximum psig**	**Flow (gpm)**	**Fluid**
*05PSV 5701	unk	6"	unk	8.5	unk	n/a	Blower air
*05PSV 5702	unk	6"	unk	8.5	unk	n/a	Blower air
41PSV 0201	V720	1/2"	1	100	5	0.13	AL
41PSV 0202	V720	1/2"	1	100	5	0.13	AL
41PSV 0203	V720	1/2"	1	100	5	0.13	AL
32ARV0301	V744	unk	n/a	n/a	n/a	n/a	W3
32ARV0302	V744	unk	n/a	n/a	n/a	n/a	W3
32ARV0601	V744	unk	n/a	n/a	n/a	n/a	W3

SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
   c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   g. C552, Standard Specification for Cellular Glass Thermal Insulation.
   h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
   i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 1—Elastomeric:

1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
3. Nominal Density: 3 pcf to 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
6. Joints: Manufacturer's adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
   a. Nomaco; K-Flex.
   b. Armacell; AP Armaflex.
   c. Or approved equal.

B. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.

8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.
   c. Or approved equal.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus **290** degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer's recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One or approved equal.

2.02 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

A. Type 1: 1-inch thick.

2.03 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.04 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
   a. Knauf Insulation; Proto 1000.
   b. Johns Manville; Zeston 2000 or 300.
   c. Speedline; 25/50 Smoke-Safe.
   d. Or approved equal.

B. Type F2—Paint:

1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
   a. Manufacturer and Product: Armacell; WB Armaflex finish or approved equal.
2. Type 2 Insulation: In accordance with Section 09 90 00, Painting and Coating.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
   a. RPR Products; Insul-Mate.
   b. ITW, Pabco-Childers.
   c. Or approved equal.

D. Type F4—Foamglass Jacketing:

1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS or approved equal.
2. Type 3 Insulation—Greater that 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30 or approved equal.

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, Process Piping—General.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

F. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.

G. Roof Drains and Overflow Drains: Insulate entire pipe runs. Where roof and overflow drains exist through an exterior wall ensure annular space between pipes and walls are properly sealed prior to insulating.

H. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.

I. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

J. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):

1. Aluminum or color coded PVC jacketing does not require painting.
2. If insulated piping system is indicated to be painted in Section 40 27 00, Process Piping—General, piping shall receive the following:
   a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
   b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness								
					Finish Systems			
Service Type	Pipe Legend	Thickness	Fluid Temperature (degrees F)*	Insulation	Concealed from View	Indoors Exposed	Outdoors	Buried
DW–Domestic and Service Hot Water Systems.	HW	ASHRAE 90.1 or IECC whichever results in thickest insulation.	105 to 140	Type 1 (6" or less)	None	F3 below 8' F3 above 8'	F3	NA
HT–Piping requiring heat tracing.		Pipe Size: Insulation Thickness Inches:* 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5		Type 2 Insulate and heat trace outside lines 1' above grade. Use Type 3 insulation from 1' above grade to frost depth.	None	F3 below 8' none above 8'	F3	F4 on Type 3
PE–Personnel Exposure		ASHRAE 90.1 or IECC whichever results in the thickest insulation	>140	Type 2 Minimum 1.5" thick	No insulation or finish	F3 below 8'	F3	NA

*Use these fluid temperatures unless otherwise noted in the Piping Schedule.
Inches*: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding. Matches the watts per foot in Section 40 05 33, Pipe Heat Tracing. 2012 IECC requires 1-inch minimum thickness.

SECTION 40 90 00
INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Section 40 91 00, Instrumentation and Control Components.
2. Section 40 95 80, Fiber Optic Communications Systems.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
2. Programmable controllers.
3. Computers and networks for Human Machine Interface (HMI).
4. Upgrade of existing VTScada application and migration to new computers and networks
5. Applications Software.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section and other PIC subsections:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   d. B32, Standard Specification for Solder Metal.
   e. B88, Standard Specification for Seamless Copper Water Tube.
3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.

4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. International Society of Automation (ISA):
    a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
    b. S5.1, Instrumentation Symbols and Identification.
    c. S5.4, Instrument Loop Diagrams.
    d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
    e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
6. International Conference on Energy Conversion and Application (ICECA).
7. National Electrical Code (NEC).
8. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    b. ICS 1, Industrial Control and Systems General Requirements.
9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
11. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. FDT: Factory Demonstration Test.
2. HMI: Human-Machine Interface.
3. HVAC: Heating, Ventilating, and Air Conditioning.
4. I&C: Instrumentation and Control.
5. I/O: Input and Output.
6. O&M: Operation and Maintenance.
7. P&ID: Process and Instrument Diagram.
8. PC: Personal Computer.
9. PIC: Process Instrumentation and Control.
10. PLC: Programmable Logic Controller.
11. SCADA: Supervisory Control and Data Acquisition.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.

E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:

1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
2. Programming in any programming or scripting language.

F. Rising/Falling: Define action of discrete devices about their setpoint.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

G. Signal Types:

1. Analog Signal, Current Type:
   a. 4 to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.

2) Transmitter Load Resistance Capacity: Class L.
3) Fully isolated transmitters and receivers.

2. Analog Signal, Voltage Type: 1 to 5 volts dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Detailed Wiring Design: Panel wiring diagrams, interconnecting wiring diagrams, and loop wiring diagrams are included in Contract Drawings and designed to completely show control panel wiring, terminations, wire numbers, interfaces with other systems, hardwired functions, interlocks, and wiring of components to be provided.

B. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
   a. Functional requirements, performance requirements, and component specifications.
   b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

C. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
   a. Completing detail design.
   b. Submittals.
   c. Equipment, enclosures, and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.

e. Verify readiness for operation.
f. Verify correctness of final power and signal connections (lugging and connecting).
g. Adjusting and calibrating.
h. Starting up.
i. Testing and coordination of testing.
j. Training.
k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.

2. Verify following Work not by PIC System Integrator is provided:
   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. NonPIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.
   c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
   d. Test to demonstrate required interface and operation with PIC.
   e. Examples of items in this category, but not limited to the following:
      1) Valve operators, position switches, and controls.
      2) Chemical feed pump and feeder speed/stroke controls.
      3) Automatic samplers.
      4) Motor control centers.
      5) Adjustable speed and adjustable frequency drive systems.
   f. Examples of items not in this category:
      1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
      2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.

2. Partial Submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format:
    a. Hard Copy: Required for all submittals.
    b. Electronic Copies: Required, unless otherwise noted for specific items.
        1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
        2) Documents created specifically for Project:
            a) Text and Graphics: Microsoft Word.
            b) Lists: Microsoft Excel, unless otherwise noted for specific items.
            c) Drawings: MicroStation.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
    a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
    b. Use identical abbreviations in PIC subsections.
    c. Submit updated versions as they occur.
6. Activity Completion:
    a. Action Submittals: Completed when reviewed and approved.
    b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
    a. Group equipment items by enclosure and field, and within an enclosure, as follows:
        1) PIC Components: By component identification code.
        2) Other Equipment: By equipment type.
    b. Data Included:
        1) Equipment tag number.
        2) Description.
        3) Manufacturer, complete model number and all options not defined by model number.
        4) Quantity supplied.
        5) Component identification code where applicable.
        6) For panels, include panel reference number and name plate inscription.
    c. Formats: Hard copy and Microsoft Excel.

2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
   a. Catalog information, marked to identify proposed items and options.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content: Specific features and configuration data for each component, including but not limited to:
      1) Tag Number.
      2) Component type identification code and description.
      3) Location or service.
      4) Service conditions.
      5) Manufacturer and complete model number.
      6) Size and scale range.
      7) Setpoints.
      8) Materials of construction.
      9) Options included.
      10) Power requirements.
      11) Signal interfaces.
      12) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
   c. Electronic Copies: Microsoft Excel.
4. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for Flow Elements:
         a) Minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
   c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
5. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.

b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
f. Submit electronic copies of Drawings.

6. Detailed Wiring Diagrams:
   a. Refer to Drawings for Detailed Wiring Diagrams including:
      1) Panel Wiring Diagrams for discrete control and power circuits.
      2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
      3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.
   b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.
   c. Submit electronic copies of Drawings.
7. Panel Wiring Diagrams:
   a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
   b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
   c. Diagram Type:
      1) Ladder diagrams, where applicable.
         a) Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
      2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
   d. Item Identification: Identify each item with attributes listed.
      1) Wires: Wire number and color. Cable number if part of multiconductor cable.
      2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.

3) Components:
   a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
   b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
5) Relay Coils:
   a) Tag number and its function.
   b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.

e. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.
f. Ground wires, surge protectors, and connections.
g. Wire and Cable Names: Show names and wire color for circuits entering and leaving a panel. Refer to Division 26, Electrical.

8. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
   a. Conform to the minimum requirements of ISA S5.4.
   b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
   c. Show loop components within a panel and identify each component, component terminals, and panel terminals.
   d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
      1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
      2) Identify the component by tag and description.
      3) Identify panel and component terminal numbers.
   e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
   f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.

g. Show:
   1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
   2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
   3) Tabular summary on each analog loop diagram:
      a) Transmitting Instruments: Output capability.
      b) Receiving Instruments: Input impedance.
      c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
      d) Total loop impedance.
      e) Reserve output capacity.
   4) Circuit and raceway schedule names.

9. Communications and Digital Networks Diagrams:
   a. Scope: Includes connections to telephone system, Ethernet network, remote I/O, and fieldbus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
   b. Format: Network schematic diagrams for each different type of network.
   c. Show:
      1) Interconnected devices, both passive and active.
      2) Device names and numbers.
      3) Terminal numbers.
      4) Communication Media: Type of cable.
      5) Connection Type: Type of connector.
      6) Node and device address numbers.
      7) Wire and cable numbers and colors.
10. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
   a. Required voltages, currents, and phases(s). Include calculations and list assumptions.
   b. Maximum heat dissipations Btu per hour. Include calculations and list assumptions.
   c. Maximum permissible internal temperature based on operating range of internal components.
   d. Computed maximum internal temperature. Include calculations and list assumptions. Include the impacts of internal heat generation, solar radiation and shielding.
   e. Use the ambient parameters listed in this section for the applicable service condition.
11. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for:
   a. Pipes and Tubes: Thickness, pressure rating, and materials.
   b. Components: Valves, regulators, and filters.

c. Connections to panel-mounted devices.
d. Panel interface connections.
e. Submit electronic copies of Drawings.

12. Installation Details: Include modifications or further details required and define installation of I&C components.
13. Spares, expendables, and test equipment.
14. Electronic Copies: Microsoft Excel.
15. Color schedule for control panels.
16. Applications Software Documentation:
    a. Existing Functions Summary:
        1) Preliminary and Final.
        2) Refer to paragraph Software Design Workshops for detail and sequencing.
    b. Loop Specifications and P&ID Summary:
        1) Preliminary and Final.
        2) Refer to paragraph Software Design Workshops for detail and sequencing.
    c. VTScada Standards submittal:
        1) Refer to paragraph Software Design Workshops for detail and sequencing.
    d. Plant Process Reporting submittal:
        1) Refer to paragraph Software Design Workshops for detail and sequencing.
    e. Complete configuration documentation for microprocessor based programmable devices.
        1) For each device, include program listings and function block diagrams, as appropriate, showing:
            a) Functional blocks or modules used.
            b) Configuration, calibration, and tuning parameters.
            c) Descriptive annotations.

C. Informational Submittals:

1. Statements of Qualification:
    a. PIC System Integrator's site representative.
    b. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).
2. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
    a. General:
        1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.

2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.

b. Final versions of Legend and Abbreviation Lists.

c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.

d. Provide the following items as defined under heading Action Submittals:
   1) Bill of materials.
   2) Catalog cuts.
   3) Instrument list.
   4) Component data sheets.
   5) Detailed Wiring Diagrams: As-built drawings.
      a) Panel wiring diagrams.
      b) Loop diagrams.
      c) Interconnecting wiring diagrams.
   6) Panel plumbing diagrams.
   7) Applications software documentation.

e. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
   1) Content for Each O&M Manual:
      a) Table of Contents.
      b) Operations procedures.
      c) Installation requirements and procedures.
      d) Maintenance requirements and procedures.
      e) Troubleshooting procedures.
      f) Calibration procedures.
      g) Internal schematic and wiring diagrams.
      h) Component and I/O Module Calibration Sheets from field quality control calibrations.
   2) Provide PDF file will linked index to all manuals.

f. List of spares, expendables, test equipment and tools provided.

g. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.

3. Provide Manufacturer's Certificate of Proper Installation where specified.

4. Testing Related Submittals:
   a. Factory Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures:
         a) Proposed test procedures, forms, and checklists.

b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.

3) Test Documentation: Copy of signed off test results.

b. Functional Test:

1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.

2) Final Test Procedures: Proposed test procedures, forms, and checklists.

3) Test Documentation:

a) Copy of signed-off test results.

b) Completed component calibration sheets.

c. Performance Test:

1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.

2) Final Test Procedures: Proposed test procedures, forms, and checklists.

3) Test Documentation: Copy of signed-off test results.

5. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.

6. Maintenance Service Agreement: Prior to Substantial Completion, submit service agreements signed by Owner and maintenance provider for work required under Article Maintenance Service.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements.

B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

A. Refer to Section 01 31 13, Project Coordination, for Contractor's scheduling requirements for applications software testing.

B. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Test Prerequisite: Associated test procedures Submittals completed.
2. Training Prerequisite: Associated training plan Submittal completed.
3. PLC and HMI Shipment to Site:
    a. General Prerequisites:
        1) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
        2) FDT completed.
4. PLC and HMI Installation Prerequisite: Equipment received at Site.
5. Functional Test Part 1 Prerequisite: PLC and HMI installation complete.
6. Functional Test Part 2 Prerequisite: Functional Test Part 1 completed.
7. Performance Test Prerequisite: Functional Test Part 2 completed and facility started up.

1.09 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software, whether indicated or not, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals".

2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Reference Instrument List in Article, Supplements.

C. Furnish equipment that is necessary to achieve required loop performance.

D. Control Panels: Reference Control Panel Schedule in Article Supplements, Instrumentation and Control Components.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for PLC components.

B. Furnish equipment that is necessary to achieve required loop performance.

2.04 NETWORK AND HMI COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for Network and HMI components.

B. Reference SCADA Equipment List in Article, Supplements.

C. Furnish equipment that is necessary to achieve required loop performance.

2.05 SERVICE CONDITIONS

A. Standard Service Conditions: The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:

1. Computer Room, Air Conditioned:
   a. Temperature: 60 degrees F to 80 degrees F.
   b. Relative Humidity: 40 percent to 60 percent.
   c. NEC Classification: Nonhazardous.
2. Inside, Air Conditioned:
   a. Temperature:
      1) Normal: 60 degrees F to 80 degrees F.
      2) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
   b. Relative Humidity:
      1) Normal: 10 percent (winter) to 70 percent (summer).
      2) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
   c. NEC Classification: Nonhazardous.
3. Inside:
   a. Temperature: 0 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. NEC Classification: Nonhazardous.
4. Inside, Corrosive:
   a. Temperature: 0 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. Corrosive Environment: Hydrogen sulfide gas.
   d. NEC Classification: Nonhazardous.
5. Inside, Hazardous:
   a. Temperature: 0 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. NEC Classification: As shown on Electrical Drawings.
6. Outside:
   a. Temperature: 0 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
   c. NEC Classification: Nonhazardous.

7. Outside, Corrosive:
   a. Temperature: 0 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
   c. NEC Classification: Nonhazardous
   d. Corrosive Environment: Hydrogen sulfide gas.
   e. NEC Classification: Nonhazardous.
8. Outside, Hazardous:
   a. Temperature: 0 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
   c. NEC Classification: Nonhazardous
   d. NEC Classification: As shown on Electrical Drawings.

B. Standard Service Conditions for Panels and Consoles: Unless otherwise noted, in Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:

1. Freestanding Panel and Consoles:
   a. Inside, Air Conditioned: NEMA 1.
   b. Inside: NEMA 12.
2. Smaller Panels and Assemblies (that are not freestanding):
   a. Inside, Air Conditioned: NEMA 12.
   b. All Other Locations: NEMA 4X.
3. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.06 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Materials: Laminated plastic attached to panel with stainless steel screws.
2. Letters: 1/2-inch high, white on black background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, white on black background, unless otherwise noted.

C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
   c. Refer to P&IDs on Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch-high, imposed.
4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.07 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs or panel control diagrams.

C. Supplemented by standard functional requirements in PIC subsections.

2.09 LOOP SPECIFICATIONS

A. See Article Supplements located at End of Section.

2.10 HMI AND NETWORK CONFIGURATION

A. Upgrade existing VTScada licensing.

1. Upgraded licenses on new servers:
   a. Existing licensing is 5000 Tag Dual Server Redundant which includes:
      1) 5000 One 5000 Tag Development Runtime which includes:
         a) One 5000 Tag Runtime.
         b) Two Alarm Notification licenses.
         c) Two Data Sharing interfaces.
         d) Two Thin Clients (concurrent users).
   b. New licensing shall be VTScada 10,000 I/O Dual Server Premium Bundle.
   c. Migration sequence:
      1) Existing application copied.
      2) Existing application upgraded per new standards.
      3) Existing application expanded per new functions.
      4) Upgraded, expanded application installed on new servers and tested at integrator's facility.
   d. Factory testing to include interface to existing PLCs and new PLCs:
      1) Integrator to simulate existing PLCs to support testing of interface to them.

B. SCADA Configuration:

1. Installed Software Packages:
   a. Primary Server:
      1) Windows Server 2016:
         a) Function as primary domain controller.
         b) Windows indexing turned off on VTScada applications folder.
      2) Antivirus:
         a) AVG.
         b) VTScada folder added to virus exclusions.
         c) Automatic virus signature updates via city server.

3) VT SCADA:
   a) Primary Server.
   b) Thin client hosting (2).
   c) Local client via dual monitor KVM extension to:
      (1) Keyboard.
      (2) Mouse.
      (3) Monitors.
   d) Historical collector.
   e) Primary Historian: Installed on separate hard drive from VTScada and operating system.
   f) Primary generator of text messages for alarms: Utilizing city's email server for text generation.

b. Backup Server:
   1) Windows Server 2016:
      a) Function as backup domain controller.
      b) Windows indexing turned off on VTScada applications folder.
   2) Antivirus:
      a) AVG.
      b) VTScada folder added to virus exclusions.
      c) Automatic virus signature updates via city server.
   3) VT SCADA:
      a) Backup Server.
      b) Thin client hosting (2).
      c) Local client via dual monitor KVM extension to:
         (1) Keyboard.
         (2) Mouse.
         (3) Monitors.
      d) Historical collector.
      e) Backup Historian: Installed on separate hard drive from VTScada and operating system.
      f) Backup generator of text messages for alarms: Utilizing city's email server for text generation.
   4) XLReporter.

2. Server Redundancy:
   a. Domain controller:
      1) Automatic switching on failure of current active controller.
      2) Configure forced switching to backup.
   b. SCADA server:
      1) Only one server polling PLCs at any time.
      2) Automatic switching on failure of current active server.
      3) Configure forced switching to backup.
   c. Thin Client Hosting:
      1) Automatic switching on failure of current active host.

d. Text Message Generation:
   1) Only one server generating messages at any time.
   2) Automatic switching on failure of current active server.
   3) Configure forced switching to backup.
e. Historian:
   1) Primary historian shall be function as active historian when available.
   2) Secondary historian shall be function as active historian when the primary historian is not available.
   3) Active historian shall continuous populate backup historian while both are available.
      a) Active historian shall populate backup historian with buffered data when backup historian returns from unavailable status to available status.
   4) Switch of active historian between primary and secondary shall be automatic.
   5) Only one collector populating active historian at any time.
   6) Only one collector populating active historian for any time interval.
   7) Collectors buffer historical data during loss of connection to active historian.

C. Application Upgrade:

1. The existing VTScada shall be upgraded:
   a. To integrate with new processes added in this Project.
   b. To eliminate existing processes eliminated in this Project.
   c. To provide a consistent format and function across existing and new processes: Standards, developed during submittals and workshops, shall establish format and function.
   d. The upgrade shall be sequenced in multiple steps as required to keep the VTScada application current as the plant is upgraded in steps during the Project.
   e. Adherence of existing processes to standards is required unless it is impossible without changing existing PLC code.

D. Software Design Workshops:

1. Location: Owner’s facility.
2. Objective: To provide a vehicle for the Owner to oversee the applications software development.
3. Documentation: Software Supplier summarizes resolutions reached in each workshop.

4. Order and minimum topics to be covered in each Software Design Workshop.
    a. Existing Functions Workshop:
        1) Contractor shall prepare and submit a summary of all existing VTScada and PLC functions. This summary is referred to as the Preliminary Existing Functions Summary elsewhere in this section.
            a) Summary shall include:
                (1) Screen capture of all current graphics.
                (2) Description of all existing control functions.
                    (a) Organized by unit process.
                    (b) Listing of parameters adjustable from the HMI.
                (3) Complete listings of all PLC programs and associated comments in portable document format (PDF).
                (4) Listing of graphics and PLC code to become obsolete with plant upgrade.
        2) Summary shall be submitted 4 weeks prior to the workshop.
        3) Owner, Engineer and Contractor will resolve any errors omissions during workshop.
        4) Contractor shall correct the Preliminary Existing Functions Summary following the workshop and submit the updated version as the Final Existing Functions Summary.
    b. Loop Specifications and P&ID Review Workshop:
        1) Contractor shall prepare and submit a summary, using P&IDs and Loop Specifications, presenting how the proposed control system design and Applications Software will meet the functional requirements specified herein. This summary is referred to as the Preliminary Loop Specifications and P&ID Summary elsewhere in this section.
            a) Contractor shall use P&IDs from previous projects at the White House WWTP and Final Existing Functions Summary for existing processes not added during this Project.
        2) Summary shall be submitted 4 weeks prior to the workshop.

3) Contractor shall correct the Preliminary Loop Specifications and P&ID Summary following the workshop and submit the updated version as the Final Loop Specifications and P&ID Summary.
   a) Update shall include existing processes not added during this Project.
      (1) Excluding those processes that become obsolete at the end of this Project.

c. VTScada Standards Workshop:
   1) Objective: To review and develop VTScada standards in a participative workshop with Owner.
   2) Design products and topics to be finalized:
      a) Tag naming conventions.
      b) Overview display design.
      c) Process graphics.
      d) Display paging and navigation.
      e) Dynamic Objects: Pumps, valves, gates, compressors, etc.
      f) Equipment control through pop up windows.
      g) Loop control through pop up windows.
      h) Display philosophy, organization and operation.
      i) General data entry: Color graphic standards, symbol standards, etc.
      j) Dynamic Objects: Pumps, compressors, valves, gates, controller faceplates, process indicators, indicators with alarms, data entry, controller face plate, dampers, aerator, chemical feed pump, mixers.
      k) Security.
      l) Alarm Management: Operation of the alarms, alarm areas, alarm filtering.
      m) Trending.
      n) Historical data storage and retrieval.
      o) Variable naming conventions.
      p) Scripting: Display file naming convention.
   3) Contractor shall document all conclusions of the workshop and submit as the VTScada Standards submittal.

d. Plant Process Reporting Workshop:
   1) Objective: Developed and document number and types of reports.
   2) Identify and define each type of Process report including:
      a) Daily flow and energy totals.
      b) Weekly flow and energy totals.

c) Monthly flow and energy totals.
d) Yearly flow and energy totals.

3) Contractor shall document all conclusions of the workshop and submit as the Plant Process Reporting submittal.

2.11 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

B. Wiring External to PIC Equipment:

1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

D. Wires within Enclosures:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits:
   a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
   b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
   c. Size: No. 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than No. 18 AWG.
4. Special Signal Circuits: Use manufacturer's standard cables.
5. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady Perma Sleev.
      2) Tyco Electronics.
      3) Or approved equal.

E. Terminate and identify wires entering or leaving enclosures as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals terminated using manufacturer's standard connectors.

3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.

F. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of connected terminals, but not less than 5 per terminal block, unless otherwise shown on Drawings.
2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
   a. Locate signal ground at dc power supply for loop.
   b. Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
   a. Is separated from nonintrinsically safe circuits as specified by NEC.
   b. Is colored light blue and has message “Intrinsically Safe Circuits Only” on raceway cover every 6 inches.

J. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer's standard connectors for the device to which the signals terminate.

K. Electrical Transient Protection:

1. General:
   a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details in Drawings.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, and field-mounted analog transmitters and receivers.
      2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.
3. Installation and Grounding of Suppressors:
   a. As shown. See Surge Suppressor Installation Details.
   b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.12 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: Refer to Control Panel Schedule in Article Supplements for maximum external dimensions allowed for individual control panels.
2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.

3. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
4. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
5. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Design to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. Ventilated Panels:
      1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
      2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
      3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
      4) Louver Construction: Stamped sheet metal.
      5) Ventilation Fans:
         a) Furnish where required to provide adequate cooling.
         b) Create positive internal pressure within panel.
         c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
      6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
   c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
2. Smaller Panels (that are not freestanding): Design to adequately dissipate heat from equipment mounted inside panel and on panel face.
3. Space Heaters:
   a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
   b. Refer to Control Panel Schedule in Article Supplements.

C. Freestanding Panel Construction:

1. Materials:
   a. Sheet steel, unless otherwise noted in Control Panel Schedule in Article Supplements.
   b. Minimum Thickness: 10-gauge, unless otherwise noted.

2. Panel Front:
    a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
    b. No seams or bolt heads visible when viewed from front.
    c. Panel Cutouts: Smoothly finished with rounded edges.
    d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
    a. Structural steel for instrument support and panel bracing.
    b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Door:
    a. Full height, fully gasketed access door where shown on Drawings.
    b. Latch: Three-point, Southco Type 44.
    c. Handle: “D” ring, foldable type.
    d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
    e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
    f. Front and Side Access Doors: As shown on Drawings.

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
    a. Panels listed as inside, air conditioned:
        1) Enclosure Type: NEMA 12.
        2) Materials: Steel.
    b. Other Panels:
        1) Enclosure Type: NEMA 4X.
        2) Materials: Type 316 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
    a. Rubber-gasketed with continuous hinge.
    b. Stainless steel lockable quick-release clamps.
4. Manufacturers: Hoffman Engineering Co. or approved equal.

E. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
      2) Make provisions for feeder circuit conduit entry.
      3) Furnish terminal block for termination of wires.
   b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
      1) Locate to provide clear view of and access to breakers when door is open.
      2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
         a) Branch Circuit Breakers: 15 amps at 250V ac.
      3) Breaker Manufacturers and Products: Refer to Division 26, Electrical.
   c. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
      1) Devices on Single Circuit: 20, maximum.
      2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
      3) Branch Circuit Loading: 12 amperes continuous, maximum.
      4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
      5) Provide 120V ac plugmold for panel components with line cords.
2. Signal Distribution:
   a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
   b. Within Panels: 4 to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 to 20 mA dc only.
   d. Signal Wiring: Twisted shielded pairs.
   e. RTD and Thermocouple Extension Cable:
      1) Continuous field to panel with no intermediate junction boxes or terminations.
      2) RTDs in motor windings are considered a 600-volt circuit.
      3) Terminate thermocouple extension wire directly to loop instrument.
3. Signal Switching:
   a. Use dry circuit type relays or switches.
   b. No interruption of 4 to 20 mA loops during switching.

c. Switching Transients in Associated Signal Circuit:
   1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
   2) 1V dc to 5V dc Signals: 0.05V, maximum.

4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
   a. Type: Switched 100-watt incandescent back-of-panel lights.
   b. Quantity: One light for every 4 feet of panel width.
   c. Mounting: Inside and in the top of back-of-panel area.
   d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
   b. Quantity:
      1) Panels 4 Feet Wide and Smaller: One.
      2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
   c. Mounting: Evenly spaced along back-of-panel area.
8. Internal Panel Lights and Service Outlets for Smaller Panels:
   a. Internal Panel Light: Switched 100-watt incandescent light.
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle:
   c. Required for panels. Refer to Control Panel Schedule in Article Supplements.
9. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black

Tag Function	Inscription(s)	Color
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.

10. Standard Light Colors and Inscriptions:
    a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

    b. Lettering Color:
       1) Black on white and amber lenses.
       2) White on red and green lenses.

F. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.

4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
    a. Locking-fork-tongue or ring-tongue lugs.
    b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
    c. Wires terminated in a crimp lug, maximum of one.
    d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
    a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
    b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
12. Conductors Carrying Foreign Voltages within a Panel:
    a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
    b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
    a. 120V ac: No. 14 AWG, MTW.
    b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
14. Panelwork:
    a. No exposed connections.
    b. Allow adjustments to equipment to be made without exposing these terminals.
    c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
15. Plastic Wire Ducts Color:
    a. 120V ac: White.
    b. 24V dc: Gray.
    c. Communications Cables and Fiber Optic Jumpers: Orange.

16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

G. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

H. Factory Finishing:

1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
3. Stainless Steel and Aluminum: Not painted.
4. Nonmetallic Panels: Not painted.
5. Steel Panels:
    a. Sand panel and remove mill scale, rust, grease, and oil.
    b. Fill imperfections and sand smooth.
    c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
    d. Sand surfaces lightly between coats.
    e. Dry Film Thickness: 3 mils, minimum.
    f. Color: Manufacturer's standard.

2.13 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
    a. Northern Instruments; Model Zerust VC.
    b. Hoffmann Engineering; Model A-HCI.
    c. Or approved equal.

2.14 TEST EQUIPMENT AND TOOLS

A. Clamp-on Ammeter:

1. Type: True RMS Digital Clamp-on meter with 3-1/2-digit display and protective case.
2. Quantity: 1.
3. Manufacturers and Products:
   a. TES; Model 3040.
   b. Fluke; Model 337E.
   c. Greenlee; Model CMI-100.
   d. Extech; Model EX830.
   e. Or approved equal.

B. Pressure and Electrical Calibrator:

1. Type: Test leads, rechargeable batteries, ac charger, pressure transducer modules, and protective case.
2. Pressure Ranges: Appropriate for pressure devices provided.
3. Quantity: One.
4. Manufacturers and Products:
   a. Transmation; Model 1091PLUS-LP.
   b. Fluke; Model 717/718.
   c. Heise; Model PTE-1.
   d. Or approved equal.

2.15 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer’s decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
   a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
   b. Describe each test item to be performed.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
   a. Provide special testing materials and equipment.

b. Wherever possible, perform tests using actual process variables, equipment, and data.
c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
d. Define simulation techniques in test procedures.
e. Test Format: Cause and effect.
    1) Person conducting test initiates an input (cause).
    2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
    a. Interconnect and test PIC, except for primary elements and smaller panels.
    b. Exercise and test functions.
    c. Provide stand-alone testing of smaller panels.
    d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
    a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
    b. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
3. Location: PIC System Integrator's facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
    a. Simulate each discrete signal at terminal strip.
    b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
    a. All required and shown functions for 100 percent of loops.
7. Nonloop-Specific Functions:
    a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion.

b. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.

8. Correct deficiencies found and complete prior to shipment to Site.
9. Failed Tests:
   a. Repeat and witnessed by Engineer.
   b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
10. Make following documentation available to Engineer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.
    d. Approved hardware Shop Drawings for equipment being tested.
    e. Approved preliminary software documentation Submittal.
11. Daily Schedule for FDT:
    a. Begin each day with meeting to review day's test schedule.
    b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.
4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

D. Mechanical Systems:

1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
4. Tubing and Conduit Bends:
    a. Tool-formed without flattening, and of same radius.
    b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
    c. Slope instrument connection tubing in accordance with installation details.
    d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
    e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
    f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
    g. Blow debris from inside of tubing.
    h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
    i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
    j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
    k. Provide separate support for components in tubing runs.
    l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
    m. Keep tubing and conduit runs at least 12 inches from hot pipes.
    n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
    o. Securely attach tubing raceways to building structural members.
5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During Functional Test**,** conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. Testing: Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.

F. Functional Test:

1. Scope: Confirm PIC, including applications software, is ready for operation.
2. Refer to PIC subsections for additional requirements.
3. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

G. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.
9. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 TRAINING

A. General:

1. Provide an integrated training program for Owner's personnel.
2. Perform training to meet specific needs of Owner's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
5. Owner reserves the right to reuse videotapes of training sessions.

B. Operations and Maintenance Training:

1. General:
   a. Refer to specific requirements specified in PIC Subsections.
   b. Include review of O&M data and survey of spares, expendables, and test equipment.
   c. Use equipment similar to that provided.
   d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Owner's operations personnel on operation of I&C components.
   a. Training Session Duration: Three instructor days.
   b. Number of Training Sessions: Two.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
   e. Content: Conduct training on loop-by-loop basis.
      1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
      2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
      3) Interfaces with PIC subsystems.
3. Maintenance Training:
   a. Training Session Duration: Three instructor days.
   b. Number of Training Sessions: One.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed for routine maintenance of PIC.
   e. Content: Provide training for each type of component and function provided.
      1) Loop Functions: Understanding details of each loop and how they function.
      2) Component calibration.
      3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
      4) Troubleshooting and diagnosis for equipment and software.
      5) Replacing lamps, chart paper, and fuses.
      6) I&C components removal and replacement.
      7) Periodic preventive maintenance.

3.05 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.06 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.07 SUPPLEMENTS

A. Supplements listed below, follows "End of Section," are part of this Specification.

1. Loop Specifications.
2. Preparation for Testing and Functional Test Forms:
    a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
    b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
    c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
3. Performance Test Sheet: Describe Performance Test for a given loop.
    a. List requirements of the loop.
    b. Briefly describe test.
    c. Cite expected results.
    d. Provide space for checkoff by witness.
4. SCADA Equipment List.
5. Control Panel Schedule.
6. Instrument List.
7. PLC I/O List.

END OF SECTION

JACOBS **LOOP STATUS REPORT—EXAMPLE FORMAT Rev.06.05.92**

Project Name: *Newport News WTP*	Project No. *WDC23456.C1*
FUNCTIONAL REQUIREMENTS:	
1. Measure, locally indicate, and transmit RAS flow to LP-10.	
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.	
3. Provide high RAS flow alarm on LP-10.	

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
FE/FIT-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-30-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

JACOBS **INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER Rev.06.05.92**

COMPONENT	MANUFACTURER		PROJECT
Code: *A7*	Name: *Leeds & Northrup*		Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Serial #: *11553322*	Name: *UOSA AWT PHASE 3*

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/ Convert? Y	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					Note No.
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*	*1.*	*N.A.*		*N.A.*		
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*	2.					*1.*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*	3.					
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*	4.					
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*	5.					
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:		6.					

#	NOTES:	Component Calibrated and Ready for Start-up
	1. Need to recheck low pH calibration solutions.	By: *J.D. Sewell*
		Date: *Jun-6-92*
		Tag No.: *AIT-12-6*[pH]

JACOBS **I&C VALVE ADJUSTMENT SHEET—EXAMPLE** Rev.06.05.92

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear – Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot	Action:	Mfr:
Solenoid	Rating: *None*	Model: Serial #:
I/P	Input: *4-20 mA dc*	Mfr: *Taylor*
Converter	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
Switch	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power	Type: *Pneumatic*	Air Set Mfr: *Air Products*
Supply	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

JACOBS **PERFORMANCE TEST SHEET - EXAMPLE** Rev.06.05.92

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

Demonstration test(s): For each functional Requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. *Jun-20-92 BDG*

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*

Vary H and observe that following.

2.a Reading of FIT indicator. *Jun-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1 *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 BDG*

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B. DeGlanville*	*Jun-6-92*	Loop No.: *30-12*

LOOP DESCRIPTIONS

1.01 GLOBAL FUNCTIONS

A. General: Global functions are required for all applicable variables and are not listed in the Unit Process Loop Specifications.

B. HMI Application Security:

1. General: Provide password protected HMI access to prevent unauthorized users from making changes from operator workstation(s). Provide the following Security Levels:
   a. Engineer Level: Access to all data parameters.
   b. Supervisor Level: Access to alarm limits, alarm inhibit status, scan inhibit status, and all operator level functions, as well as all adjustable parameters.
   c. Operator Level: Set Points, control commands and all operator adjustable parameters.
   d. Display Level: No changes allowed.

C. Parameter Access:

1. Provide access to entry and adjustment of parameters designated as “operator adjustable,” “operator input,” or “operator entry” to any user logged in at engineer, supervisor or operator security level.
2. Provide access to entry and adjustment of all other adjustable parameters including, but not limited to, set points, tuning coefficients (for example proportional and integral), timer presets, control sequence presets, and alarm trip points to any user logged in at engineer or supervisor security level.
3. Provide for PLC programmer entry and adjustment of parameters designated as “preset” or “preset but adjustable.”
4. Present these parameters in an efficient easily navigated format. Provide adequate information to allow the facility maintenance staff to easily identify each variable. The intent is to allow the maintenance staff to tune facility performance and operation without having to alter the PLC program.

D. Alarm Processing:

1. Provide alarms as noted or shown. Include the following alarms:
   a. Equipment or motor fail alarm:
      1) Provide fail alarms for each fail condition. Upon fail, remove the run command.

b. Run Fail Alarm:
   1) A motor is commanded-to-run, but is not confirmed running within a preset time. Unless otherwise noted, running is confirmed by receiving an ON status M-contact from the motor's starter.
   2) Provide run fail alarms for each motor. Upon motor run fail, remove the run command.

c. Open Fail Alarm:
   1) A valve is commanded-to-open, but is not confirmed open within a preset time. Unless otherwise noted, a valve is confirmed open by receiving OPEN limit switch contact from the valve.
   2) Provide open fail alarms for each nonmodulating valve with open position feedback. Upon open fail, remove the open command.

d. Close Fail Alarm:
   1) A valve is commanded-to-close, but is not confirmed closed within a preset time. Unless otherwise noted, a valve is confirmed closed by receiving Close limit switch contact from the valve.
   2) Provide close fail alarms for each nonmodulating valve with closed position feedback. Upon close fail, remove the close command.

e. Position Fail Alarm:
   1) A modulating valve is commanded to a Set Point position, but the valve is not confirmed to be within a preset percentage of set point within a preset time.
   2) Provide position fail alarms for each modulating valve with position feedback.

f. Analog Signal Failure:
   1) An analog input is out of normal range.
   2) Provide analog signal failure alarms on all analog inputs.

2. Sequencing and Display:
   a. Sound the alarm tone, indicate the alarm condition on appropriate HMI displays, and add to the HMI alarm summary display.
   b. Upon acknowledgement, silence the alarm tone and indicate the alarm condition on appropriate HMI displays and the alarm summary display.
   c. Remove acknowledged alarms from the alarm summary once they are cleared.
   d. Log alarm occurrence, acknowledgement, and clearance in the alarm log file.

e. Unless otherwise noted or shown, provide alarm logic that resets automatically when the acknowledged alarm condition clears. Display alarms on alarm summaries as follows:
   1) Display flashing text when Alarm is present and is Unacknowledged.
   2) Display steady text when Alarm is present and is Acknowledged.
   3) Display ceases when Alarm clears and is or has been Acknowledged.

f. Alarm Summary Display:
   1) Display for each alarm:
      a) Tag.
      b) Descriptor.
      c) Current Value.
      d) Engineering Units (analogs only).
      e) Area.
      f) Priority.
      g) Date and time of alarm.
      h) Alarm state.
      i) Acknowledgement state.
   2) Provide for operator adjustable filtering and sorting by:
      a) Area.
      b) Priority.
      c) Date and time of alarm.
      d) Alarm state.
      e) Acknowledgement state.

3. Prioritization: Prioritize alarms into two levels: critical and noncritical. Provide separate colors and audible tones for critical and noncritical alarms. Log but do not alarm events that does not require an immediate action.
4. Categorization: Categorize alarms into unit process categories.
5. Nuisance alarm suppression:
   a. Alarms shall be provided with an adjustable delay timer so that they do not become nuisance alarms.
   b. Analog alarms shall be provided with a dead band to prevent nuisance re-alarming.
   c. Conditioning alarm signals. For example disable all but selected alarms when power is off, and include startup delays, momentary excursion delays, and contact bounce delays. Suppress dysfunctional alarms during and immediately following power outages.
   d. Provide alarm disable functions:
      1) Selectable by the supervisor on a point-by-point basis.
      2) Does not prevent point status from being shown on graphic process displays.
      3) Maintain summary of disabled alarms.

E. Analog Inputs:

1. Provide sample times for analog inputs of no slower than one sample every 2 seconds. For inputs that are used for control purposes, use sample times no slower than once every 1 second.
2. Provide a first order digital filter on all analog inputs. All analog inputs shall be configured into a floating point variable and scaled in engineering units.
3. All analog switches used for interlocking and control:
    a. Executed in PLC logic.
    b. Configured with a dead band and time delay to prevent nuisance tripping.
    c. Provide supervisor access through the HMI to the analog switch set points.
    d. Switch computations executed in values scaled to engineering units.

F. Run-Time Counters:

1. Provide a run-time counter for all equipment that has an ON signal to the PLC.
2. Increment run time counters after each tenth of an hour of operation.
3. Maintain a nonresetable 99,999.9 hour cumulative counter that rolls over to zero after 99,999.9 hours.
4. Indicate runtime counters on appropriate HMI displays.
5. Perform all run time summing in the PLC.
6. Unless otherwise noted, provide supervisor-accessible reset of run time counter.

G. Cycle counters:

1. Provide cycle counters for all equipment that has an ON signal to the PLC.
2. Maintain a non-resetable 99,999 start cumulative counter that rolls over to zero after 99,999 counts.
3. Indicate cycle counters on appropriate HMI displays.
4. Perform all counting in the PLC.
5. One cycle is defined as the transition from OFF to ON.
6. Unless otherwise noted, provide supervisor-accessible reset of cycle counter.

H. Totalization:

1. All flow and power signals, include computed values, shall be totalized (integrated with respect to time) in the PLC and the totalized values communicated to the HMI.

2. Totalizer shall be 6-digit: Select units such that totalizer would reach 999,999 if the input remained at full scale continuously for an interval between 0.5 and 5 years.
3. Each totalizer shall reset to 0 at 30,000 counts or by a reset command, supervisor-accessible, from the HMI.
4. Totalizer computation shall occur at least once every 3 seconds.
5. A threshold detector shall be developed to inhibit the totalizer from totalizing until the process value is greater than a preset percentage of the scale range.
6. Indicate totals on the appropriate HMI display.
7. Perform integration in the PLC.
8. Unless otherwise noted, provide supervisor-accessible reset of totalized value.

I. Trending:

1. At intervals appropriate for the variable being trended, place the current value of analog variable, along with a time and date stamp, into a historical trend file for that variable. Display the trend on selectable HMI screens with appropriate scaling and units.
2. Trend all analog variables, including computed process analog variables.
   a. Controller tuning parameters do not need to be trended.
   b. Group related analog variables into trend groups.

J. Historical data collection and reporting:

1. Log each discrete input and output change of state.
2. Log each analog variable, including computed process analog variables using a compression scheme based on change from last log value: Controller tuning parameters do not need to be logged.
3. Totalizers, run timers, cycle counters and statistical values: Log hourly and prior to resets.
4. Maintain storage of trend, log, and alarm summary files for two years.
5. Provide a procedure for archiving to CD or DVD trend, log, and alarm summary files on a monthly basis.
6. Reports: as a minimum, one each of the following reports shall be provided:
   a. Monthly operations report.
   b. Monthly equipment runtime report.
   c. Monthly chemical use report.
7. Reports content:
   a. Report up to thirty process variables per report, as identified by the owner.
   b. Minimum, maximum, and average for each process variable over the time period identified by the report.
   c. Monthly totals in the case of flows or runtimes.

K. Communications watchdog (applies to any PLC or SCADA link):

1. Create a watchdog function to alarm at the HMI if any of the PLCs do not communicate within a preset time or when any PLC is unable to communicate with any I/O base. To avoid nuisance alarming, make the preset at least three times the nominal update period for the specific device. This nominal update period will be noted during startup. Provide a HMI operator adjustment for disabling communications alarming during extreme conditions such as storms or network outages. Additionally, when communications watchdog alarms is disabled, display a message at the HMI indicating this condition.
2. For PLC controlled equipment operating under HMI Manual control, maintain equipment in the last state following a loss of communications. For PLC controlled equipment under automatic PLC control, maintain automatic equipment control and sequencing during a loss of communications.

L. Ethernet Network Management:

1. Provide a network display for the network showing the status of every SNMP managed device including PLC and I/O Ethernet interfaces.
2. For unmanaged devices, provide OSI layer 1 heartbeat response and reply status indication.
3. Each server is connected to two switches. The design intent is to enable a server to maintain communication with the other network nodes should a single switch, or the server's connection to that switch, fail.

M. Bumpless Transfer:

1. Configure all "software" Manual/Auto switches to provide "bumpless transfer."
    a. Manual to Auto Transition:
        1) Once the transition occurs, immediately start the device if the Auto Mode so commands.
        2) For modulating devices, initially maintain the last manual control variable output value on transition to Auto. After the transition, enable the automatic control algorithm to commence incrementally from the final manual value.
    b. Auto to Manual Transition:
        1) If a device has been running in Auto, configure so it continues to run once placed in Manual.
        2) If a device has not been running in Auto, configure so it does not run once placed in Manual.

3) If an adjustable speed device has been running at a certain speed in Auto, configure so it runs at the same speed once placed in Manual.
4) For all modulating devices, maintain the last analog control variable output value on transition to Manual.

1.02 STANDARD PLC/HMI FUNCTIONS BLOCKS

A. General: The follow Standard functions blocks specify the standard PLC/HMI functions block to be developed and used to implement the PLC/HMI requirements specified in the Loop Specifications.

B. Discrete HMI/PLC Mode Command and Feed Back Status: When the HMI commands the PLC to specific mode such as Auto or Manual, the HMI shall be configured with an Auto write command database point and a in Auto mode database status.

C. Analog HMI/PLC Read-Write Process: When an analog value such as set point or controller output is specified to be accessible to the operator, the HMI shall be configured to write to the PLC register through one database tag and then read back the variable written to the PLC through a second database tag.

D. Solenoid Valve Control:

1. Solenoid valves have OPEN-CLOSED-REMOTE (OCR) switches with an IN REMOTE input signal. PLC outputs include an OPEN signal (or CLOSE signal) to open (or close) the valve. The applications software shall prevent control of valve by the PLC unless the OCR switch is in the REMOTE position.
2. Equipment Available Statues: Provide equipment available status that is logically true when equipment is in REMOTE and HMI AUTO.
3. When the controlled valve is in REMOTE the HMI and PLC shall be configured to set the valve mode to HMI AUTO or HMI MANUAL. When the controlled valve is in HMI Manual the HMI and PLC shall be configured to Open and Close the valve from the HMI. When the Controlled valve is in HMI Auto the automatic PLC routine shall control the Open/Close position of the valve.
4. Provide a test input that to be used for System Testing. When the TEST input is true the OPEN (or OPEN/CLOSE) output shall be prohibited from energizing. When in this mode, the OPEN/CLOSE status points read by the HMI and used by the PLC logic will follow the command to OPEN/CLOSE, instead of the field OPEN/CLOSE inputs.

E. Equipment Order Control:

1. The order control function shall route control and feedback signals between controllers and devices.
2. The follow orders shall be provided for a set of N equipment items:
   a. 1, 2 …….N
   b. 2, 3 ……..N, 1
   c. and so on, until
   d. N, 1, 2 ……N-1
3. Automatic alternation shall be provided where specified.
   a. The alternation order shall be incremented in the order listed above.
   b. The specific unit process description will provide information on the trigger for automatic alternation.
   c. Automatic alternation parameters (e.g. run time) shall be preset, but adjustable.
4. A change to a new order, either through operator selection or automatic alternation trigger, shall not immediately start or stop equipment. The order change shall first take effect on the next start or stop due to other logic.
5. Provide an operator access to order and automatic alternation selection.

F. Proportional Integral Derivative (PID) Controller:

1. Provide the following features:
   a. Derivative Error.
   b. Anti-reset windup.
   c. Bumpless transfer:
      1) AUTO TO MAN.
      2) REMOTE SP to LOCAL SP.
   d. PV tracking.
   e. SP tracking.
   f. Set point initialization: Routine that initializes the set point to the value of process variable when the loop in set to Automatic.
   g. PV signal failure response: Unless otherwise noted, the Analog control shall be one shot into Manual when signal failure is detected on the Process variable. Provide a HMI alarm that indicates that the loop was set to MANUAL.
   h. Hold State: Output is frozen and controller values adjusted to provide bumpless transfer at exit from hold state.
   i. Deviation alarm: Provide a deviation alarm that is activated when the controller has been in AUTO and the difference between the active set point and process value have been greater than a preset amount for greater than a preset period.

2. Provide an operator accessible HMI control faceplate display for the controller.
    a. Unless otherwise indicated, include display of:
        1) Process value.
        2) Local set point.
        3) Remote set point, if required for controller.
        4) Output value.
        5) AUTO/MANUAL mode status.
        6) LOCAL/REMOTE set point status, if required for controller.
        7) Deviation alarm status.
    b. Unless otherwise indicated, include adjustment of:
        1) Local set point.
        2) Output value, when in manual.
        3) AUTO/MANUAL mode.
    c. Indicate, in proximity to display and adjustment objects, engineering units for parameters.
3. Provide a supervisor-accessible HMI tuning display for the controller:
    a. Provide for display and adjustment of gain, integral time and derivative time.
    b. Provide a means to enable/disable integral and derivative action.
    c. Provide for bias entry to be used when integral action is disabled.
    d. The tuning display shall have a trend that trends the Process Variable, Set point and Output.
    e. Indicate, in proximity to display and adjustment objects, engineering units for parameters.
4. Tune controller during startup to provide stable operation.

G. Cascade Controller:

1. Cascade controller shall consist of two PID controllers, each with all of the features provided for PID controller, unless noted otherwise.
2. The output of the master controller shall serve as the set point for the slave controller.
3. The master controller shall have no MANUAL output, this level of functionality is to be accomplished with the SLAVE controller operated in AUTO/LOCAL SETPOINT MODE.
4. The master controller shall be forced to MANUAL when the slave controller is in LOCAL SET POINT or MANUAL modes.
5. The operator accessible HMI control faceplate displays for the two PID controllers shall be combined to a single faceplate for the cascade controller. The display shall have a master or slave descriptor for each controller.

6. The supervisor-accessible HMI tuning displays for the controllers shall be combined to a single faceplate for the cascade controller. The display shall have a master or slave descriptor for each controller.

H. Chemical Dose Trim:

1. Inputs:
   a. Operator process variable set point.
   b. Current process variable value.
   c. Track command.
   d. Chemical flow set point.
2. Outputs:
   a. Trim (%).
3. Parameters:
4. Function:
   a. Use PID control to generate a trim output (%) to maintain the process variable value at the set point.
   b. When hold track command received hold the current values in the PID controller, set the trim to zero.

I. Flow Pacing:

1. Inputs:
   a. Equipment auto/manual status.
   b. Manual speed set point.
   c. Device ready.
   d. Flow (gpm).
   e. Operator dosage (mg/l).
   f. Trim (%).
   g. Bulk Strength (Percent active chemical) (%).
2. Outputs:
   a. Speed (%).
   b. Track command.
   c. Chemical flow set point (gph).
3. Parameters:
   a. Trim Range (mg/l).
   b. Stroke (%).
   c. Device capacity at 100% output and 100% stroke (gph).
   d. Bulk density (lbs/gal).
   e. Percent bulk strength (percent active chemical) (%).
4. Function:
   a. When device is in manual and ready, calculate the percent speed based on the operator entered speed set point.

b. When device is in auto and ready:
   1) Calculate the trim range using the operator input and the trim percent. The trim percent from the PID controller shall be scaled to flow using the scale factor. A 50 percent output shall scale to 0 gpm. Zero and 100 percent outputs shall scale to negative and positive scaling factor values.
   2) Calculate the demand flow of active chemical.

$$DemandFlow, ActiveChemical = 5.007x10^{-4} * TrimRange * Flow$$

   3) Calculate the percent output for the dosage required.

$$\%Ouput = \frac{1{,}000{,}000 * DemandFlow}{DeviceCapacity * Stroke * Bulkdensity * PercentBulkStrength}$$

J. Metering Pump Flow Computation:

1. Compute an estimated rate of chemical flow based upon:
   a. Metering pump speed input.
   b. Current stroke setting:
      1) This parameter shall be viewable at the HMI and modifiable at the HMI when the user is logged in at the Supervisor or Engineer level.
      2) Units for display and entry shall be percent of full stroke with resolution of 1 percent.
   c. Capacity of pump at 100 percent stroke and 100 percent speed:
      1) This parameter shall be viewable at the HMI and modifiable at the HMI when the user is logged in at the Supervisor or Engineer level.
      2) Units for display and entry shall be gph will a resolution of at least three significant figures.
2. Computed flow shall be the product of metering pump speed input (in percent), current stroke setting (in percent) and capacity of pump at 100 percent stroke and 100 percent speed.

K. Manual Equipment Control from the PLC:

1. Provide a HMI AUTO/MANUAL mode for PLC-controlled devices. In the HMI AUTO mode, the device shall operate as described in the Loop Specifications. In the HMI MANUAL mode, the operator shall control the device through Start/Stop or Open/Close commands from the HMI.
2. The software AUTO/MANUAL selection shall be allowed only when the device's panel switch is in the REMOTE position.
3. Provide MANUAL mode start and stop capability on all equipment, valves, and packaged systems (devices) that are controlled from the PLC, unless otherwise noted.
4. Receive a discrete variable from the HMI in the MANUAL mode, indicating that the device should start or stop (open or close).

5. When the device is in MANUAL, disable normal sequence of operations from controlling the device. Do not override shut-down interlocks.

L. Sequences:

1. Sequences specified in the loop descriptions shall have the following general requirements:
   a. All sequences shall be divided into individual steps and be a command report-back type sequence. For example, the PLC shall issue a command for a valve to open (or pump to start) and it will monitor the valve limit switches (or motor starter auxiliary contact or flow switch) to verify that it did open (or pump start). If the correct feedback status is not received within a preset time limit an individual failed alarm shall be initiated.
   b. Provide a tabular summary of the entire sequence on the HMI. Include the step number, a step description and timer presets for each step. Indicate, via highlighting or other means, the current step. Provide an indication of accumulated time for any timers in the current step. Provide for HMI adjustment of all timers with validity checking (i.e. limited ranges for inputs).
   c. Once a sequence has been started, it shall advance from one step to the next when all of the previous steps commanded by the PLC have been verified by the "report-back" portion of the program.
   d. Clarify, either through HMI notation or deactivation of graphic objects, when the sequence is presently in a condition where it can be started (i.e. transition from step 0 to step 1).
   e. Each sequence shall have a systems level MANUAL/OFF/AUTOMATIC control from the HMI. In the OFF mode the sequence shall be reset to the home, step 0. In the manual mode the sequence shall be started by a HMI START/STOP control. In the AUTOMATIC mode the sequence shall be started by the specified automatic control functions.
   f. If in any sequence step, unless otherwise noted, a device fails to respond to the control of the PLC the sequence shall stop and remain in the current step. The sequence shall remain in the failed step until the HMI start function is initiated. The sequence will then retest the current step and advance to the next step if the device has responded to the control action.
   g. Each sequence shall have a HMI JOG function. The JOG function shall advance the step by one, independent of the normal step advance conditionals and timers.
   h. Each sequence shall transmit bit variable indicating the active step to the HMI

1.03 UNIT PROCESS SPECIFIC CONTROL DESCRIPTIONS

A. General:

1. Each Unit Process's specific control loops are described in a contiguous section of text.
2. These control loop descriptions are limited to equipment added as a part of this Project. The contractor is responsible for re-configuration of existing controls as noted elsewhere in this Specification section.
3. These descriptions assume that a device is ready to operate if the operator has placed the device into the REMOTE mode.

B. Unit Process 2, Grit Removal:

1. P&IDs: 08-N-6001.
2. The supplier of the equipment used in this unit process will provide the primary control and monitoring of this system. That monitoring and control is described in the associated specification sections. The PIC system supplier shall configure the plantwide PLCs and HMI as needed to provide HMI monitoring of the I/O points wired to the plantwide PIC system.

C. Unit Process 5, Bioreactor Flow Approximation:

1. P&IDs: 008-N-6001A.
2. The flow of raw wastewater into the bioreactors shall be assumed to be equal to the flow of treated wastewater entering the UV unit process. That would be the sum of effluent flow plus plant water flow. Provide for operator entry of the status of each bioreactor: Online or Offline. The assumed flow to each bioreactor shall be 50% of the flow of treated wastewater entering the UV unit process when both bioreactors are online. The assumed flow to an online bioreactor shall be 100% of the flow of treated wastewater entering the UV unit process it is the only online reactor. The assumed flow to an offline reactor shall be 0.

D. Unit Process 5, Bioreactors:

1. P&IDs: 008-N-6002 and 008-N-6003.
2. The supplier of the equipment used in this unit process will provide the primary control and monitoring of this system. That monitoring and control is described in the associated specification sections.
3. The PIC system supplier shall configure the plantwide PLCs and HMI as needed to provide a monitoring and control interface on VTScada. Refer to the specification of the Bioreactor system for details of that interface.
    a. The PIC system supplier shall coordinate data exchange with the equipment vendor.

b. The PIC system supplier shall not alter the programs residing in the equipment vendor's hardware (e.g. PLC, operator interface, actuators).

E. Unit Process 5, Reaeration:

1. P&IDs: 008-N-6004.
2. Provide aeration header flow and flow split control and Equipment Order control as detailed below.
3. Flow Control:
   a. The blowers are VFD-driven. The blowers shall be sequenced and their speeds are modulated to maintain system flow.
   b. Use a PID algorithm to provide feedback manipulation of speed to control flow.
   c. LEAD blower shall be called to run when the flow setpoint is greater than a preset value corresponding to the minimum possible flow from single blower.
   d. Create an alarm when the flow to an online bioreactor is lower than an adjustable alarm limit.
   e. LAG blowers shall be added when the PID output has exceeded a preset high for a preset time period. Restart the blower-add timer after a blower is started.
   f. LAG blowers shall be dropped when the PID output has fallen below a preset low for a preset time period. Restart the blower-drop timer after a blower is started.
4. Flow Split Control:
   a. Flow Split Control shall be achieved by modulation of the position of 05FCV2301 and 05FCV2302.
      1) Provide an operator entry of the desired flow split
      2) When both reaeration zones are operating and 05FCV2301 and 05FCV2302 are both in auto.
         a) Sample the flow rates once every operator adjustable preset interval
         b) Open the valve connected to the basin with the flow below setpoint by 1 percent if:
            (1) The flow deviation is greater than 2 percent of setpoint
            (2) The valve is less than 85 percent open
            (3) The values of 1 percent, 2 percent and 85 percent are sample initial values. Each shall be operator adjustable and separate values for each valve.
         c) Close the valve connected to the basin with the flow above setpoint by 1 percent if:
            (1) The flow deviation is greater than 2 percent of setpoint

(2) Both valves are at least 85 percent open
(3) The values of 1 percent and 2 percent and 85 percent are sample initial values. They shall be the same as those values used for valve opening.

3) The valve for an active bioreactor shall be fully open if the valve for the other bioreactor is not in AUTO.

F. Unit Process 6, Secondary Clarification:

1. P&IDs: 008-N-6005, 008-N-6011.
2. Operation of the clarifier mechanism drive on the new and existing clarifier shall be manual. The operator shall be able to start or stop the mechanisms from the SCADA system.
3. The scum pump on the new clarifier shall be started and stopped to control level in the scum pit.
   a. The pump shall start and be latched into operation when either:
      1) 06LIT0303 is above a preset setpoint, or
      2) The level is above 06LSHH0303.
   b. The pump shall be stopped when either:
      1) 06LIT0303 is below a preset setpoint, or
      2) The level is below 06LSLL0303.
   c. An alarm shall be generated when the level is above 06LSHH0303.
   d. An alarm shall be generated when the level is below 06LSLL0303.
   e. Provide operator entry of the start and stop setpoints based on 06LIT0303.
   f. Provide an operator selection that disables the use of 06LIT0303 or 06LSHH0303 in starting.
   g. Provide an operator selection that disables the use of 06LIT0303 or 06LSLL0303 in stopping.

G. Unit Process 7, Filtration:

1. P&IDs: 008-N-6006.
2. The supplier of the equipment used in this unit process will provide the primary control and monitoring of this system. That monitoring and control is described in the associated specification sections. The PIC system supplier shall configure the plantwide PLCs and HMI as needed to provide HMI monitoring of the I/O points wired to the plantwide PIC system.

H. Unit Process 8, Ultraviolet (UV) Disinfection:

1. P&IDs: 008-N-6007.
2. The supplier of the equipment used in this unit process will provide the primary control and monitoring of this system. That monitoring and control is described in the associated specification sections.
3. The PIC system supplier shall configure the plantwide PLCs and HMI as needed to provide a monitoring and control interface on VTScada. Refer to the specification of the UV system for details of that interface.
    a. The PIC system supplier shall coordinate data exchange with the equipment vendor.
    b. The PIC system supplier shall not alter the programs residing in the equipment vendor's hardware (e.g. PLC, operator interface, actuators).

I. W3 Pumps:

1. P&IDs: 008-N-6007, 008-N-6012.
2. Provide pressure control using a Proportional Integral Derivative (PID) Controller and Equipment Order control as detailed below.
3. Pressure Control:
    a. Overview: The pumps are VFD-driven. The pumps shall be sequenced and their speeds are modulated to maintain system pressure.
    b. Use a PID algorithm to provide feedback manipulation of speed to control pressure.
    c. LEAD pump shall be called to run when the pressure, measured by 32PIT0401 is below a LOW pressure setpoint.
    d. LAG pumps shall be added when the PID output has exceeded a preset high for a preset time period. Restart the pump-add timer after a pump is started.
    e. LAG pumps shall be dropped when the PID output has fallen below a preset low for a preset time period. Restart the pump-drop timer after a pump is started.
    f. LEAD pump shall be dropped when 32PIT0401 is above a HIGH pressure setpoint.
    g. For each of the transitions above, provide logic which manipulates pump speeds during the transition to minimize flow transients and avoids placing pumps into a no flow (i.e. dead head) condition.
4. Equipment order control:
    a. Provide Automatic alternation in addition to fixed orders.
    b. Automatic alternation shall be triggered when the lag pump starts.

J. Unit Process 21, RAS Pumping:

1. P&IDs: 008-N-6008.
2. Provide closed loop feedback control modulating each RAS pump's speed to control its output flow rate. Feedback control shall be Proportional Integral Derivative.
3. Provide an option to have the flow setpoint for each RAS pumps flow controller set equal to an operator entered percentage multiplied by the total RAS flow setpoint.
    a. Force the three percentages to sum to 100 percent.
4. Provide for two methods of computing overall RAS flow rate setpoint and operator selection of mode:
    a. Direct entry (Local Setpoint).
    b. Product of total estimated flow entering UV reactor and operator entered ratio (Remote Setpoint).

K. Unit Process 21, WAS Pumping:

1. P&IDs: 008-N-6008.
2. Provide for operator entry of volume of sludge to be wasted from each clarifier and time of day for wasting to start.
    a. Each clarifier to have independent setpoints.
3. WAS pump shall start at operator-entered time of day and run until pumped volume exceeds operator-entered volume setpoint.

L. Unit Process 41, Alum Storage and Feed System:

1. P&IDs: 008-N-6009.
1. Alum shall be flow paced into each bioreactor.
2. The wastewater flow rates shall be based on approximations of the rates of wastewater entering each bioreactor. That approximation is described in Unit Process 5.
3. The alum target dose (mg/l) shall be an operator-entered HMI value.
4. The HMI shall provide a display of a suggested target dose based on an operator-entered HMI value of the phosphorus concentration and programmed equations converting this value to the suggested alum target dose (mg/l).

M. Unit Process 91, Electrical Infrastructure:

1. P&IDs: 008-N-6010.
2. Overview:
    a. Determine Switchgear power modes and power mode alarms based on monitored signals as follows:

State	Alarm	Utility Power OK	ATS in Utility Position	Emergency Power Available	ATS in Emergency Position
No Power	None	0	0	0	1
No Power	ATS signal	0	0	0	0
On Generator	None	0	0	1	1
No Power	ATS signal	0	0	1	0
No Power	None	1	0	0	1
No Power	ATS signal	1	0	0	0
On Generator	None	1	0	1	1
No Power	ATS signal	1	0	1	0
No Power	ATS signal	0	1	0	1
No Power	None	0	1	0	0
No Power	ATS signal	0	1	1	1
No Power	None	0	1	1	0
No Power	ATS signal	1	1	0	1
On Utility	None	1	1	0	0
No Power	ATS signal	1	1	1	1
On Utility	None	1	1	1	0

b. Create an HMI annunciation of alarms.

c. Monitor for SWITCHGEAR change in mode. Assume a power loss has occurred on change of mode.
   1) If in the No Power mode for an extended period, disable the automatic restart of devices on return of power.
   2) If not in the No Power mode for this extended period, start a timer on change to either generator or utility power modes. On completion of timer, begin power recovery.

d. Power Loss Recovery:
   1) Provide for re-enabling of loads at differing intervals on completion of timer initiating power recovery.
   2) Provide for separate re-enabling sequences for return to generator power and return to utility power.
      a) Completion of the return to generator power may not result in re-enabling of all loads.

e. The following details shall be established during the Loop Specifications and P&ID Review Workshop:
   1) The number of steps in the return to utility power sequence
   2) The loads re-enable at each step in the return to utility power sequence.

3) The intervals between steps in the return to utility power sequence.
4) The number of steps in the return to generator power sequence.
5) The loads re-enable at each step in the return to generator power sequence.
6) The intervals between steps in the return to generator power sequence.

f. Provide a graphic display of the Switchgear and generator that display the data provided by the Switchgear. Refer to Section 26 23 00 Low Voltage Switchgear for minimum required data exchange.

N. Unit Process 94, Plant Drain Pump Station:

1. P&IDs: 008-N-6011.
2. Overview: The PIC system supplier shall configure the plantwide PLCs and HMI as needed to provide HMI monitoring of the I/O points wired to the plantwide PIC system.

END OF SUPPLEMENT

Tag	Component Code	Component Descriptor	Notes
99-SVR-1	Y1	Computer, Server	
99-SVR-2	Y1	Computer, Server	
99-MON-1	Y2	Monitor, Large	
99-EWS-1	Y3	Computer, Laptop	Installed Software: Microsoft Windows 10 Professional, 64 bit Microsoft Office 2016 Rockwell Software Studio 5000 Logix Designer Bundle AVG Antivirus
99-ESW-1	Y4	Switch, Rackmount	Fiber port SFP modules: As shown on Network Diagram, plus 2 spare of same type
99-ESW-2	Y4	Switch, Rackmount	Fiber port SFP modules: None
ENS-700	Y5	Switch, Panel Mounted	
ENS-800	Y5	Switch, Panel Mounted	
ENS-100	Y5	Switch, Panel Mounted	
PLC-700	Y6	Programmable Logic Controller	
PLC-800	Y6	Programmable Logic Controller	
99-FW-1	Y6	Firewall	

CONTROL PANEL SCHEDULE								
Tag	Ingress Protection	Material	Maximum External Dimensions (inches)	Space Heater	Internal Panel Lights and Service Outlets	Environment	Details	Notes
WWTPCP700	NEMA 12	Painted Steel	90Hx72Wx24D	None	Required	Inside, Air Conditioned	4091-409G	
WWTPCP800	NEMA 4X	316 SST	48Hx36Wx12D	Required	Required	Outside, Corrosive	4091-409G	Provide solar shields on top, sides and back, coordinate with mounting rack dimensions
41FP0501	NEMA 4X	316 SST	30Hx24Wx8D	Required	Not Required	Outside, Corrosive	4091-411G	

INSTRUMENT LIST						
TAG NO	FUNCTION	ACCESSORY TAG 1	COMP_CODE	INSTRUMENT NAME	P+ID NO	OPTIONS
02FI5301			F16	FLOW ELEMENT, ROTAMETER	008-N-6001	Flow Range: 0 to 20 gpm
02FI5901			F16	FLOW ELEMENT, ROTAMETER	008-N-6001	Flow Range: 0 to 50 gpm
02LSH5801			L18	LEVEL SWITCH, NON MERCURY	008-N-6001	Setpoint: EL 833 ft
02PI5401			P04	PRESSURE GAUGE	008-N-6001	Range: 0 to 30 psig
02PI5701			P04	PRESSURE GAUGE	008-N-6001	Range: 0 to 60 psig
02PI6001			P04	PRESSURE GAUGE	008-N-6001	Range: 0 to 60 psig
02PE5401			P15	PRESSURE SEAL, ANNULAR	008-N-6001	
05LE0401		05LIT0401	L05	LEVEL ELEMENT & TRANSMITTER, ULTRASONIC	008-N-6001A	Calibrated Range: 0 to 6 feet Zero Reference: EL 826 feet
05LSH0301			L18	LEVEL SWITCH, NON MERCURY	008-N-6001A	Setpoint: EL 831 feet
05AE0801	ORP		A05	ORP ELEMENT AND TRANSMITTER	008-N-6002	Calbrated Range: -1200 to 1200 mV
05UT0801			A100	MULTIPARAMETER CONTROLLER	008-N-6002	
05UT0901			A100	MULTIPARAMETER CONTROLLER	008-N-6002	
05UT1001			A100	MULTIPARAMETER CONTROLLER	008-N-6002	
05UT1101			A100	MULTIPARAMETER CONTROLLER	008-N-6002	
05AN2901	FILTER	05AX2901[PUMP]	A101	SAMPLE PREPARATION SYSTEM	008-N-6002	
05AE0901	DO		A20	DISSOLVED OXYGEN ELEMENT & TRANSMITTER	008-N-6002	Calbrated Range: 0 to 9 mg/l
05AE1001	DO		A20	DISSOLVED OXYGEN ELEMENT & TRANSMITTER	008-N-6002	Calbrated Range: 0 to 9 mg/l
05AE1101	DO		A20	DISSOLVED OXYGEN ELEMENT & TRANSMITTER	008-N-6002	Calbrated Range: 0 to 9 mg/l
05AE2901	PO4		A48	PHOSPHATE ANALYZER	008-N-6002	Calbrated Range: 0 to 15 mg/l
05FE2201		05FIT2201	F51	FLOW ELEMENT & TRANSMITTER, THERMAL MASS FLOW	008-N-6002	Calbrated Range:0 to 500 scfm
05LE2801		05LIT2801	L05	LEVEL ELEMENT & TRANSMITTER, ULTRASONIC	008-N-6002	Calibrated Range: 0 to 6 feet Zero Reference: EL 826 feet
05AE0802	ORP		A05	ORP ELEMENT AND TRANSMITTER	008-N-6003	Calbrated Range: -1200 to 1200 mV
05UT0802			A100	MULTIPARAMETER CONTROLLER	008-N-6003	
05UT0902			A100	MULTIPARAMETER CONTROLLER	008-N-6003	
05UT1002			A100	MULTIPARAMETER CONTROLLER	008-N-6003	
05UT1102			A100	MULTIPARAMETER CONTROLLER	008-N-6003	
05AN2902	FILTER	05AX2902[PUMP]	A101	SAMPLE PREPARATION SYSTEM	008-N-6003	
05AE0902	DO		A20	DISSOLVED OXYGEN ELEMENT & TRANSMITTER	008-N-6003	Calbrated Range: 0 to 9 mg/l
05AE1002	DO		A20	DISSOLVED OXYGEN ELEMENT & TRANSMITTER	008-N-6003	Calbrated Range: 0 to 9 mg/l
05AE1102	DO		A20	DISSOLVED OXYGEN ELEMENT & TRANSMITTER	008-N-6003	Calbrated Range: 0 to 9 mg/l
05AE2902	PO4		A48	PHOSPHATE ANALYZER	008-N-6003	Calbrated Range: 0 to 15 mg/l
05FE2202		05FIT2202	F51	FLOW ELEMENT & TRANSMITTER, THERMAL MASS FLOW	008-N-6003	Calbrated Range:0 to 500 scfm
05LE2802		05LIT2802	L05	LEVEL ELEMENT & TRANSMITTER, ULTRASONIC	008-N-6003	Calibrated Range: 0 to 6 feet Zero Reference: EL 826 feet
05PIT6001			P09	PRESSURE TRANSMITTER, ELECTRONIC	008-N-6004	Calbrated Range: 0 to 10 psig
06LT0303		06LX0303	L142	LEVEL ELEMENT/TRANSMITTER, SUBMERSIBLE, WASTEWATER	008-N-6005	Range: 0 to 14 ft Zero Reference: Pit floor
06LSHH0303			L18	LEVEL SWITCH, NON MERCURY	008-N-6005	Setpoint: EL 824 ft
06LSLL0303			L18	LEVEL SWITCH, NON MERCURY	008-N-6005	Setpoint: EL 815 ft
06PI0703			P04	PRESSURE GAUGE	008-N-6005	Range: 0 to 60 psig
06PE0703			P15	PRESSURE SEAL, ANNULAR	008-N-6005	
07LSHH0101			L18	LEVEL SWITCH, NON MERCURY	008-N-6006	Setpoint: 1" below overflow weir
08FE5101		08FIT5101	L05	LEVEL ELEMENT & TRANSMITTER, ULTRASONIC	008-N-6007	Calbrated Range: 0 to 4200 gpm

INSTRUMENT LIST						
TAG NO	FUNCTION	ACCESSORY TAG 1	COMP_CODE	INSTRUMENT NAME	P+ID NO	OPTIONS
21FE2901		21FIT2901	F04	FLOW ELEMENT & TRANSMITTER, ELECTROMAGNETIC	008-N-6008	Line Size: As shown Calibrated range: 0 to 1000 gpm
21FE2902		21FIT2902	F04	FLOW ELEMENT & TRANSMITTER, ELECTROMAGNETIC	008-N-6008	Line Size: As shown Calibrated range: 0 to 1000 gpm
21FE2903		21FIT2903	F04	FLOW ELEMENT & TRANSMITTER, ELECTROMAGNETIC	008-N-6008	Line Size: As shown Calibrated range: 0 to 1000 gpm
22FE3001		21FIT3001	F04	FLOW ELEMENT & TRANSMITTER, ELECTROMAGNETIC	008-N-6008	Line Size: As shown Calibrated range: 0 to 500 gpm
22FE3002		21FIT3002	F04	FLOW ELEMENT & TRANSMITTER, ELECTROMAGNETIC	008-N-6008	Line Size: As shown Calibrated range: 0 to 500 gpm
22FE3003		21FIT3003	F04	FLOW ELEMENT & TRANSMITTER, ELECTROMAGNETIC	008-N-6008	Line Size: As shown Calibrated range: 0 to 500 gpm
21PI2201			P04	PRESSURE GAUGE	008-N-6008	Range: -30" Hg/15psig
21PI2202			P04	PRESSURE GAUGE	008-N-6008	Range: -30" Hg/15psig
21PI2203			P04	PRESSURE GAUGE	008-N-6008	Range: -30" Hg/15psig
21PI2301			P04	PRESSURE GAUGE	008-N-6008	Range: -30" Hg/15psig
21PI2302			P04	PRESSURE GAUGE	008-N-6008	Range: -30" Hg/15psig
21PI2303			P04	PRESSURE GAUGE	008-N-6008	Range: -30" Hg/15psig
21PI2701			P04	PRESSURE GAUGE	008-N-6008	Range: 0 to 30 psig
21PI2702			P04	PRESSURE GAUGE	008-N-6008	Range: 0 to 30 psig
21PI2703			P04	PRESSURE GAUGE	008-N-6008	Range: 0 to 30 psig
21PI2801			P04	PRESSURE GAUGE	008-N-6008	Range: 0 to 30 psig
21PI2802			P04	PRESSURE GAUGE	008-N-6008	Range: 0 to 30 psig
21PI2803			P04	PRESSURE GAUGE	008-N-6008	Range: 0 to 30 psig
21PE2201			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2202			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2203			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2301			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2302			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2303			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2701			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2702			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2703			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2801			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2802			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
21PE2803			P15	PRESSURE SEAL, ANNULAR	008-N-6008	
41LE0401		41LIT0401	L05	LEVEL ELEMENT & TRANSMITTER, ULTRASONIC	008-N-6009	Range: 0 to 7 feet Zero Reference: Tank Bottom
41LSH0301			L25	LEVEL SWITCH, FLOOR FLOODING	008-N-6009	Setpoint: 6" above sump bottom
41HS0501	SILENCE		M26	HAND SWITCH & LIGHT, CORROSION, ROUND	008-N-6009	
41HS0502	TEST		M26	HAND SWITCH & LIGHT, CORROSION, ROUND	008-N-6009	
41LLH0301			M26	HAND SWITCH & LIGHT, CORROSION, ROUND	008-N-6009	
41LAX0501	HORN		M30	HORN, INDOOR/OUTDOOR	008-N-6009	
41LAH0501	BEACON		M31	WARNING LIGHT, INDOOR/OUTDOOR	008-N-6009	
41LI0501			S12	INDICATOR, FIELD MOUNT	008-N-6009	
06LT0301		06LX0301	L142	LEVEL ELEMENT/TRANSMITTER, SUBMERSIBLE, WASTEWATER	008-N-6011	Range: 0 to 14 ft Zero Reference: Pit floor
06LT0302		06LX0302	L142	LEVEL ELEMENT/TRANSMITTER, SUBMERSIBLE, WASTEWATER	008-N-6011	Range: 0 to 14 ft Zero Reference: Pit floor

INSTRUMENT LIST						
TAG NO	FUNCTION	ACCESSORY TAG 1	COMP_CODE	INSTRUMENT NAME	P+ID NO	OPTIONS
06LSHH0301			L18	LEVEL SWITCH, NON MERCURY	008-N-6011	Setpoint: EL 824 ft
06LSHH0302			L18	LEVEL SWITCH, NON MERCURY	008-N-6011	Setpoint: EL 824 ft
06LSLL0301			L18	LEVEL SWITCH, NON MERCURY	008-N-6011	Setpoint: EL 815 ft
06LSLL0302			L18	LEVEL SWITCH, NON MERCURY	008-N-6011	Setpoint: EL 815 ft
06PI0701			P04	PRESSURE GAUGE	008-N-6011	Range: 0 to 60 psig
06PI0702			P04	PRESSURE GAUGE	008-N-6011	Range: 0 to 60 psig
06PE0701			P15	PRESSURE SEAL, ANNULAR	008-N-6011	
06PE0702			P15	PRESSURE SEAL, ANNULAR	008-N-6011	
32FE0501		32FIT0501	F04	FLOW ELEMENT & TRANSMITTER, ELECTROMAGNETIC	008-N-6012	Line Size: As shown Calibrated range: 0 to 200 gpm
32PI0201			P04	PRESSURE GAUGE	008-N-6012	Range: 0 to 200 psig
32PSH0401			P08	PRESSURE SWITCH, FIXED DEAD BAND	008-N-6012	Setpoint: 120 psig
32PSL0401			P08	PRESSURE SWITCH, FIXED DEAD BAND	008-N-6012	Setpoint: 85 psig
32PIT0401			P09	PRESSURE TRANSMITTER, ELECTRONIC	008-N-6012	Calibrated range: 0 to 200 psig

PLC NO	IO_TAG	IO_TYPE	P+ID NO
PLC-700	05BLR5301_SF	AI	008-N-6004
PLC-700	05BLR5302_SF	AI	008-N-6004
PLC-700	06LT0301_LEVEL	AI	008-N-6011
PLC-700	06LT0302_LEVEL	AI	008-N-6011
PLC-700	06LT0303_LEVEL	AI	008-N-6005
PLC-700	08F5101_FLOW	AI	008-N-6007
PLC-700	21PMP2001_SF	AI	008-N-6008
PLC-700	21PMP2002_SF	AI	008-N-6008
PLC-700	21PMP2003_SF	AI	008-N-6008
PLC-700	21F2901_FLOW	AI	008-N-6008
PLC-700	21F2902_FLOW	AI	008-N-6008
PLC-700	21F2903_FLOW	AI	008-N-6008
PLC-700	21F3001_FLOW	AI	008-N-6008
PLC-700	21F3002_FLOW	AI	008-N-6008
PLC-700	21F3003_FLOW	AI	008-N-6008
PLC-700	32PMP0101_SF	AI	008-N-6007
PLC-700	32PMP0102_SF	AI	008-N-6007
PLC-700	32PIT0401_PRESSURE	AI	008-N-6012
PLC-700	32FI0501_FLOW	AI	008-N-6012
PLC-700	41PMP0101_SF	AI	008-N-6009
PLC-700	41PMP0102_SF	AI	008-N-6009
PLC-700	41PMP0103_SF	AI	008-N-6009
PLC-700	41LE0401_LEVEL	AI	008-N-6009
PLC-700	05BLR5301_SK	AO	008-N-6004
PLC-700	05BLR5302_SK	AO	008-N-6004
PLC-700	08FE5201_FLOW	AO	008-N-6007
PLC-700	21PMP2001_SK	AO	008-N-6008
PLC-700	21PMP2002_SK	AO	008-N-6008
PLC-700	21PMP2003_SK	AO	008-N-6008
PLC-700	32PMP0101_SK	AO	008-N-6007
PLC-700	32PMP0102_SK	AO	008-N-6007
PLC-700	41PMP0101_SK	AO	008-N-6009
PLC-700	41PMP0102_SK	AO	008-N-6009
PLC-700	41PMP0103_SK	AO	008-N-6009
PLC-700	05BLR5301_FA	DI	008-N-6004
PLC-700	05BLR5301_IR	DI	008-N-6004
PLC-700	05BLR5301_OFF	DI	008-N-6004
PLC-700	05BLR5301_YS	DI	008-N-6004
PLC-700	05BLR5302_FA	DI	008-N-6004
PLC-700	05BLR5302_IR	DI	008-N-6004
PLC-700	05BLR5302_OFF	DI	008-N-6004
PLC-700	05BLR5302_YS	DI	008-N-6004
PLC-700	06SCM0201_IR	DI	008-N-6011
PLC-700	06SCM0201_NSH	DI	008-N-6011
PLC-700	06SCM0201_NSHH	DI	008-N-6011

PLC NO	IO_TAG	IO_TYPE	P+ID NO
PLC-700	06SCM0201_OFF	DI	008-N-6011
PLC-700	06SCM0201_YS	DI	008-N-6011
PLC-700	06SCM0202_IR	DI	008-N-6011
PLC-700	06SCM0202_NSH	DI	008-N-6011
PLC-700	06SCM0202_NSHH	DI	008-N-6011
PLC-700	06SCM0202_OFF	DI	008-N-6011
PLC-700	06SCM0202_YS	DI	008-N-6011
PLC-700	06SCM0203_IR	DI	008-N-6005
PLC-700	06SCM0203_NSH	DI	008-N-6005
PLC-700	06SCM0203_NSHH	DI	008-N-6005
PLC-700	06SCM0203_OFF	DI	008-N-6005
PLC-700	06SCM0203_YS	DI	008-N-6005
PLC-700	06XA0203_SHEAR.PIN	DI	008-N-6005
PLC-700	06LSHH0301_HI-HI LEVEL	DI	008-N-6011
PLC-700	06LSLL0301_LO-LO LEVEL	DI	008-N-6011
PLC-700	06LSHH0302_HI-HI LEVEL	DI	008-N-6011
PLC-700	06LSLL0302_LO-LO LEVEL	DI	008-N-6011
PLC-700	06LAHH0303_HI-HI LEVEL	DI	008-N-6005
PLC-700	06LALL0303_LO-LO LEVEL	DI	008-N-6005
PLC-700	06PMP0501_FA	DI	008-N-6011
PLC-700	06PMP0501_IR	DI	008-N-6011
PLC-700	06PMP0501_OFF	DI	008-N-6011
PLC-700	06PMP0501_TSH	DI	008-N-6011
PLC-700	06PMP0501_XSH	DI	008-N-6011
PLC-700	06PMP0501_YS	DI	008-N-6011
PLC-700	06PMP0502_FA	DI	008-N-6011
PLC-700	06PMP0502_IR	DI	008-N-6011
PLC-700	06PMP0502_OFF	DI	008-N-6011
PLC-700	06PMP0502_TSH	DI	008-N-6011
PLC-700	06PMP0502_XSH	DI	008-N-6011
PLC-700	06PMP0502_YS	DI	008-N-6011
PLC-700	06PMP0503_FA	DI	008-N-6005
PLC-700	06PMP0503_IR	DI	008-N-6005
PLC-700	06PMP0503_OFF	DI	008-N-6005
PLC-700	06PMP0503_TSH	DI	008-N-6005
PLC-700	06PMP0503_XSH	DI	008-N-6005
PLC-700	06PMP0503_YS	DI	008-N-6005
PLC-700	07LSHH0101_HI-HI LEVEL	DI	008-N-6006
PLC-700	07LAHH0201_HIGH LEVEL	DI	008-N-6006
PLC-700	07LAHH0202_HIGH LEVEL	DI	008-N-6006
PLC-700	07PMP0301_OFF	DI	008-N-6006
PLC-700	07PMP0302_OFF	DI	008-N-6006
PLC-700	07PDD0501_OFF	DI	008-N-6006
PLC-700	07PDD0502_OFF	DI	008-N-6006
PLC-700	07FLT0601_BACKWASH	DI	008-N-6006

PLC NO	IO_TAG	IO_TYPE	P+ID NO
PLC-700	07FLT0601_FA	DI	008-N-6006
PLC-700	07FLT0601_YS	DI	008-N-6006
PLC-700	07FLT0602_BACKWASH	DI	008-N-6006
PLC-700	07FLT0602_FA	DI	008-N-6006
PLC-700	07FLT0602_YS	DI	008-N-6006
PLC-700	08LCP0101_CRITICAL INST FAIL	DI	008-N-6007
PLC-700	08LCP0101_HI PRIORITY ALRM	DI	008-N-6007
PLC-700	08LCP0101_LOW PRIORITY ALRM	DI	008-N-6007
PLC-700	08LCP0101_RUNNING	DI	008-N-6007
PLC-700	08LCP0101_UV DOSE FAIL	DI	008-N-6007
PLC-700	21PMP2001_FA	DI	008-N-6008
PLC-700	21PMP2001_IR	DI	008-N-6008
PLC-700	21PMP2001_OFF	DI	008-N-6008
PLC-700	21PMP2001_PSL	DI	008-N-6008
PLC-700	21PMP2001_YS	DI	008-N-6008
PLC-700	21PMP2002_FA	DI	008-N-6008
PLC-700	21PMP2002_IR	DI	008-N-6008
PLC-700	21PMP2002_OFF	DI	008-N-6008
PLC-700	21PMP2002_PSL	DI	008-N-6008
PLC-700	21PMP2002_YS	DI	008-N-6008
PLC-700	21PMP2003_FA	DI	008-N-6008
PLC-700	21PMP2003_IR	DI	008-N-6008
PLC-700	21PMP2003_OFF	DI	008-N-6008
PLC-700	21PMP2003_PSL	DI	008-N-6008
PLC-700	21PMP2003_YS	DI	008-N-6008
PLC-700	21PMP2101_FA	DI	008-N-6008
PLC-700	21PMP2101_IR	DI	008-N-6008
PLC-700	21PMP2101_OFF	DI	008-N-6008
PLC-700	21PMP2101_PSL	DI	008-N-6008
PLC-700	21PMP2101_YS	DI	008-N-6008
PLC-700	21PMP2102_FA	DI	008-N-6008
PLC-700	21PMP2102_IR	DI	008-N-6008
PLC-700	21PMP2102_OFF	DI	008-N-6008
PLC-700	21PMP2102_PSL	DI	008-N-6008
PLC-700	21PMP2102_YS	DI	008-N-6008
PLC-700	21PMP2103_FA	DI	008-N-6008
PLC-700	21PMP2103_IR	DI	008-N-6008
PLC-700	21PMP2103_OFF	DI	008-N-6008
PLC-700	21PMP2103_PSL	DI	008-N-6008
PLC-700	21PMP2103_YS	DI	008-N-6008
PLC-700	21ZSC3101_CLOSED	DI	008-N-6008
PLC-700	21ZSC3102_CLOSED	DI	008-N-6008
PLC-700	21ZSC3103_CLOSED	DI	008-N-6008
PLC-700	21ZSC3201_CLOSED	DI	008-N-6008
PLC-700	21ZSC3202_CLOSED	DI	008-N-6008

PLC NO	IO_TAG	IO_TYPE	P+ID NO
PLC-700	21ZSC3203_CLOSED	DI	008-N-6008
PLC-700	32PMP0101_FA	DI	008-N-6007
PLC-700	32PMP0101_IR	DI	008-N-6007
PLC-700	32PMP0101_OFF	DI	008-N-6007
PLC-700	32PMP0101_YS	DI	008-N-6007
PLC-700	32PMP0102_FA	DI	008-N-6007
PLC-700	32PMP0102_IR	DI	008-N-6007
PLC-700	32PMP0102_OFF	DI	008-N-6007
PLC-700	32PMP0102_YS	DI	008-N-6007
PLC-700	32PAH0401_HIGH PRESSURE	DI	008-N-6012
PLC-700	32PAL0401_LOW PRESSURE	DI	008-N-6012
PLC-700	41PMP0101_FA	DI	008-N-6009
PLC-700	41PMP0101_IR	DI	008-N-6009
PLC-700	41PMP0101_OFF	DI	008-N-6009
PLC-700	41PMP0101_YS	DI	008-N-6009
PLC-700	41PMP0102_FA	DI	008-N-6009
PLC-700	41PMP0102_IR	DI	008-N-6009
PLC-700	41PMP0102_OFF	DI	008-N-6009
PLC-700	41PMP0102_YS	DI	008-N-6009
PLC-700	41PMP0103_FA	DI	008-N-6009
PLC-700	41PMP0103_IR	DI	008-N-6009
PLC-700	41PMP0103_OFF	DI	008-N-6009
PLC-700	41PMP0103_YS	DI	008-N-6009
PLC-700	41LAH0301_HIGH LEVEL	DI	008-N-6009
PLC-700	41LAH0401_HIGH LEVEL	DI	008-N-6009
PLC-700	41TNK0601_LEAK	DI	008-N-6009
PLC-700	94PDP0201_YS	DI	008-N-6011
PLC-700	94PDP0202_YS	DI	008-N-6011
PLC-700	05BLR5301_RK	DO	008-N-6004
PLC-700	05BLR5302_RK	DO	008-N-6004
PLC-700	06SCM0201_RK	DO	008-N-6011
PLC-700	06SCM0202_RK	DO	008-N-6011
PLC-700	06SCM0203_RK	DO	008-N-6005
PLC-700	06PMP0501_RK	DO	008-N-6011
PLC-700	06PMP0502_RK	DO	008-N-6011
PLC-700	06PMP0503_RK	DO	008-N-6005
PLC-700	21PMP2001_RK	DO	008-N-6008
PLC-700	21PMP2002_RK	DO	008-N-6008
PLC-700	21PMP2003_RK	DO	008-N-6008
PLC-700	21PMP2101_RK	DO	008-N-6008
PLC-700	21PMP2102_RK	DO	008-N-6008
PLC-700	21PMP2103_RK	DO	008-N-6008
PLC-700	32PMP0101_RK	DO	008-N-6007
PLC-700	32PMP0102_RK	DO	008-N-6007
PLC-700	41PMP0101_RK	DO	008-N-6009

PLC NO	IO_TAG	IO_TYPE	P+ID NO
PLC-700	41PMP0102_RK	DO	008-N-6009
PLC-700	41PMP0103_RK	DO	008-N-6009
PLC-800	05LE0401_LEVEL	AI	008-N-6001A
PLC-800	05PIT6001_PRESSURE	AI	008-N-6004
PLC-800	02LCP0101_FA	DI	008-N-6001
PLC-800	02LCP0101_IA	DI	008-N-6001
PLC-800	02PMP0101_YS	DI	008-N-6001
PLC-800	02FV5201_ZOF	DI	008-N-6001
PLC-800	02FV5501_ZOF	DI	008-N-6001
PLC-800	02CLSFR5601_YS	DI	008-N-6001
PLC-800	02LAH5801_HIGH LEVEL	DI	008-N-6001
PLC-800	05LAH0301_HIGH LEVEL	DI	008-N-6001A

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. For air or water service, unless otherwise noted.
2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral differential pressure regulators:
   a. For water service.
   b. For air service for level ranges greater than 10 feet of water.
7. Rotameters for water service.
8. Manufacturers and Products:
   a. Fischer & Porter; Series 10A3130.
   b. Brooks; Series DS-1350.
   c. Or approved equal.

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Products:
   a. Anderson, Greenwood and Co.; Type M1.
   b. Evans.
   c. Or approved equal.

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
   a. Ashcroft Utility; Gauge Series 1000.
   b. Marsh; Standard Gauge Series.
   c. Ametek U.S.; Gauge Series P500.
   d. Acculite; Series 2000.
   e. Or approved equal.

D. Valve, Needle:

1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers and Products:
   a. Whitey; Model 21RF2.
   b. Hoke; 3700 Series.
   c. Or approved equal.

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Flomite 7100 Series.
   c. Or approved equal.

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Catalog No. RF or No. RS.
   b. Hoke; 3100 through 3300 Series.
   c. Or approved equal.

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Selecto-Mite Series.
   c. Or approved equal.

H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316 stainless steel.
   b. Handle: Black nylon.
   c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
   a. Whitey; Series 457.
   b. Hoke; Multi-Mite Series.
   c. Or approved equal.

I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
2. Materials: Aluminum construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO or approved equal.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
   a. Body: Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
   b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4.
6. Manufacturer and Product: ASCO; Red Hat Series 8260 or approved equal.

K. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.
2. Setscrew for outlet pressure adjustment.
3. Integral filter and relief valve.

4. Manufacturers and Products:
    a. Masoneilan; Series 77-4.
    b. Fisher; Series 67FR.
    c. Or approved equal.

L. Pressure Regulator, Water:

1. Materials:
    a. Body: Bronze.
    b. Spring Case: Cast iron.
    c. Seat Rings: Brass.
    d. Valve Disk and Holder: Buna-N and bronze.
    e. Diaphragm: Buna-N diaphragm.
2. Sizing: For maximum of 7 psi offset pressure.
3. Manufacturers and Products:
    a. Fisher; Controls Type 95H or 95L.
    b. Masoneilan; Series 17.
    c. Or approved equal.

M. Test Tap:

1. Manufacturers and Products:
    a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
    b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
    c. Parker; CPI Series precision quick couplings.
    d. Or approved equal.

N. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. Manufacturers:
    a. Parker-Hannifin.
    b. Swagelok tube fittings.
    c. Or approved equal.

O. Plastic Tubing and Fittings:

1. Tubing:
    a. Polyethylene capable of withstanding 190 psig at 175 degrees F.

b. Manufacturers and Products:
   1) Dekoron; Type P.
   2) Imperial Eastman; Poly-Flo black instrument tubing.
   3) Or approved equal.

2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.
      3) Or approved equal.

P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.

Q. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
   b. Manufacturers and Products:
      1) Parker Flodar; BA Series.
      2) Swagelok tube fittings.
      3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
      4) Or approved equal.
2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.
      4) Or approved equal.

R. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

S. Purge Set:

1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on Drawings and as required in this section.
2. Pressure Gauge Scale Range: 150 percent of the process variable.

3. Mounting:
    a. Within consoles, panels, or a separate enclosure as shown.
    b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.

T. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer's recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
4. Manufacturers:
    a. Globetray.
    b. Cope.
    c. Or approved equal.

U. Air Supply Sets:

1. Parts: Integrally Mounted:
    a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
    b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
    c. Pressure gauge.
    d. Inlet filter muffler.
    e. Power: 120V ac.
    f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
    g. Manufacturers and Products:
        1) ITT Pneumotive; GH Series.
        2) Gast.
        3) Or approved equal.
2. Simplex Air Supply Sets:
    a. Air Receiver: 2 gallons.
    b. Compressors: One.
3. Duplex Air Supply Sets:
    a. Air Receiver: 20 gallons.
    b. Compressors: Two.
    c. Automatic Failover Control: Factory set at 20 psig.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funneled shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Standard DIN rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: Minimum of one at each end of rail.
   g. Wire Preparation: Stripping only permitted.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
      5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
   j. Test Plugs: Soldered connections for 18 AWG wire.
      1) Pin Diameter: 0.079 inch.
      2) Quantity: 10, 20, 40 (need two plugs per test meter).
      3) Manufacturer and Product: Entrelec; Type FC2 or approved equal.
2. Terminal Block, General Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 24 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.

f. Spacing: 0.25 inch, maximum.
g. Test Sockets: One screw test socket 0.079-inch diameter.
h. Manufacturer and Product: Entrelec; Type M4/6.T or approved equal.

3. Terminal Block, Ground:
   a. Wire Size: 24 AWG to 10 AWG.
   b. Rated Wire Size: 10 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25 inch, maximum.
   e. Grounding: Electrically grounded to mounting rail.
   f. Manufacturer and Product: Entrelec; Type M4/6.P or approved equal.
4. Terminal Block, Blade Disconnect Switch:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 10 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body, orange switch.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.SNT or approved equal.
5. Terminal Block Diode:
   a. Rated Voltage: 24V dc.
   b. Rated Current: 30 ma.
   c. Wire Size: 16 AWG.
   d. Manufacturer and Product: Phoenix Contact ST-IN or approved equal.
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: LED diode 24V dc.
   h. Spacing: 0.512 inch, maximum.
   i. Manufacturer and Product: Entrelec; Type ML10/13.SFD or approved equal.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.

g. Indication: Neon lamp, 110V ac.
h. Leakage Current: 1.8 mA, maximum.
i. Spacing: 0.512 inch, maximum.
j. Manufacturer and Product: Entrelec; Type ML10/13.SFL or approved equal.

8. Terminal Block, Fused, 120V ac, High Current:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 35 amps.
   c. Wire Size: 18 AWG to 8 AWG.
   d. Rated Wire Size: 8 AWG.
   e. Color: Gray.
   f. Fuse: 13/32 inch by 1.5 inches.
   g. Spacing: 0.95 inch, maximum.
9. Manufacturer and Product: Entrelec; Type MB10/24.SF or approved equal.

B. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide holddown clips.
2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA or approved equal.
3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.

h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Push-to-test button.
k. Manufacturer and Product: Potter and Brumfield; Series KUP or approved equal.

4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP or approved equal.
5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V dc or 277V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   i. Time Delay Setpoint: As noted or shown.
   j. Mode of Operation: As noted or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.
   l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges or approved equal.

C. Surge Suppressors:

1. General:
   a. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
   b. Response: 5 nanoseconds maximum.
   c. Recovery: Automatic.
   d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
   e. Enclosure Mounted: Encapsulated inflame retardant epoxy.

f. Types:
    1) 120V ac Power Supply Connection.
    2) Analog Signal, in Control Panel.
    3) Analog Signal, in field.
    4) 120V ac Power Supply Connection and Analog Signal, in field.

2. Suppressors on 120V ac Power Supply Connections:
    a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
    b. First-Stage Clamping Voltage: 350 volts or less.
    c. Second-Stage Clamping Voltage: 210 volts or less.
    d. Power Supplies for Continuous Operation:
        1) Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
        2) All Other Applications: Minimum 30 amps at 130V ac.
3. Suppressors on Analog Signal Lines:
    a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
    b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform:
        1) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
        2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
        3) Maximum Loop Resistance: 18 ohms per conductor.
4. Manufacturers and Products:
    a. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series or approved equal.
    b. 120V ac Lines: Emerson Edco HSP-121 or approved equal.
    c. Field Mounted at Two-Wire Instruments:
        1) Encapsulated in stainless steel pipe nipples.
        2) Emerson Edco SS64 series or approved equal.
    d. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
        1) Enclosure:
            a) NEMA 4X Type 316 stainless steel with door.
            b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
        2) Emerson Edco; SLAC series or approved equal.

D. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
   a. Protect instruments from damage due to power supply failure.
   b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
   a. Type: Indicating.
   b. Mount so fuses can be easily seen and replaced.

E. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.

2.04 I&C COMPONENTS

A. A5 ORP Element and Transmitter:

1. General: Includes sensor and integral cable.
2. Method: Differential electrode.
3. Performance:
   a. Measuring Range: minus 1500 to plus 1500 mV.
   b. Sensitivity: plus or minus 0.5 mV.
4. Sensor:
   a. Environmental:
      1) Temperature: 32 to 122 degrees F.
      2) Pressure: 100 psi.
   b. Features:
      1) Temperature Element: NTC 300 ohm thermistor.
   c. Materials:
      1) Body: PEEK.

2) Electrode: Platinum.

5. Cable:
   a. Jacket: Polyurethane.
   b. Temperature: 221 degrees F, maximum.
   c. 4 conductor.
6. Manufacturer and Model:
   a. Hach RD1P5: Suitable for installation in Class 1, Division 2, Group D areas.
   b. Cables: Length as required for final installation locations.
   c. PVC Pole Mount Kit.
   d. Or approved equal.

B. A20 Dissolved Oxygen Sensor:

1. General: Measurement of dissolved oxygen in an aqueous solution. Includes body, CPVC ends, replaceable sensor cap and integral cable.
2. Method:
   a. The method of measuring dissolved oxygen shall be a probe using luminescent sensor technology.
      1) Blue LED light excites platinum based luminescent material in the probe. Red light shall be emitted by luminescent material with characteristics that are directly proportional to the amount of dissolved oxygen present. The red light shall be measured with a photo detector.
      2) Red LED light shall be used to zero the instrument between measuring cycles.
3. Performance Requirements:
   a. Measurement range: 0.01 to 20.00 mg/L.
   b. Resolution: 0.01 mg/L.
   c. Accuracy:
      1) Less than 5 ppm: plus or minus 0.1 ppm.
      2) Greater than 5 ppm: plus or minus 0.2 ppm.
   d. Repeatability: plus or minus 0.1 ppm.
   e. Response Time:
      1) Less than 40 seconds to 90 percent at 20 degrees C.
      2) Less than 60 seconds to 95 percent at 20 degrees C.
   f. Temperature sensor: PT100 integrated, external sensor.
   g. Temperature range: 0 to 50 degrees C.
   h. Temperature accuracy: plus or minus 0.2 degrees C.
   i. When connected to a multi-parameter digital controller the overall status of the instrument performance shall be displayed as a percentage value via a measurement indicator.
   j. When connected to a multi-parameter digital controller the overall time remaining until maintenance tasks are due shall be displayed in days.

4. Operational Criteria:
    a. Operating temperature: 0 to 50 degrees C.
    b. Relative humidity: 95 percent, noncondensing.
    c. Immersion depth: 15 meters (50 feet), maximum.
    d. Immersion pressure: 345 kPa, maximum.
    e. Sample pH range: 0.0 to 12.0.
    f. Distance, analyzer to sensor: 1000 meters, maximum.
5. Other:
    a. The probe shall be made of CPVC and Type 316 stainless steel – 1.4404.
    b. The probe shall be made with Viton o-rings.
    c. The probe shall be entirely corrosion-resistant and fully immersible.
    d. The probe utilizes a 1-inch NPT external thread for mounting hardware connections.
    e. The probe does not require sample conditioning or electrolyte solutions.
    f. The probe interface to the controller shall be MODBUS®.
    g. The operation of the probe shall not be affected by: H2S, pH, K+, Na+, Mg2+, Ca2+, NH4 +, Al3+, Pb2+, Cd2+, Zn2+, Cr (total), Fe2+, Fe3+, Mn2+, Cu2+, Ni2+, Co2+, CN–, NO3–, SO4 2–, S2–, PO4 3–, Cl–, Anion Active Tensides, Crude Oils, Cl2 < 4 ppm.
        1) The probe shall be factory calibrated and need no calibration or polarization prior to use.
6. Manufacturer and Model:
    a. Hach LDO Model 2 probe. Suitable for installation in Class 1, Division 2, Group D areas.
    b. Digital extension cables: Included if required for final installation locations.
    c. PVC Pole Mount Kit.
    d. Or approved equal.

C. A48 Phosphate Analyzer:

1. General: Measure phosphate concentration in aqueous solutions.
2. Method: Photometric method using vanado-molydan.
3. Performance:
    a. Measurement Range: 0.05 to 15 mg/L.
    b. Low Detection Limit: 0.05 mg/L.
    c. Accuracy: 2% +/- 0.05 mg/L
    d. Reproducibility: 2% +/- 0.05 mg/L
    e. Response Time: Less than 5 minutes, including sample preparation.
4. Sample conditions:
    a. Temperature 39 to 104 degrees F.

b. pH: 5 to 9.

5. Sample conditions:
   a. Temperature 39 to 104 degrees F.
   b. Humidity: 95 percent relative humidity, non-condensing.
6. Features:
   a. Automatic cleaning and calibration.
   b. Extensive self-diagnostics.
7. Data Transmission: Compatible with associated controller.
8. Construction: ASA UV-resistant, lockable housing, rated to IP 55.
9. Power Supply: 115 VAC, 60 Hz.
10. Digital Extension cables: Include if required for final installation locations.
11. Power box: Include if required for final installation locations
12. Manufacturer and Model: Analyzer: Hach Phosphax sc Phosphate Analyzer or approved equal.

D. A100 Multiparameter Controller:

1. General: A modular single or dual channel controller that works with analog sensor modules and/or digital sensors.
2. Type: Microprocessor-based sensor controller
3. Sensor connections:
   a. Change digital sensors connected to the controller by unplugging and plugging in sensors as necessary.
   b. Change analog sensor modules connected to the controller by unplugging and plugging analog sensor modules as necessary.
4. Features:
   a. The controller uses a menu-driven operation system.
   b. The controller display is graphic dot matrix LCD with LED backlighting.
   c. The controller is equipped with a real-time clock.
   d. The controller is equipped with two security levels.
   e. The controller is equipped with a data logger with RS-232 capability.
   f. The controller shall have worded operation menus in 19 languages.
   g. The controller is equipped with an SD card reader for data download and controller software upload.
5. Four electromechanical, UL rated, SPDT relays (Form C) are provided for user-configurable contacts rated 100 to 230 Vac, 5 Amp at 30 VDC resistive maximum.
   a. The following can be programmed:
      1) Alarm.
      2) Warning.
      3) Timer/scheduled cleaning.

4) Feeder control.
5) Event control.
6) Pulse width modulation.
7) Frequency modulation.

b. The following can be assigned:
1) Primary value measurement I.
2) Secondary value measurement I.
3) Tertiary value measurement I.
4) Quaternary value measurement I.
5) Primary value Measurement II.
6) Secondary value measurement II.
7) Tertiary value measurement II.
8) Quaternary value measurement II.
9) Real time clock.
10) Calculated values.

6. Two analog 0/4-20 mA outputs are provided with a maximum impedance of 500 ohms.
a. The controller can be equipped with three additional 4-20 mA outputs with a maximum impedance of 500 ohms.
b. The following can be programmed:
1) Alarms:
a) Low alarm point.
b) Low alarm point deadband.
c) High alarm point.
d) High alarm point deadband.
e) Off delay.
f) On delay.
2) Controls:
a) Linear.
b) Bi-linear.
c) Logarithmic.
d) PID.
c. The following can be assigned:
1) Primary value measurement I.
2) Secondary value measurement I.
3) Tertiary value measurement I.
4) Quaternary value measurement I.
5) Primary value measurement II.
6) Secondary value measurement II.
7) Tertiary value measurement II.
8) Quaternary value measurement II.
9) Calculated values.

7. The controller can be equipped with the following forms of communication:
a. MODBUS RS-232.
b. MODBUS RS-485.

c. Profibus DP.

8. All user settings of the controller are retained for 10 years in flash memory. M. The controller is equipped with a system check for:
   a. Power up test (monitoring and shutdown).
   b. Total power draw.
   c. Memory devices.
   d. Temperature mother board.
9. The controller has the option of graphical measurement that tracks measurement values over time.
10. Materials:
    a. Housing: polycarbonate, aluminum (powder coated), and stainless steel.
    b. Rating: NEMA 4X enclosure, rated IP66.
11. Environmental:
    a. Operational Criteria:
       1) Temperature: minus 4.0 to 140.0 degrees F (minus 20.0 to 60.0 degrees C).
       2) Relative humidity: 0 to 95 percent, non-condensing.
12. AC powered: 100 to 240 Vac plus or minus 10 percent, 50/60 Hz; 15 W with 7 W sensor/network card load, 37 W with 25 W sensor/network card load.
13. Certifications:
    a. EMC: CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits).
    b. Safety: General Purpose UL/CSA 61010-1 with cETLus safety mark.
14. Manufacturer and Model: Hach model sc200 Controller or approved equal.

E. A101 Sample Preparation System:

1. General: Designed to extract samples directly from activated sludge aeration basins and create high quality permeate. Includes filter module holder, control unit, suction hose and sample delivery hose.
2. Features:
   a. Automatic alternation of two cleaning elements and cleaning of offline filter.
   b. Air purge system.
   c. Self-diagnostics with three levels of error messages.
   d. Menu-driven operator interface.
   e. Flow rate readout.
3. Sample:
   a. Flow: Approximately 900 mL/hr.
   b. Suction: Up to 9 feet.

c. Delivery: Up to 90 feet.

4. Environmental:
   a. Temperature: minus 4 to 104 degrees F.
5. Filter module:
   a. Stainless steel holder.
   b. Ultra-filtration membrane.
6. Suction hose:
   a. Contains air compressor tubing and sample line.
   b. Suction Hose Heater: Do not connect power, insulate suction hose.
7. Control Unit:
   a. Contains two peristaltic sample pumps, air compressor and controller.
   b. Internally heated.
8. Installation kit: SS Pole Mounting kit.
9. Power: 115 or 230 Vac plus or minus 10 percent, 50/60 Hz.
10. Standards: UL, CSA and CE safety standards.
11. Manufacturer and Model: Hach Filtrax or approved equal.

F. F1 Flow Element – Parshall Flume Liner:

1. Type: Full length; single piece construction (through 60-inch size); polyester resin reinforced with not less than 30 percent fiberglass by weight. Flume shall have UV Stabilizing pigment in the Resin to provide long-term protection from UV.
2. Minimum wall thickness is 3/16-inch for throat widths to 9 inches; 1/4-inch for throat widths greater than 9 inches to 36 inches; and 3/8-inch for throat width greater than 36 inches. Provide 2-inch stiffening flanges on the top and ends of the flume.
3. Provide locking devices for engagement with the grout around the liner, integral reinforcing ribs, and removable top cross bracing to insure proper dimensions during shipment and installation.
4. Flume shall be provided with a 12-inch diameter stilling well.
5. Dimensions: Conform to U.S. Department of the Interior, Bureau of Reclamation, Water Measurement Manual. Dimensional tolerances for large flumes shall be plus or minus 1/8-inch (3 mm) maximum in the throat, and plus or minus 1/4-inch (6 mm) maximum elsewhere.
6. Schedule:

Tag	Flow Range (gpm)	Throat Width
Effluent channel, downstream of W3 pumps	0-7,240	12”

7. Acceptable Manufacturers: Plasti-Fab or Tracom or approved equal.

G. F4 Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
   b. Type:
      1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
      2) Full bore meter with magnetic field traversing entire flow-tube cross section.
      3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
   c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
   b. Flow Stream Descriptions: If and as described below.
3. Operating Temperature:
   a. Element:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.
4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.

6. Process Connection:
    a. Meter Size (diameter inches): As noted.
    b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
    c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
    a. Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.
    b. Liner Material:
        1) Teflon, unless otherwise noted.
        2) For potable water service, must have appropriate approvals.
    c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
    d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
    e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
    f. Grounding Ring:
        1) Required, unless otherwise noted.
        2) Quantity: Two, unless otherwise noted.
        3) Material: Type 316 stainless steel, unless otherwise noted.
    g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    h. Submergence:
        1) Temporary: If noted.
        2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
    i. Direct Buried (3 to 10 feet): If noted.
    j. Hazardous Area Certification:
        1) Class 1, Division 2, Groups A, B, C, D: If noted.
        2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
        3) Class 1, Division 1, Groups C, D, and FM approved: If noted.
9. Transmitter:
    a. Mounting: Surface (wall), unless otherwise noted.
    b. Display: Required, unless otherwise noted.
        1) Digital LCD display, indicating flow rate and total.
        2) Bi-directional Flow Display: Required, unless otherwise noted.
            a) Forward and reverse flow rate.
            b) Forward, reverse and net totalization.
    c. Parameter Adjustments: By keypad or non-intrusive means.
    d. Enclosure: NEMA 4X, minimum, unless otherwise noted.

e. Empty Pipe Detection:
   1) If noted.
   2) Drives display and outputs to zero when empty pipe detected.

10. Signal Interface (at Transmitter):
    a. Analog Output:
       1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
       2) Supports Superimposed Digital HART protocol: If noted.
    b. Discrete Outputs: If noted.
       1) Two discrete outputs, typical, rated for up to 30 volts, typical.
       2) Programmable as noted for the following typical parameters: Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.
    c. Discrete Input: If noted.
       1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
    d. Other: As noted.
11. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
12. Built-in Diagnostic System:
    a. Features:
       1) Field programmable electronics.
       2) Self-diagnostics with troubleshooting codes.
       3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
       4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Factory Ready for Future In situ Verifications: If noted.
    a. Original meter parameter values available from vendor by request.
15. Accessories:
    a. In situ Verification System: If noted.
       1) Quantity: One complete system provided for the Project.

2) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
3) Physical access to the flow-tube not required.
4) Meet standards established by the National Testing Laboratory.
5) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
6) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
7) Windows-based software

b. Primary Simulation System: If noted.
1) Quantity: One complete system provided for the Project.
2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
b) Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
c) Switch selectable for forward, reverse and zero flow rate.
3) Verifies various input and output signals.

16. Manufacturers:
a. Krohne: Optiflux 2000 with IFC 100 Signal Converter or approved equal.

H. F16 Flow Element, Rotameter:

1. General:
a. Function: Indicate flow rate.
b. Type: Variable area; float and tapered tube.
2. Service Conditions:
a. Process Fluid: Water, unless otherwise noted.
b. Temperature Range:
1) Process Fluid: 33 degrees F to 250 degrees F.
2) Ambient: 32 degrees F to 125 degrees F..
3. Performance:
a. Flowrate Range: As noted.
b. Accuracy: Plus or minus 2 percent of maximum flow, uncalibrated, over 12.5:1 turndown.
c. Repeatability: 0.5 percent of full scale.

4. Features:
    a. Nominal Length: 10 inches.
    b. Float Material: Type 316 stainless steel.
    c. Tube: Borosilicate glass.
    d. Seal:
        1) Type: O-ring, unless otherwise noted.
        2) Material: Buna-N, unless otherwise noted.
    e. Polycarbonate operator protection shield.
    f. Mounting: In line, unless otherwise noted.
    g. Scales: Direct-reading external metal scale, unless otherwise noted.
    h. Pressure Drop Design: Standard, unless otherwise noted.
5. Size and Process Connections:
    a. Connection Size: As noted or shown.
    b. Connection Material: Type 316 stainless steel, unless otherwise noted.
    c. Connection Type: Threaded NPT, unless otherwise noted.
    d. Connection Orientation: Vertical, unless otherwise noted.
6. Signal Interface: None, unless otherwise noted.
7. Manufacturers and Products: ABB; Series 10A4500 or approved equal.

I. Emerson Process Management Brooks; Series 1100 or approved equal.

J. F51 Flow Element and Transmitter, Thermal Mass Flow:

1. General:
    a. Function: Directly measure, indicate, and transmit mass flow of gas in pipe.
    b. Type: Insertion type, thermal dispersion detection probe using platinum resistance temperature detectors (RTD).
    c. Parts: Elements, transmitter, and interconnecting cable.
2. Performance:
    a. Process Gas: As noted or shown.
    b. Range for Air at 70 Degrees F and 14.7 psia:
        1) As noted, within the following:
            a) 0.25 to 1,600 standard fps.
            b) 0.25 to 200 actual fps.
    c. Calibrated Span: As noted.
    d. Accuracy:
        1) Flow: Plus or minus 1 percent of reading plus 0.5 percent full scale.
        2) Temperature: Plus or minus 2 degrees F.

e. Repeatability:
   1) Flow: Plus or minus 0.5 percent of reading.
   2) Temperature: Plus or minus 1 degree F.
f. Temperature, Operating:
   1) Flow Element: Minus 50 degrees F to plus 350 degrees F, unless otherwise noted.
   2) Transmitter Housing: 0 degree F to plus 150 degrees F.
g. Pressure, Operating, Flow Element: Up to 50 psig, unless otherwise noted.

3. Flow Element:
   a. Features:
      1) Insertion Length: As noted or manufacturer's recommendation.
      2) Wetted Surfaces Materials: Type 316 stainless steel with nickel braze, unless otherwise noted.
   b. Process Connection:
      1) Line Size: As noted or shown.
      2) Connection Type: Retractable sensor with graphite-packed gland with 1-1/4-inch MNPT, unless otherwise noted.
      3) Connection Material: Type 316 stainless steel, unless otherwise noted.
   c. Sensor Enclosure:
      1) Type: Aluminum, NEMA 4X, rated for Classes 1 and 2, Divisions 1 and 2, Groups B, C, D, E, F, G, and Eexd IIC; unless otherwise noted.
4. Transmitter:
   a. Features: 4-line by 20-character LCD, keypad programmable.
   b. Nonvolatile memory.
   c. Signal Interface:
      1) Outputs:
         a) Analog: Two isolated 4 mA to 20 mA dc for maximum 600 ohm load, unless otherwise noted.
         b) Discrete:
            (1) Two independently adjustable 10 amps at 115V ac or 24V dc.
            (2) Configurable as high or low flow or process temperature.
      2) Communication:
         a) RS-232C serial port enables remote adjustment and reading of process values and set points.
         b) Protocols: If and as noted.
   d. Power:
      1) Selectable: 115V ac, 230V ac, 24V dc.
   e. Electrical Connection: 1-inch FNPT.

f. Transmitter Enclosure:
   1) Type: Fiberglass NEMA 4X, unless otherwise noted.
   2) Mounting: Remote from sensor.
g. Single factory calibration, unless otherwise noted.

5. Cables:
   a. Length: As required.
   b. Cable Jacket: PVC rated for 220 degrees F, unless otherwise noted.
6. Manufacturer and Product:
   a. Fluid Components International; Model ST100 or approved equal.

K. L5 Level Element and Transmitter, Ultrasonic:

1. General:
   a. Function: Continuous, noncontacting level measurement.
   b. Type: Ultrasonic.
   c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.
2. Service:
   a. Application: If and as noted.
   b. Vapor Space Pressure: Atmospheric, unless otherwise noted.
   c. Operating Temperature Range:
      1) Element: Minus 4 degrees F to plus 149 degrees F.
      2) Transmitter: Minus 4 degrees F to 113 degrees F.
3. Performance:
   a. Range: As noted.
   b. Zero Reference: As noted.
   c. Accuracy: Plus or minus 0.25 percent of maximum range or 6 mm, whichever is greater.
   d. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
   e. Blanking Distance: Sensor dependent, typically 1 foot.
4. Element:
   a. NEMA 6P waterproof.
   b. Housing: PVDF, unless otherwise noted.
      1) Other materials subject to Engineer approval.
   c. Facing: None, unless otherwise noted.
   d. Integral Flange: If noted or shown.
      1) Face: PTFE, unless otherwise noted.
      2) Size: As noted.
   e. Process Connection:
      1) 1-inch NPT, unless otherwise noted or shown.
      2) Top mounted.
   f. Electrically Hazardous Rating:
      1) Class I, Div 1, Groups A, B, C, and D: If noted.
      2) Class II, Div 1, Groups E, F, and G: If noted.

3) Other Ratings: As noted.
g. Beam Angle: 12 degrees or less.
h. Integral temperature compensation.

5. Transmitter:
a. Display.
b. Integral keypad or nonintrusive external programming.
c. Enclosure: NEMA 4X polycarbonate, unless otherwise noted.
d. Power Supply: 115 volts, 50/60-Hz, unless otherwise noted.
e. Isolated Analog Output:
1) One Minimum: 4 mA to 20 mA dc for load impedance of 0 to 750 ohms.
f. Digital Communication: As noted.
g. Discrete Outputs:
1) Minimum, two relay (SPDT) rated for 2 amps continuous at 230V ac.
2) Assignable and as noted.

6. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.

7. Accessories:
a. Submergence Shield: If noted.
b. Remote Programming Software: If noted.
1) Allows remote programming via computer and echo traces for troubleshooting.
2) One per lot of units furnished.
c. Others: As noted.

8. Manufacturers and Products:
a. Siemens; SITRANS L, Model HydroRanger 200 and Sensor or approved equal.

L. L18 Level Switch, Non-Mercury:

1. General:
a. Function: Actuate contact at preset liquid level.
b. Type:
1) Direct-acting, 316 stainless steel float with enclosed, encapsulated switch and integral cable.
2) Mercury free.

2. Service (Liquid): Wastewater, unless otherwise noted.

3. Performance:
a. Setpoint: As noted.
b. Zero Reference: Tank or channel bottom, unless noted otherwise.
c. Differential: 6 inches maximum.
d. Temperature: 32 degrees F (nonfreezing) to 160 degrees F.

4. Features:
a. Entire Assembly: Watertight and impact-resistant.

b. Float:
   1) Material and Size: 5.5-inch diameter polymer-coated, Type 316 stainless steel float.
   2) Buoyancy: 2 pounds.
c. Cable:
   1) Length as noted or as necessary per mounting requirements.
   2) Plastic-jacketed cable, oil-resistant, and suitable for continuous service.
d. Mounting: Pipe, unless otherwise noted.
   1) Pipe Mounting:
      a) Cable clamp, suitable for connection to 1-inch pipe.
      b) Pipe-to-wall bracket, suitable for connection to 1-inch pipe.
   2) Anchor Mounting Kit: If noted.
      a) 15-pound vinyl-coated cast-iron anchor.
      b) 1/8-inch, Type 316 stainless steel wire rope.
      c) Stainless steel cable clips.

5. Signal Interface:
   a. Switch Type: Magnetic reed.
   b. Switch Contacts:
      1) Isolated, rated at least 0.8 amp continuous at 120V ac.
      2) Contact Type: Either NO or NC, as required by application or as noted; or SPDT (NO and NC).
6. Accessories: As noted.
7. Manufacturers and Products: Contegra; Model FS90 or approved equal.

M. L25, Level Switch, Floor Flooding:

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type: Direct acting; rises on stem.
2. Service: Liquid, water, wastewater, unless otherwise noted or shown.
3. Performance:
   a. Setpoint as noted or shown.
   b. Switch Actuation Point: Approximately one-half distance from end of stem to mounting.
   c. Operating Temperature Range: Minus 40 to plus 176 degrees F.
4. Features:
   a. Material: Polypropylene.
   b. Float Size: 1-inch diameter.
5. Mounting: Stem Mount: 1/8-inch NPT.
6. Signal Interface:
   a. Switch Type: Magnetic reed switch.
   b. Switch Contacts:
      1) Isolated, rated at 20 VA.

2) NO or NC (by inverting float on unit stem).
3) Lead Wires: 18 AWG.

7. Manufacturer and Product: GEMS; Single Station Liquid Level Switch, Model LS-3 or approved equal.

N. L142 Level Element/Transmitter, Submersible, Wastewater:

1. General:
   a. Function: Measure and transmit signal proportional to level.
   b. Type: Totally submersible pressure sensor (loop powered).
   c. Parts: Sensor, interconnecting cable, protective baffle plate, other parts as noted.
2. Service:
   a. Fluid: Wastewater, unless otherwise noted.
3. Performance:
   a. Process Range:
      1) As noted.
      2) Provide fixed factory range such that noted process range is between 40 and 80 percent of fixed factory range.
   b. Accuracy: 0.5 percent of full scale, unless otherwise noted.
   c. Temperature, Operating Ambient: Minus 40 to plus 150 degrees F.
   d. Temperature, Compensated: Zero to plus 140 degree F.
   e. Overpressure:
      1) Proof: 2.0 X full scale.
      2) Burst: 5.0 X full scale.
4. Features:
   a. Sensor:
      1) Stainless steel.
      2) 3-inch sensing diaphragm.
      3) Loop powered, 9-36V dc.
   b. Interconnecting Cable:
      1) Length: 40 feet.
      2) Hytel jacketed, unless otherwise noted.
      3) 1/2-inch NPT fitting with strain relief.
      4) Integral vent tube.
      5) Hydrophobic breather vent.
   c. Sensor Termination Enclosure: Required, unless otherwise noted.
      1) Enclosure: NEMA 4X, Type 316 stainless steel.
      2) Mounting holes.
      3) Houses such items as hydrophobic breather vent.
   d. Miscellaneous:
      1) Protective Standoff Plate: 3.75-inch diameter.
      2) All Type 316 stainless steel construction of sensor, baffle plate and housing.

e. Accessories:
1) As noted.
2) External lightning/surge protection: Required.

5. Signal Interface: 4 to 20 mA dc output, for load impedance of 0 to 750 ohms, minimum for 24V dc supply without load adjustment.
6. Electrical Connection: 1/2-inch NPT conduit.
7. Certification(s):
a. FM/CSA hazardous approvals: Required.
8. Manufacturers:
a. GP: 50 Model 311/Z-M351 or approved equal.

O. M26 Hand Switch and Light, Corrosion, Round:

1. General:
a. Function: Select, initiate, and display discrete control functions.
b. Type: Heavy-duty, corrosion-resistant, industrial.
2. General Features:
a. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.
b. Legend Plate: Standard size, square style laminate with white field and black markings, unless otherwise noted. Markings as shown, or as implied by P&IDs.
c. Configuration: Light, pushbutton, or switch as noted or shown.
3. Light Features:
a. Lights: 6V ac lamps and integral transformer for operation for operation from 120V ac, unless otherwise noted.
b. Lens Color: Color as specified, noted, or shown.
c. Push-to-test, unless otherwise noted.
d. Additional: As noted.
4. Pushbutton Features:
a. Operator: Single pushbutton, flush, unless otherwise noted.
b. Color: Black, unless otherwise noted.
c. Boot: None, unless otherwise noted.
d. Contact Arrangement: As required or shown.
e. Additional: As noted.
5. Selector Switch Features:
a. Operator: Knob, unless otherwise noted.
b. Color: Black, unless otherwise noted.
c. Boot: None, unless otherwise noted.
d. Positions: As required or shown.
e. Return: Manual, unless otherwise noted.
f. Contact Arrangement: As required or shown.
g. Additional: As noted.

6. Signal Interface:
    a. Contact Block:
        1) Type: Standard, unless otherwise noted.
        2) Materials: Silver amalgam, unless otherwise noted.
        3) Rating: 10 amps continuous at 120V ac, unless otherwise noted.
        4) Sequence: Break-before-make, unless otherwise noted or shown.
        5) Arrangement: Normally open or normally closed as shown, or to perform the functions noted.
7. NEMA Rating: NEMA 4, watertight, dust-tight, and NEMA 4X, corrosion-resistant.
8. Manufacturers and Products:
    a. Allen-Bradley; Bulletin 800H.
    b. Square D Co.; Class 9001, Type SK.
    c. Eaton Corp.; Cutler-Hammer, Type E34.
    d. Or approved equal.

P. M30 Horn, Indoor/Outdoor:

1. General:
    a. Function: Audible alarm. Produces sound by electro-mechanical vibration of a diaphragm.
2. Performance:
    a. Temperature, Operating: Minus 65 degrees F to 150 degrees F.
    b. Sound Output Level: 100 dB nominal at 10 feet (110 dB at 1 meter).
3. Features:
    a. Dimensions: 4-3/8 inches in height and width, and 2.5 inches in depth, for horn and enclosure.
    b. Body: Die-cast zinc.
    c. Diaphragm: Stainless steel.
    d. Projector: None, unless otherwise noted.
    e. Listings: UL, cUL listed, FM, CSA approved.
4. Enclosure:
    a. Type: Cast aluminum with neoprene-gasketed NEMA 4X housing.
    b. Mounting: Surface mount.
5. Power: 120V ac, 50/60-Hz, unless otherwise noted.
6. Manufacturer: Federal Signal Corp.; Model 350WB or approved equal.

Q. M31 Warning Light, Indoor/Outdoor:

1. General:
    a. Function: Visual alarm.

b. Type: Rotating reflector or flashing bulb.
c. Parts: Light and spare bulbs.

2. Performance:
   a. Temperature, Operating: Minus 35 degrees F to 190 degrees F.
   b. Flash Rate: Nominally 90 per minute.
3. Features:
   a. Dome: Polycarbonate.
   b. Dome Color: Amber, unless otherwise noted.
   c. Lamp Life: 200 hours.
   d. Lamp: Incandescent/25 watts.
4. Enclosure:
   a. Type: IP65 (NEMA 4X).
   b. Mounting: 1/2-inch pipe, unless otherwise noted.
   c. Listing: UL listed, CSA certified.
5. Power: 120V ac, 50/60-Hz.
6. Spare Bulbs: Provide two for each light.
7. Manufacturers: Federal Signal; Model 225 or approved equal.

R. P4 Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: Plus or minus 0.50 percent of full scale.
3. Features:
   a. Dial: 4-1/2-inch diameter.
   b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
      1) Liquid filled gauge front, unless otherwise noted.
         a) Glycerine fill, unless otherwise noted.
   c. Case Material: Black thermoplastic, unless otherwise noted.
   d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
      1) Stainless steel, unless otherwise noted.
   e. Pointer: Adjustable by removing ring and window.
   f. Window: Glass or acrylic, unless otherwise noted.
   g. Threaded reinforced polypropylene front ring.
   h. Case Type: Solid front with blow-out back.
4. Process Connection:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/2-inch MNPT, unless otherwise noted.

5. Accessories:
   a. Throttling Device: Required, unless otherwise noted.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.
6. Manufacturers and Products: Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS! Or approved equal.

S. P6 Pressure Seal, Diaphragm:

1. General:
   a. Function: Isolate sensing element from process fluid.
   b. Type:
      1) Diaphragm.
      2) Fluid filled between diaphragm and sensing element.
2. Service:
   a. Pressure: Same as associated sensor.
   b. Temperature Range: If noted.
3. Performance:
   a. Pressure:
      1) For threaded process connections, at least 2,500 psig at 100 degrees F.
      2) Glycerin Fill: Suitable only for pressure (not vacuum applications).
   b. Temperature:
      1) Dependent upon fill fluid:
         a) Glycerin (food grade): Zero to 400 degrees F.
         b) Silicone: Minus 40 degrees F to plus 600 degrees F.
         c) Silicone (food grade): Zero to 375 degrees F.
         d) Halocarbon: Minus 70 degrees F to 300 degrees F.
4. Features:
   a. Materials:
      1) Lower Housing: Type 316 stainless steel, unless otherwise noted.
      2) Diaphragm Material: Type 316 stainless steel, unless otherwise noted.
      3) Top Housing: Steel, unless otherwise noted.
   b. Diaphragm: Welded to upper housing, unless otherwise noted.
   c. Filling screw in upper housing.
   d. Fill Fluid:
      1) As noted.
      2) Or approved equal.
      3) Factory assembled and filled.
   e. Flushing Connection: 1/4-inch NPT in lower housing.
   f. Diaphragm Seal Displacement: 0.1 cubic inch, nominal.

5. Connections:
    a. Instrument: 1/2-inch female NPT, unless otherwise noted or shown.
    b. Process: 1/2-inch female NPT, unless otherwise noted or shown.
6. Manufacturers:
    a. Ashcroft; Type 201.
    b. Ametek; Mansfield and Green Division; Type SG.
    c. WIKA; Type L990.10.
    d. Or approved equal.

T. P8 Pressure Switch, Fixed Deadband:

1. General:
    a. Function: Monitor pressure.
    b. Type: Diaphragm actuated switch.
2. Performance:
    a. Setpoint:
        1) As noted.
        2) Repeatability: Plus or minus 1 percent.
    b. Range: Noted setpoint shall fall between 20 percent and 80 percent of range.
    c. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
    d. Operating Temperature Range:
        1) Dependent on actuator seal materials.
        2) For Buna-N seal, 0 degrees F to 150 degrees F.
3. Features:
    a. Actuator Seal: Buna-N, unless otherwise noted.
    b. Differential (deadband): Fixed.
    c. Reset: Automatic, unless otherwise noted.
    d. Mounting: Surface, unless otherwise noted.
4. Process Connection:
    a. 1/4-inch NPT female connections, unless otherwise noted.
    b. Materials: Nickel-plated brass, unless otherwise noted.
5. Enclosure: NEMA 4X.
6. Signal Interface:
    a. Contact Type:
        1) SPDT, unless otherwise noted.
        2) Rated for 10 amps minimum at 120V ac.
    b. Hermetically Sealed Switch: If noted.
7. Manufacturers and Products:
    a. Ashcroft; Type 400, B Series.
    b. United Electric; 400 Series.
    c. Or approved equal.

U. P9 Pressure Transmitter:

1. General:
   a. Function: Measure pressure and transmit signal proportional to pressure.
   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics”.
   c. Parts: Transmitter and accessories.
2. Performance:
   a. Range: As noted.
      1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
   b. Accuracy: Plus or minus 0.04 percent of span, unless otherwise noted.
   c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
   d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
   e. Humidity: 0 to 100 percent relative humidity.
   f. Hazardous Location Certifications: If and as noted.
3. Features:
   a. Type: Gauge pressure, unless otherwise noted.
   b. Adjustable damping.
   c. LCD indicator, unless otherwise noted.
      1) Display in either percent or engineering units, field configurable.
   d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
      1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
   e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
   f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
   g. Fill Fluid: Silicone, unless otherwise noted.
4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.

5. Signal Interface:
    a. 4mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
        1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
    b. FOUNDATION fieldbus protocol: If noted.
    c. Profibus: If noted.
6. Enclosure:
    a. Type: NEMA 4X.
    b. Materials: Coated aluminum, unless otherwise noted.
    c. Mounting bracket, unless otherwise noted.
        1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
    a. Two-valve (isolate and vent) Manifold: Required.
        1) Type 316 stainless steel.
8. Manufacturers and Products:
    a. Gauge Pressure Units: Rosemount; Model 3051.
    b. Absolute Pressure Units: Rosemount; Model 3051.
    c. Or approved equal.

V. P14 Pressure Gauge, Low Range:

1. General:
    a. Function: Local pressure indication.
    b. Type: Bellows or diaphragm capsules element(s).
2. Performance:
    a. Scale Range: As noted.
    b. Accuracy: Plus or minus 2.5 percent of span.
3. Features:
    a. Dial: 4-1/2-inch diameter.
    b. Case Material: Black thermoplastic, unless otherwise noted.
    c. Material of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components): Stainless steel, unless otherwise noted.
    d. Pointer: Adjustable by removing ring and window.
    e. Window: Glass or acrylic, unless otherwise noted.
    f. Threaded reinforced polypropylene front ring.
    g. Case Type: Solid front with blow-out back.
4. Process Connection:
    a. Mounting: Lower stem, unless otherwise noted.
    b. Size: 1/2-inch MNPT, unless otherwise noted.
5. Accessories:
    a. Throttling Device: Required, unless otherwise noted.
        1) Type and materials suitable for the intended service.

2) Install in gauge socket bore.

6. Manufacturers and Products:
   a. Ashcroft; Type 118X.
   b. Ametek U.S. Gauge; Solfrunt 4-1/2-inch Low Pressure Gauge, Model 1919/1929.
   c. WIKA; Type 6X2.34.
   d. Or approved equal.

W. P15 Pressure Seal, Annular:

1. General:
   a. Function:
      1) Sense pressure in a process line and transfer to pressure monitoring device.
      2) Protect attached pressure monitoring device from sludge or slurry.
   b. Type: Annular fluid-filled device that senses pressure through flexible sleeve around full pipe circumference.
2. Performance:
   a. Operating Conditions: Suitable for line pressures up to pipe flange rating.
3. Features:
   a. Construction:
      1) In-line, 8 Inches and Smaller: Full-faced thru-bolted with outside diameter same as mating flanges, unless otherwise noted.
      2) In-line, 10 Inches and Larger: Wafer style.
      3) Offline: Threaded, unless otherwise noted.
   b. Materials:
      1) Body: Carbon steel, unless otherwise noted.
      2) Flanges (where applicable): Carbon steel, unless otherwise noted.
      3) Flexible Sleeve: Buna-N, unless otherwise noted.
      4) Fill Fluid: Ethylene glycol/water or propylene glycol, unless otherwise noted.
   c. Factory Filled System:
      1) Filled and assembled with pressure monitoring device(s).
      2) Coordinate attached pressure monitoring device(s) with system integrator. Seal vendor’s standard pressure monitoring device(s) only acceptable if it meets specification of the related pressure monitoring device.
4. Process Connections:
   a. Mounting: In-line or offline, as noted or shown.
   b. Pipe Size:
      1) In-line: As noted or shown.
      2) Offline: 2 inches, unless otherwise noted.

c. Connections:
1) In-line, Full-faced through-bolted: ASME B16.5, 150-pound flanges.
2) In-line, Wafer style: Compatible with Classes 150/300 flange drilling.
3) Offline: Female NPT Threaded, unless otherwise noted.

5. Manufacturers and Products: Red Valve Company; Series 40, Series 42/742, Series 48 or approved equal.

X. S12 Indicator, Field Mount:

1. General:
a. Function: Digital indication of analog signal.
b. Type:
1) Integral enclosure suitable for field mounting.
2) Loop-powered.
2. Performance:
a. Accuracy: Plus or minus 0.1 percent of full scale plus or minus one count.
b. Display Update Rate: 2.5 second minimum.
c. Operating Temperature Range: Minus 40 degrees C to 80 degrees C.
3. Features:
a. Display:
1) LCD.
2) 3.5-digits.
3) 0.35 inch minimum.
b. Input Impedance: 75 ohms maximum.
4. Enclosure:
a. NEMA 4X, unless otherwise noted.
b. Mounting: Surface, unless otherwise noted.
5. Loop-powered.
6. Signal Interface: 4 to 20 mA dc at 24V dc maximum.
7. Accessories: As required to support the noted options.
8. Manufacturers and Products:
a. Newport Electronics, Santa Ana, CA; Model 508B.
b. Precision Digital, Natick, MA; Model Trident Model PD660/661.
c. Or approved equal.

Y. Y1 Computer, Server:

1. Form factor: Tower.
2. CPU:
a. 3.3 GHz clock speed, minimum.
b. Quad core processors.

3. RAM: 8 GB, minimum.
4. Sound card:
   a. Internal.
   b. Sample rate: 192 kHz.
5. Speakers:
   a. Nominal Output Power: 5 watts.
   b. Quantity: 2.
   c. Amplifier: Integrated.
   d. Power: USB.
6. Hard Drives: 1 TB.
7. Keyboard:
   a. Interface: USB.
   b. Layout: English.
   c. Spillproof, tilt legs.
8. Mouse:
   a. Interface: USB.
   b. Type: Optical.
   c. Scrolling wheel: Required, 1000 dpi resolution.
9. Monitors:
   a. Diagonal Size: 27 inches, minimum.
   b. Native Resolution: 2560 by 1440 at 60 Hz.
   c. Aspect Ratio: 16:09.
   d. Pixel Pitch: 0.233 mm by 0.233 mm.
   e. Contrast Ration: 1000:1, typical.
   f. Color Support: 16.7 million colors.
   g. Response time: 5 ms (fast), 8 ms (normal).
   h. Energy Star Certification: Required.
10. Manufacturer and Model: Dell PowerEdge server and Dell Ultrathin 27, or approved equal.

Z. Y2 Monitor, Large:

1. Diagonal Size: 43 inches, minimum.
2. Native Resolution: 4K, 3840 by 2160 at 60 Hz.
3. Aspect Ratio: 16:09.
4. Pixel Pitch: 0.2451 mm.
5. Contrast Ration: 1000:1, typical.
6. Color Support: 1.06 billion colors.
7. Brightness: 350 cd/m2.
8. Response time: 8 ms (grey to grey).
9. Mount Interface: VESA 100 by 100 mm, 200 by 200 mm.
10. VESA Mount:
    a. Minimum profile: 3.8 inches.
    b. Outward extension: Up to 18 inches.
    c. Tilt: Required, 16 degrees.

d. Pan: Required, 180 degrees.
e. Lateral Adjustment: 2.9 inches.
f. Mount interfaces 200 by 200 mm, 600 by 400 mm.
g. Color: Black.

11. Manufacturer and Model: Dell 43 Ultra HD 4K with Ergotron Neo-Flex Cantilever, UHD-mounting kit (Lift and Lock), or approved equal.

AA. Y3 Computer, Laptop:

1. Processor: Intel Core i5-8300H, Quad Core 2.30 GHz.
2. Operating System: Windows 10 Professional, 64-bit.
3. Memory 16 GB.
4. Display: 14-inch impact resistant screen, LED backlit, 1366 by 768.
5. Keyboard: Internal dual pointing.
6. Hard Drive: 500 GB SSD 7200 rpm SATA.
7. Power: 6 cell lithium battery with 90 W ac power adapter.
8. Communications:
   a. 10/100/1000 Gigabit Ethernet, RJ-45 connector
   b. 802.11 a/c Dual Band 2 by 2 wireless adapter.
   c. Bluetooth 4.1.
   d. VGA.
   e. HDMI.
   f. 2 USB 2.0.
   g. 2 USB 3.0.
9. Manufacturer: Dell Precision 7730, or approved equal.

BB. Y4 Switch, Rackmount:

1. Type: Managed Layer 2 switch.
2. Mounting: Rack.
3. Fanless, minus 10 to 60 degrees C operating temperature range.
4. Power supply: Redundant 120 ac.
5. Copper ports: 20 Gigabit Ethernet.
6. Fiber ports:
   a. SFP slots for up to 28 connections.
   b. Quantity: As noted.
7. Manufacturer and Model: Moxa ICS-G7528A Series, or approved equal.

CC. Y5 Switch, Panel Mounted:

1. Ports:
   a. Copper:
      1) 10/100BASE-TX.
      2) RJ45.

3) Qty: As required for initial installation, with at least two spare.

b. Fiber:

1) Qty: As required for initial installation, with at least one spare pair

2. Manufacturer and Model: Schneider Electric Connexium managed switches, no exceptions or approved equal.

DD. Y6 Firewall:

1. Interfaces:
   a. Switch Ports: 5 RJ45.
   b. WAN Ports: 2 RJ45.
   c. USB Ports: 1.
   d. Console: 1RJ45.
   e. Wireless: 1 802.11 a/b/g/h.
2. Internal Storage: 1 by 32 GB SSD.
3. Performance:
   a. Firewall Throughput: 2.5 Gbps.
   b. Latency (64 byte UDP packets): 180 microseconds.
   c. Concurrent Sessions: 1.8 million.
   d. Firewall Policies: 5000.
   e. IPsec VPN Throughput (512 bytes): 90 Mbps.
   f. SSL VPN Throughput: 100 Mbps.
4. IPS: 350 Mbps.
5. NGFW: 220 Mbps.
6. Threat Protection: 160 Mbps.
7. Manufacturer and Model: Fortinet Fortigate 51e, or approved equal.

EE. Y20 Programmable Logic Controller:

a. Each PLC shall be Allen-Bradley CompactLogix, no exceptions. The following components shall be used:
   1) CPU: 1769-L33ER.
   2) Power Supply: 1769-PA4.
   3) Analog Input Modules: 1769-IF4I.
   4) Analog Output Modules: 1769-OF4CI.
   5) Discrete Input Modules: 1769-IA16.
   6) Discrete Output Modules: 1769-OA16.

b. Physical I/O points are shown on P&IDs and are included in the Input/Output Lists which are listed in the PLC Input/Output List. This list is not all-inclusive. Provide any additional I/O, functions or operations required to provide a completely operational system.

c. Spare I/O:
   1) Provide each PLC with at least 20 percent installed spare I/O points for each type of I/O used by that PLC.

2) Use the actual I/O for this Project in calculating the installed spare I/O quantities.
3) Wire all spare I/O to terminal blocks. Provide surge suppression on all spare analog I/O.

d. Separate Output Modules for Parallel Controlled Modules: Unless otherwise noted or shown, for parallel controlled devices, provide separate discrete and, if applicable, analog output modules. For instance, if there are a total of 3 adjustable speed high service pumps, provide 2 sets of analog and discrete output modules. Wire 2 high service pumps to 1 set of analog and discrete output modules; wire the third high service pump to the other set of analog and discrete output modules.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
9. Telecommunications Industry Association (TIA):
   a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
   b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
   c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
   d. 568-C.3, Optical Fiber Cabling Components Standard.
   e. 598, Optical Fiber Cable Color Coding.
   f. 606, Administration Standard for Commercial Telecommunications Infrastructure.
10. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.

b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
k. 942, Telecommunications Infrastructure Standard for Data Centers.
l. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.

11. Underwriter Laboratories (UL): 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. AUI: Attachment Unit Interface.

C. dB: Decibel.

D. EMB: Effective Modal Bandwidth.

E. ETL: Electrical Test Laboratories.

F. FDDI: Fiber Distributed Data Interface.

G. FIM: Facilities Information Management.

H. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

I. FOCS: Fiber Optic Communication System.

J. FOIRL: Fiber Optic Inter Repeater Link.

K. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

L. Hybrid Cable: Cable containing more than one type of fiber.

M. LAN: Local Area Network.

N. LIMS: Laboratory Information Management System.

O. m: Micrometer.

P. Mbps: Megabits per Second.

Q. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

R. Megahertz (MHz): One million cycles per second.

S. MHz: Megahertz.

T. micro: x 10^{-6}.

U. Micron: Micrometer or one millionth meter.

V. MIS: Management Information System.

W. n, nano: x 10^{-9}.

X. N: Newton.

Y. nm: Nanometer—unit of measure equal to one billionth meter.

Z. OFL: Over-filled Launch.

AA. OFN: Nonconductive Optical Fiber Cable.

BB. OFNP: Nonconductive Optical Fiber Plenum Cable.

CC. OFNR: Nonconductive Optical Fiber Riser Cable.

DD. OLTS: Optical Loss Test Sets.

EE. OTDR: Optical Time Domain Reflectometer.

FF. OVD: Outside Vapor Deposit.

GG. PIC: Process Instrumentation and Control.

HH. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

II. RLM: Restricted Mode Launch.

JJ. ROL: Reverse Oscillation Lay.

KK. SPC: Super Physical Contact.

LL. UPC: Ultra Physical Contact.

MM. UPS: Uninterruptible Power Supply.

NN. V ac: Volts Alternating Current.

OO. WAN: Wide Area Network.

1.03 SYSTEM DESCRIPTION

A. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

B. Provide a FOCS based on referenced standards for use in the following local and wide area networks: Ethernet

C. Network(s) will be used by PIC to distribute data and coordinate Owner's operations.

1.04 SUBMITTALS

A. Action Submittals:

1. Site Layout Diagram Showing:
   a. Access holes, with identification.
   b. Abovegrade cable routings, with pole and cable identification.
   c. Belowgrade conduit routings between access holes and buildings, with conduit counts and identification.
   d. Belowgrade innerduct routings through conduits, with innerduct counts and identification.
   e. Cable routings through innerducts and to patch panels, fiber centers, or network nodes, with cable and node identification.

2. Cable Schedule Showing:
    a. Cable identification.
    b. Fiber counts for each cable and identification of used fiber pairs.
    c. Cable length and attenuation, with **two** connector pairs and **no** splice(s), based on TIA 568-C.3, Annex H.
3. Component Data:
    a. Manufacturer and model number.
    b. General data and description.
    c. Engineering specifications and data sheet.
    d. Scaled drawings and mounting arrangements.

B. Informational Submittals:

1. Manufacturer's statement that installer is certified to perform installation Work.
2. Subcontractor Qualifications:
    a. FOCS Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
        1) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
            a) Owner's name, address, telephone number, and name of current operations supervisor or other contact.
            b) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
            c) System block diagram.
            d) Dates when contract was signed, equipment was delivered, and system was accepted by Owner. Also, include originally scheduled completion date and if different from actual date, explain why.
            e) Approximate value of listed FOCS provided in dollars.
            f) Detailed horizontal and riser routing.
            g) Distribution frame arrangements.
            h) Fiber and termination identification, including spares.
    b. FOCS Subcontractor's Site Representative: Minimum of 5 years' experience installing similar systems.
    c. Qualification of Personnel:
        1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.

2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
   a) Fiber optic cable handling and placement techniques.
   b) Fiber optic splicing and installation of connections.
   c) Attenuation testing procedures.

d. Owner acceptance of FOCS Subcontractor does not exempt FOCS Subcontractor or Contractor from meeting Contract Document requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.

e. Sample of Network Test Report, minimum 10 pages, that Contractor generated in a previous project.

f. Testing and acceptance plan, 30 days prior to beginning of testing.

g. Fiber test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing:
   1) Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
   2) Attenuation of each fiber upon delivery to Site.
   3) Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
   4) Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.

h. For each maintenance organization, identify location of base of service and how required coverage will be achieved.

3. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
4. Manufacturer's suggested installation practice.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 20 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 20 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 20 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.
3. Connector:
   a. ISO 9001 or QF TL 9000 registered.
   b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. Certified by fiber cable manufacturer.

C. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
   a. Manufacturer of fiber optic cable and fiber optic connectors.
   b. Manufacturer of test equipment used for field certification.
   c. Other independent training organizations acceptable to Owner.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

PART 2 PRODUCTS

2.01 MULTIMODE FIBER OPTIC CABLE

A. 62.5/125 -micron, graded-index for use in backbone and horizontal distribution subsystems, meets or exceeds the requirements of TIA 568-C.3, including the following specifications:

1. Maximum Mean Fiber Loss:
   a. 3.5 dB per km at 850 nm.

b. 1.5 dB per km at 1,300 nm.
2. Minimum OFL Bandwidth:
   a. OM1 200 MHz-km at 850 nm, 500 MHz-km at 1300 nm.
3. Distance Capacity per IEEE 802.3:
   a. 100Mbit Ethernet: 2000m at 1,310 nm.

B. Type 62.5/250 Backbone for Underground Conduit Installation:

1. Individual Fibers: 62.5/125/250 microns.
2. Assembly:
   a. Nonmetallic, gel-free, dry water blocked, loose-tube fiber core with dielectric strength member enclosed by nonmetallic cross-ply sheath; requires buffer tubing.
   b. Cable: Comply with ICEA S-87-640.
3. NEC/UL Listing: None; not approved for general use within building except when installed in metallic conduit.
4. Protective Covering: Black, antifungus, UV-resistant, polyethylene jacket with rip-cord.
5. Minimum Short Term Pull Strength: 600 lbf.
6. Manufacturers and Products:
   a. Corning Cabling Systems; ALTOS loose-tube dielectric cable.
   b. Mohawk; Outdoor loose-tube cable.
   c. Or approved equal.

C. Type 62.5/250, Backbone for Underground Conduit and Building Riser Installation:

1. Individual Fibers: 62.5/125/250 microns.
2. Assembly:
   a. Nonmetallic, gel-free, dry water blocked, loose-tube fiber core with dielectric strength member enclosed by nonmetallic cross-ply sheath; requires buffer tubing.
   b. Cable: Comply with ICEA S-104-696.
3. NEC/UL Listing: OFNR.
4. Protective Covering: Black, flame and UV-resistant, thermoplastic jacket with rip-cord.
5. Minimum Short Term Pull Strength: 600 lbf.
6. Manufacturers and Products:
   a. Corning Cabling Systems; FREEDM cable.
   b. Mohawk; RiserLite loose-tube cable.
   c. Or approved equal.

D. Type 62.5/900, Indoor/Outdoor Cable:

1. Individual Fibers: 62.5/125/250/900 microns.
2. Assembly:
   a. Distribution Style with core of individually tight-buffered fibers surrounded by nonmetallic sheath.
   b. Cable: Comply with ICEA S-83-596.
3. Protective Covering: Flame retardant outer jacket with pull string.
4. NEC/UL Listing: OFNR Manufacturers and Products:
   a. Corning Cabling Systems; (MIC) cable.
   b. Mohawk; Distribution Riser cable.
   c. Or approved equal.

2.02 FIBER CENTERS

A. Function: Provides secure place to terminate fiber optic cables.

B. Features:

1. Compartments: Two; one for fiber optic cable, one for jumpers to individual equipment.
2. Coil Former: Former to wind slack cable around, provides controlled long radius bends.
3. Connectors: Minimum 24 connectors for entry and exit.
4. Size: Maximum 450 mm by 300 mm by 100 mm.
5. Construction: 1.5-mm steel with corrosion proof finish.
6. Mountings: Suitable for permanent attachment as shown, or provide separate mountings that do not obscure covers and doors.
   a. oriented on inside of panel so that it is not accessible to user once system is installed.

2.03 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
2. Pull Strength: 0.2 N minimum.
3. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   a. Ferrules: Free-floating low loss ceramic.
   b. Polarizing key on duplex connector systems.
4. Attenuation:
   a. In accordance with TIA 568-C.3.
   b. Maximum of 0.75 dB per connector pair.
5. Manufacturer: AMP or approved equal.

2.04 PATCHCORDS

A. General:

1. In accordance with TIA 568-C.3.
2. Function: Connect fiber centers to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
4. Cable Configuration:
   a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
   b. Protected with kevlar strength members and enclosed in thermoplastic jacket.
5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
6. Connectors:
   a. As required by Article Connectors.
   b. On-axial Pull Strength: 33 N.
   c. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector: Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).

2.05 CONDUIT

A. In accordance with Section 26 05 33, Raceway and Boxes.

2.06 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduit:

1. Ensure installed conduit system conforms to fiber optic system requirements, including:
   a. Conduits: Size and number.
   b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables and innerducts may be installed without exceeding manufacturer’s limitations.
   c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.

2. Spare Conduit: No cables shall be pulled into spare conduit.
3. Expansion Plugs: Seal conduit to stop ingress of water and grit with fabricated expansion plugs.
4. Ensure duct bank, conduit, and other confined routing is free and clear of debris before cable placement.

3.02 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
   a. Not dented, nicked, or kinked.
   b. Not subjected to pull stress greater than manufacturer's specification.
   c. Not bent to a radius below manufacturer's minimum bend radius.
   d. Not subjected to treatment that may damage fiber strands during installation.
5. Cables per Conduit or Innerduct: In accordance with NFPA 70 NEC conduit fill limitations.
6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. Splices: Install fiber optic cables in unspliced lengths from fiber centers to switches or hubs.
8. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
9. Identification:
   a. Identify cable on both ends, in access holes, and pull points.
   b. In accordance with TIA 606.
10. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.
11. Access Holes:
    a. Provide supports for cables in access and handholes at maximum 600 mm centers along sides.
    b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
   a. Sleeve over individual fibers with transparent furcation tubes.
   b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.

3. Break-out Kits:
   a. Terminate cables using manufacturer-supplied break-out kits.
   b. Terminate in accordance with manufacturer's recommendations.
4. Slack:
   a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
   b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
   a. Terminate 100 percent fibers in each cable to specified connector.
   b. Connect into fiber management system.

C. Conduit: Install in accordance with Section 26 05 33, Raceway and Boxes.

3.03 LABELING CONVENTIONS

A. Conform to TIA 606 or to requirements specified by Owner or Owner's representative.

B. Backbone (Riser) Cables:

1. Multiconductor cables connecting main distribution field to an intermediate distribution field, usually a wiring closet or cabinet, and are labeled at each terminating end. Label name identifies each endpoint, cable medium, and number of conductors as follows:
   a. Copper: IDF-MDF-C-PPP-N.
   b. Fiber: IDF-MDF-F-MMM, SSS-N.

Where:

IDF	Is the 3-5 position IDF/wiring closet/building code
MDF	Is the 3-5 position MDF (or IDF) code
F	Fiber
PPP	Is pair count of a copper cable
MMM	Is multimode strand count
SSS	Is single-mode strand count
N	Is a sequential number

C. Horizontal (Station) Cables:

1. Connect jack stations to wiring closets or cabinets and are labeled at each end to identify wiring closet they connect to and sequential jack station number as follows:
   a. Data: IDF-D-NNN-A/B.
   b. Voice: IDF-V-NNN-A/B.

Where:

IDF	Is the 3-5 position IDF/wiring closet/building code
D	Data cable (green)
V	Voice cable (gray)
NNN	Is the sequence number
A/B	Indicates left or right port in faceplate

3.04 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 48 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results: Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
    a. Field test instrument shall be within calibration period recommended by manufacturer.
    b. Optical Loss Test Set (OLTS):
        1) Single-mode Optical Fiber Light Source:
            a) Provide dual laser light sources with central wavelengths of 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
            b) Output Power: Minus 10 dBm, minimum.
            c) Manufacturer: Fluke Networks or approved equal.
        2) Multimode Optical Fiber Light Source:
            a) Provide dual LED light sources with central wavelengths of 850 nm (plus or minus 30 nm) and 1,300 nm (plus or minus 20 nm).

b) Output Power: Minus 20 dBm minimum.
c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap, as described in Clause 11 of TIA 568-C.3, with Category 1 light source.
d) Manufacturer: Fluke Networks or approved equal.

3) Power Meter:
a) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.
b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
c) Store reference power measurement.
d) Save at least 100 results in internal memory.
e) PC interface (serial or USB).
f) Manufacturer: Fluke Networks or approved equal.

4) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.

3. Optical Time Domain Reflectometer (OTDR):
a. Bright, color transmissive LCD display with backlight.
b. Rechargeable for 8 hours of normal operation.
c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
e. Serial and USB ports to transfer data to PC.
f. Single-mode OTDR:
1) Wavelengths: 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
2) Event Dead Zone: 2 meters maximum at 1,310 nm and 2 meters maximum at 1,550 nm.
3) Attenuation Dead Zone: 15 meters maximum at 1,310 nm and 15 meters maximum at 1,550 nm.
4) Distance Range: Minimum 10,000 meters.
5) Dynamic Range: Minimum 10 dB at 1,310 nm and 1,550 nm.
g. Multimode OTDR:
1) Wavelengths: 850 nm (plus or minus 20 nm) and 1,300 nm (plus or minus 20 nm).
2) Event Dead Zone: 1 meter maximum at 850 nm and 2 meters maximum at 1,300 nm.
3) Attenuation Dead Zone: 6 meters maximum at 850 nm and 15 meters maximum at 1,300 nm.
4) Distance Range: 2,000 meters minimum.
5) Dynamic Range: Minimum 10 dB at 850 nm and 1,300 nm.
h. Manufacturer: Fluke Networks or approved equal.

C. Conduit Test:

1. Test and seal spare conduits.
2. Conduit and Innerduct Testing:
   a. Blow full-diameter mouse through each spare conduit and innerduct to verify they are unrestricted over full length.
   b. If conduit is restricted over full length, advise Engineer.
3. Documentation: Confirm conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.

D. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
   a. LIA Z136.2.
   b. TIA/EIA 455-78.
   c. TIA/EAI 455-133.
   d. TIA 526-7.
   e. TIA 526-14.
   f. TIA 568-C.1.
   g. TIA 568-C.3.
   h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for single-mode and multimode links and channels.
   b. OTDR traces and event tables for single-mode and multimode links and channels.

E. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.

b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Multimode 62.5/125 µm	850	3.5	1300	1.5

b. OTDR Testing:
1) Reflective Events: Maximum 0.75 dB.
2) Nonreflective Events: Maximum 0.3 dB.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

H. Test Execution:

1. Optical Fiber Cable Testing:
a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
c. Perform Testing:
1) On each cabling segment (connector to connector).
2) On each cabling channel (equipment to equipment).
3) Using high-quality test cords of same fiber type as cabling under test.
a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.

b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.

2. Optical Loss Testing (OLTS):
   a. Backbone Link:
      1) Test single-mode at 1,310 nm and 1,550 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.
      2) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
      3) Perform tests in both directions.
3. OTDR Testing:
   a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      1) Single-mode: 1,310 nm and 1,550 nm.
      2) Multimode: 850 nm and 1,300 nm.
   b. Test each fiber link and channel in one direction.
   c. Install launch cable between OTDR and first link connection.
   d. Install receive cable after last link connection.
4. Length Measurement:
      1) Record length of each fiber.
      2) Measure optical length using OLTS or OTDR.
5. Polarity Testing:
   a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
   b. Verify polarity of paired duplex fibers using OLTS.
6. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
   c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.

d. Circuit IDs reported by test instrument shall match specified label identification.
e. Provide in electronic database for each tested optical fiber with the following information:
    1) Identification of Site.
    2) Name of test limit selected to execute stored test results.
    3) Name of personnel performing test.
    4) Date and time test results were saved in memory of tester.
    5) Manufacturer, model, and serial number of field test instrument.
    6) Version of test software and version of test limit database held within test instrument.
    7) Fiber identification number.
    8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
    9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
    10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
    11) Length for each optical fiber as calculated by the OTDR.
    12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

I. Drawings:

1. Record Copy: Provide at end of Project on CD-ROM.
    a. CAD format and include notations reflecting as-built conditions of additions and variations from Drawings provided, such as to cable path and termination point.
    b. CAD drawings are to incorporate test data imported from test instruments.
2. As-built Drawings:
    a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.
    b. Include field changes made up to construction completion:
        1) Field directed changes to pull schedule.
        2) Field directed changes to cross connect and patching schedule.
        3) Horizontal cable routing changes.
        4) Backbone cable routing or location changes.
        5) Associated detail drawings.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.

1. As-Built Fiber Optic Cable Installation Form.
2. As-Built Conduit Installation Form.

END OF SECTION

PROJECT: *WHITEHOUSE TN WWTP*

Contractor:

Signed by:

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Cable Identification:
Routing: From: In:
(Identify field panel, control room, etc. in building)

Through: 1
(Identify access hole, building, gallery, etc.)
Through: 2 Through: 5
Through: 3 Through: 6
Through: 4 Through: 7
To: In:
See As-Built Conduit/Innerduct Installation forms for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:
Multimode Fibers

		cable length*	
850 nm:	3.5 dB/km x	km + 1.5 dB =	dB
1300 nm:	1.0 dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		850 nm	1,300 nm	850 nm	1,300 nm

Single-mode Fibers

		cable length*	
1310 nm:	1.0 dB/km x	km + 1.5 dB =	dB
1550 nm:	0.5 dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		1,310 nm	1,550 nm	1,310 nm	1,550 nm

PROJECT: *WHITEHOUSE TN WWTP*

Contractor:

Signed by:

AS-BUILT CONDUIT INSTALLATION

From: To:

(Identify building, access hole, field panel, etc.) Sheet 1 of 1

Conduits:
Used: 4 inches; 2 inches
Spare: 4 inches; 2 inches Confirm all spares unrestricted: Yes/No
(Provide number of conduits in each category)

Innerducts:

Conduit ID	Cable ID / Spare

(Continued overleaf delete if not applicable)

END OF SUPPLEMENT

SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. International Society of Automation (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer’s factories.

B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer’s factory.

1.03 SUBMITTALS

A. Action Submittals:

1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
5. Plumbing diagrams of pre-plumbed panels and interconnecting plumbing diagrams.

6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces
7. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
    a. Required voltages, currents, and phases(s). Include calculations and list assumptions.
    b. Maximum heat dissipations Btu per hour. Include calculations and list assumptions.
    c. Maximum permissible internal temperature based on operating range of internal components.
    d. Computed maximum internal temperature. Include calculations and list assumptions. Include the impacts of internal heat generation, solar radiation and shielding.
    e. Use the ambient parameters listed in this section for the applicable service condition.

B. Informational Submittals:

1. Programmable Controller Submittals:
    a. Complete set of user manuals.
    b. Fully documented ladder logic listings.
    c. Function listing for function blocks not fully documented by ladder logic listings.
    d. Cross-reference listing.
2. Manufacturer's list of proposed spares, expendables, and test equipment.
3. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

PART 2 PRODUCTS

2.01 SIGNAL CHARACTERISTICS

A. As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

2.02 SERVICE CONDITIONS

A. As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.
3. Or approved equal.

2.04 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14 gauge.

D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.

E. Doors:

1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
2. For other doors, stainless steel quick release clamps.

F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:

1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
2. Furnish cooling fans with air filters if required to dissipate heat.
3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

J. Lighting: Minimum of one hand switch controlled internal 100-watt incandescent light for panels 12 cubic feet and larger.

K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

L. Finish:

1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer's standard gray unless otherwise specified.
2. Internal Surfaces: White enamel.

M. Panel Manufacturers:

1. Hoffman.
2. H.F. Cox.
3. Or approved equal.

N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B or approved equal.

2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures: UL recognized or UL listed.

C. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
   a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
   b. Branch Circuit Breakers: 15 amps at 250V ac.
   c. Breaker Manufacturers and Products:
      1) Heineman Electric Co.; Series AM.
      2) Airpax/North American Philips Controls Corp.; Series 205.
      3) Or approved equal.

D. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. Interlock main circuit breaker with panel door.
   a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
   b. Mount operator controls and indications on front access door.
2. Circuit Breakers:
   a. In accordance with NEMA AB 1.
   b. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
   c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
   d. 22,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
   e. Tripping: Indicate with operator handle position.
3. Magnetic Motor Starters:
   a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
   b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
   c. Manual reset type with reset button mounted on panel door.
4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
   a. Power Control Transformer:
      1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
      2) Limit voltage variation to 15 percent during contact pickup.
      3) Fuse one side of secondary winding and ground the other.
      4) Furnish primary winding fuses in ungrounded conductors.
5. Power Monitoring Relay:
   a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Furnas; Class 47 or approved equal.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.

2. Analog Signal Circuits:
   a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination:
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.
      3) Or approved equal.

F. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

G. Terminal Blocks:

1. Quantity:
   a. For external connections.
   b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
   c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
   b. Compression Clamp:
      1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
      2) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 to plus 110 degrees C.
      2) Two funnel shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Rail.

2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
3) End Stops: One at each end of rail, minimum.

g. Wire Preparation: Stripping only.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
1) Terminal number shown on both sides of terminal block.
2) Allow use of preprinted and field marked tags.
3) Terminal strip numbers shown on end stops.
4) Mark terminal block and terminal strip numbers as shown.

3. Terminal Block, 120-Volt Power:
a. Rated Voltage: 600V ac.
b. Rated Current: 30 amp.
c. Wire Size: 22 through 10AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Gray body.
f. Spacing: 0.25 inch, maximum.
g. Manufacturer and Product: Entrelec; Type M4/6 or approved equal.

4. Terminal Block, Ground:
a. Wire Size: 22 through 12 AWG.
b. Rated Wire Size: 12 AWG.
c. Color: Green and yellow body.
d. Spacing: 0.25 inch, maximum.
e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
f. Manufacturer and Product: Entrelec; Type M4/6.P or approved equal.

5. Terminal Block, Blade Disconnect Switch:
a. Use: Provide one for each discrete input and output field interface wire.
b. Rated Voltage: 600V ac.
c. Rated Current: 10 amp.
d. Wire Size: 22 through 12 AWG.
e. Rated Wire Size: 12 AWG.
f. Color: Gray body, orange switch.
g. Spacing: 0.25 inch, maximum.
h. Manufacturer and Product: Entrelec; Type M4/6.SN or approved equal.

6. Terminal Block, Fused, 24V dc:
a. Rated Voltage: 600V dc.
b. Rated Current: 6.3 amp.
c. Wire Size: 22 through 12 AWG.
d. Rated Wire Size: 12 AWG.

e. Color: Gray body.
f. Fuse: 5 by 20 GMA fuses.
g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
h. Indication: LED diode 24V dc.
i. Leakage Current: 5.2 mA, maximum.
j. Spacing: 0.32 inch, maximum.
k. Manufacturer and Product: Entrelec; Type M4/6.SFD or approved equal.

7. Terminal Block, Fused, 120V ac:
a. Rated Voltage: 600V ac.
b. Rated Current: 6.3 amp.
c. Wire Size: 22 through 12 AWG
d. Rated Wire Size: 12 AWG.
e. Color: Gray body.
f. Fuse: 5 by 20 GMA fuses.
g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
h. Indication: Neon lamp 110V ac.
i. Leakage Current: 1.8 mA, maximum.
j. Spacing: 0.32 inch, maximum
k. Manufacturer and Product: Entrelec; Type M4/6.SFL or approved equal.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

I. Relays:

1. General:
a. Relay Mounting: Plug-in type socket.
b. Relay Enclosure: Provide dust cover.
c. Socket Type: Screw terminal interface with wiring.
d. Socket Mounting: Rail.
e. Furnish holddown clips.

2. Control Circuit Switching Relay, Nonlatching:
a. Type: Compact general purpose plug-in.
b. Contact Arrangement: 3 Form C contacts.
c. Contact Rating: 10A at 28V dc or 240V ac.
d. Contact Material: Silver cadmium oxide alloy.
e. Coil Voltage: As noted or shown.
f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.

j. Push-to-test button.
k. Manufacturer and Product: Potter and Brumfield; Series KUP or approved equal.

3. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP or approved equal.
4. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As specified or shown.
   f. Operating Temperature: Minus 10 to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 to 80 percent or range.
   i. Time Delay Setpoint: As specified or shown.
   j. Mode of Operation: As specified or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.
   l. Manufacturer and Products: Potter and Brumfield.
      1) Series CB for 0.1-second to 100-minute delay time ranges.
      2) Series CK for 0.1- to 120-second delay time ranges.
      3) Or approved equal.

J. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.

K. Network connected packaged control systems:

1. Programmable Controllers: Programmed with same software used to programmable controllers provided under Section 40 90 00, Instrumentation and Control for Process Systems.
2. Ethernet Switches: Match manufacturer and series provided under Section 40 90 00, Instrumentation and Control for Process Systems:
   a. Provide no less than 2 spare ports.
3. Operator Interface Units:
   a. Luminance: 1000 cd/m2 (nit), minimum.
   b. Conformal coating: required.
   c. Color.
   d. NEMA 4X.
   e. Hinged window kit: Required.
   f. Anti-glare overlays: Required.
   g. Communications: Ethernet.
   h. PanelView Plus; or equal.
4. Fiber optic components: Meet requirements of Section 40 95 80, Fiber Optic Communication Systems.

L. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:

1. Potentiometer Units:
   a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include legend plates with service markings.
   d. Manufacturers and Products:
      1) Allen-Bradley; Model 800T.
      2) Eaton/Cutler-Hammer; Model 10250T.
      3) Or approved equal.
2. Indicating Lights:
   a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
   b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Eaton/Cutler-Hammer; Type 10250T.
      2) General Electric; CR2940U.
      3) Or approved equal.
3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.

b. Standard size legend plates with black field and white markings for service legend.
c. Manufacturers and Products:
1) Square D; Class 9001, Type K.
2) Eaton/Cutler-Hammer; Type T.
3) General Electric; Type CR-2940.
4) Or approved equal.

4. Selector Switch:
a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
b. Standard size, black field, legend plates with white markings, for service legend.
c. Operators: Black knob type.
d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
e. Manufacturers and Products for Units with up to Four Selection Positions:
1) Eaton/Cutler-Hammer; Type T.
2) Square D; Type K.
3) Or approved equal.
f. Manufacturers and Products for Units with up to 12 Selection Positions:
1) Rundel-Idec; Standard Cam Switch.
2) Electroswitch; 31.
3) Or approved equal.

M. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
c. Include engraved legend plates with service markings.
d. Manufacturer and Product: Allen-Bradley; Bulletin 800H or approved equal.
2. Indicating Lights, Watertight:
a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
b. Screwed on prismatic lenses and factory engraved legend plates for service legend.

c. Manufacturers and Products:
   1) Square D; Type SK.
   2) Allen-Bradley; Type 800H.
   3) Or approved equal.

3. Pushbutton, Momentary, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
      3) Or approved equal.
4. Selector Switch, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
   e. Manufacturer and Products:
      1) Square D; Class 9001, Type SK.
      2) Allen-Bradley; Type 800H.
      3) Or approved equal.

2.06 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.

1. Panel Mounted: Plastic, mounted to instrument behind panel face.
2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:

1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
2. Color: White with black letters.
3. Letter Height: 3/16 inch.

4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2-inch high.

C. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

1. Lettering: Black on white and amber lenses; white on red and green lenses.
2. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black

Tag Function	Inscription(s)	Color
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.

2.07 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.

B. Suppressor Locations:

1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressor Design:

1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2. Response: 5 nanoseconds maximum.
3. Recovery: Automatic.
4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
5. Enclosure Mounted: Encapsulated inflame retardant epoxy.

D. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Power Supplies for Continuous Operation:
   a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
   b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
   b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series or approved equal.
2. 120V ac Lines: Emerson Edco HSP-121 or approved equal.
3. 480-Volt, Three-Phase Power Supplies: Square D Model SDSA3650 or approved equal.
4. Field Mounted at Two-Wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Edco SS64 series or approved equal.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
   a. Enclosure:
      1) NEMA 4X Type 316 stainless steel with door.
      2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Emerson Edco; SLAC series or approved equal.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26 05 26, Grounding and Bonding for Electrical Systems and suppressor manufacturer's requirements.
2. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.

3.02 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

END OF SECTION

SECTION 43 22 56.01
SUBMERSIBLE MIXERS

PART 1 GENERAL

1.01 SUMMARY

A. Comply with Division 01, General Requirements, Section 26 05 02, Basic Electrical Requirements.

B. Section includes the supply, delivery, Site storage, installation, testing and placement into operation of submersible mixers including all appurtenances required to complete an operating system as specified.

C. Section includes supply and installation of all components necessary to install a submersible mixer in six Anaerobic Zones, four 1st Anoxic Zones and four 2nd Anoxic Zones.

D. The composite cable that is supplied with each submersible mixer will be wired as required under Division 26 provisions.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. American Water Works Association (AWWA).
3. ASTM International (ASTM).
4. Canadian Government Specification Board (CGSB).
5. Canadian Standards Association (CSA).
6. Electrical and Electronic Manufacturers Association of Canada (EEMAC).

1.03 SUBMITTALS

A. Action Submittals:

1. General layout, mast, complete engineering description, and performance characteristics.
2. Size, details, and complete list of materials.
3. Details of control panel and wiring schematics.
4. Commissioningg reports.

B. Informational Submittals:

1. Installation Manuals. Submit installation manuals before shipment of any equipment. No payment will be made for equipment delivered before installation manuals.
2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data. Submit operation and maintenance manuals before requesting initial start-up.

C. Submit all Drawings in SI metric.

1.04 QUALITY ASSURANCE

A. Provide a written guarantee that the submersible mixer will provide uniform mixing of Mixed Liquor in one Cell. If in the opinion of the Engineer, the unit fails to uniformly blend the fluid, replace the unit with a suitable mixer at no additional cost to the Owner.

1.05 WARRANTY

A. The manufacturer shall provide a full warranty on all parts and labor for 60 months from acceptance by the Owner and in beneficial use.

PART 2 PRODUCTS

2.01 EQUIPMENT MANUFACTURER

A. Wilo.

B. Or approved equal.

2.02 SUBMERSIBLE MIXERS

A. The submersible mixers for the System shall be and furnished by the aerator manufacturer, and, where possible, shall be of the identical model. Each mixer shall include a motor, gear reduction section, bearings, mechanical seals, stainless steel shafts, A48 class 35 or 40 Cast Iron Housing, and machined fits for circular cross section O-rings, non-clogging propeller, designed for mixing raw or processed sewage. Each mixer shall be mounted in the basin and each unit shall have a hoist and rail retrieval system that does not require anyone entering the basin to install or remove the mixer.

B. The mixer design is based on the performance requirements for the biological nutrient removal system; consideration of the future long-term operational and maintenance costs to the Owner; minimum pumping rate required per basin; optimization of mixing efficiency (HP/MG) and long-term power use (e.g., geared units required for the anoxic basins); efficiency and hydraulic profile

of the polyurethane blade design; and specific features (e.g., silicon carbide mechanical seals, pre-chamber) to protect against moisture intrusion into the unit. No exceptions will be made to these performance requirements as specified in this section.

C. Performance:

1. Anaerobic Basin mixer key details.
   a. Number of mixers required: 6.
   b. 237 rpm (Maximum) propeller speed.
   c. Maximum Motor HP - 3.9 HP
   d. Minimum 162 pounds of thrust.
2. 1st Anoxic Basin mixer key details.
   a. Number of mixers required: 4.
   b. 155 rpm (Maximum) propeller speed.
   c. Maximum Motor HP - 3.9
   d. Minimum 232 pounds of thrust.
3. 2nd Anoxic Basin mixer key details.
   a. Number of mixers required: 4.
   b. 116 rpm (Maximum) propeller speed.
   c. Maximum Motor HP: 2.7
   d. Minimum 299 pounds of thrust.

2.03 MIXER MOTORS

A. Each mixer shall be furnished with a squirrel cage, induction motor enclosed in a watertight housing suitable for use and compatible with variable frequency drive systems without special order requirements such as “inverter duty”. The motors shall be furnished with moisture resistant Class F insulation treated to be moisture resistant, NEMA B design designed for continuous duty and shall be non-overloading throughout the entire mixer range of operation without utilizing the motor service factor. Motors shall be capable of sustaining 15 starts per hour (unlimited starts with VFD) at a minimum ambient temperature of 40 degrees C. Motors shall be capable of uninterrupted operation with a voltage drop of 10 percent.

B. The motor rotor and stator, as well as all bearings shall be located in an air-filled chamber that is isolated from the seal chamber. Motor cooling shall be accomplished by submergence in the mixed liquid. Thermal switches shall be furnished to monitor stator temperatures. The stator shall be equipped with two thermal switches, embedded in the end coils of the stator winding. Thermal switches shall automatically de energize the motor when its temperature exceeds a preset limit. The mixer manufacturer's nameplates shall be engraved or stamped on stainless steel and fastened to the motor casing with stainless steel screws or drive pins.

C. Power and control cables shall be furnished in lengths to run continuously from the mixer to the mixer control panel or disconnect as shown on the Contract Drawings and as specified herein. Cables shall terminate with conductor sleeves. Cables shall be of the "NSSHOU" type and shall conform to industry standards for loads, resistance under submersion against sewage, and be of stranded construction. The power cables entering the motor housing shall prevent the moisture from gaining access to the motor even in the event of complete power or control cable break while under water. The cables shall enter the mixer through a heavy-duty entry assembly that shall be provided with an internal grommet assembly to protect against tension once secured and must have a strain relief assembly as part of standard construction. The cables for each mixer shall be bundled in 10 feet segments for overall neatness and ease of mixer removal.

2.04 MIXER GEAR REDUCER

A. The motor shall drive the submersible mixer propeller through a planetary gear reduction drive system. The motor shaft shall be fitted with a gear that uses high efficiency teeth to engage the gear section. The gear system shall be custom matched to allow for propeller speed changes by ordering and installing new gearing. The gear section shall be designed to withstand 100 percent lock stress from the propeller without gear or bearing damage. Each gear shall be supplied with precision bearings, which are lubricated by the gear lubricant in the gear chamber. The gear section shall be fitted to the output propeller shafting using a straight spline connection. The gear section design shall be such that with regular oil changes, no further maintenance should be required during the life of the submersible mixer in the installation. Gear oil changes shall be easily made using external stainless-steel pipe plugs that are sealed via nylon washers. Standard 80 to 90-weight gear oil either normal or synthetic shall lubricate the gear section.

B. Direct-driven, motor speed units are not allowed on this Project.

C. Each anoxic submersible mixer shall be provided with two separate seal oil chambers. The inner chamber shall be located between the motor and the gear reducer and the outer chamber shall be located between the gear reducer and the propeller. The anaerobic mixer shall have the outer chamber only between the motor and the propeller. Each mixer shall be provided with two (anoxic) or one (anaerobic) set(s) of independent mechanical seals running in an oil bath. The sealing system shall require failure of mechanical seals prior to moisture entering the motor.

D. The two mechanical seals shall be interchangeable from one location to the other and each set shall have solid silicon carbide seal face material on both the stationary and rotating components. The metal components of the mechanical seal case shall be constructed of Type 316 stainless steel.

2.05 INSTRUMENTATION AND CONTROLS

A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements.

B. Functional Requirements:

1. A moisture sensor probe shall be furnished in the seal oil pre-chamber of each mixer.
2. A motor thermal protection switch shall be furnished.
3. A relay for connection to moisture sensor probe and motor thermal protection switch shall be furnished.
    a. Enclosed in NEMA 4X, Type 316 stainless steel enclosure for mounting near motor.
    b. Powered by external 120V ac power source.

2.06 MIXER SHOP TEST

A. Each submersible mixer shall be given a factory test during which the mixer shall be run for a minimum of one-half hour. Tests shall show that the mixer has the general characteristics of amp draw, starting capability, and such other properties as appear on the approved submersible mixer shop drawings without overheating or excessive vibration.

B. One copy of all test data shall be submitted with the Operation and Maintenance manuals. As a minimum, shop test results shall include the following information:

1. Tests for each submersible mixer showing:
    a. Mechanical and electrical integrity check established by physical inspection and by megger prior to applying power.
    b. Power leads shall be applied, and the motor started to verify proper rotation.
    c. Mixer shall be run in the submerged condition to verify amp draw, starting capability, mechanical and electrical integrity.
    d. After running, the unit shall again be checked by megger and by physical inspection.

2.07 MIXER PROPELLER AND SHAFT

A. Mixer propellers shall be PUR (closed cell polyurethane resin) and/or ductile cast iron or steel that is resistant to chemical effects and provides the highest mixing efficiency due to the blade cross section. Welded steel or stainless-steel propellers shall not be accepted. The propeller vanes shall be smooth, finished throughout, and shall be free from sharp edges. The surface of the

propeller shall be free from defects and surface protrusions and shall be smooth. Propellers shall be statically and dynamically balanced.

B. Propellers shall be statically and dynamically balanced after assembly to the rotor. Propellers shall be slip fit and securely held to the shaft by a stainless-steel washer and bolt assembly that is enclosed in a separate hub chamber.

C. The hub chamber is fitted with an O-ringed cap that seals the entrance of the propeller hub chamber device. The output shaft shall be splined to mate with the matching spline insert of stainless steel that forms the hub of the propeller. The arrangement shall be such that the propeller cannot unscrew or be loosened by torque from either forward or reverse rotation. Designs based on threaded connection between mixer shaft and impeller will not be considered.

D. Mixer shafts shall be series 421 stainless steel with a minimum 1.375 inches diameter. Shafts shall be supported by bearings for axial and radial thrust and bearing life shall be designed to provide minimum B10 = 100,000 hours at design flowrate. All shafts shall be dynamically balanced and shall be amply sized to minimize shaft deflection. Shaft overhang shall not exceed 2.5 times the shaft diameter where it passes through the mechanical seal area and the overhang shall be the length of the shaft from the propeller side of the last bearing closest to the hub of the propeller.

E. The engineer reserves the right to require submission of a sample of the output shaft detail drawing details to independently verify submittal calculations. Carbon steel shafts with or without shaft sleeves are not acceptable or equal to stainless steel.

2.08 MIXER MOUNT ASSEMBLY

A. Each mixer shall be provided with a stainless-steel mixer mount assembly to serve as a guide mast for the mixer during installation and to guide the mixer for removal from the liquid for service. The assembly shall consist of a minimum 3-inch by 3-inch tube and an upper and lower bracket constructed of stainless steel. The assembly shall also contain a stainless-steel floor-mounted bracket to support and securely hold the mast assembly and shall allow horizontal rotation of the mast through not less than 120 degrees. The mast bearings shall be constructed of Teflon.

B. The mast assembly shall be capable of proper operation with the mixer operating in any direction. The mixer mast shall be designed in such a way that the mixer can be lowered onto and off of the mast. The upper guide holder assembly shall secure the system to the top platform/wall and shall provide lateral support for the guide pile and a securing device for the electrical motor cable.

C. Each mixer shall be provided with a crane assembly permanently located at the top of the basin over each mixer. The boom arm of the mixer shall be designed to properly reach and locate the mixer and to alter the angle of the mixer to assure proper mixing angles. The boom shall include a rotational turning handle and shall be capable of rotating a minimum of 360 degrees within the receiving box by means of a Teflon bearing. Each crane assembly shall include a winch and a minimum 1/4 inch, Type 316 stainless steel lift cable with proper length to remove and set the mixer on the walkway. The winch assembly shall be capable of manual lift. All anchor bolts for the rail, mast and crane assembly shall be Type 304 stainless steel.

2.09 MIXER CASING AND COATING

A. Casings shall be manufactured from ASTM A48 Class 35 or 40 close-grained cast iron. The outside contours of the mixer(s) shall be shaped to reduce hydraulic losses and to aid in mixing efficiency. Each casting shall be free from porosity, voids, casting fins, and other casting quality defects. The surface shall be smooth to the touch and free from all sharp edges and coated with ceramic base coating for chemical and abrasion resistance. Corners shall have smooth radius contours to avoid sharp edged corners and surfaces.

B. The entire body of the mixer assembly shall be abrasive blasted to SSPC-SP10 with a minimum 2.5 mil profile. The mixer shall then be immediately coated with a minimum of 15 mils of Ceramic compound. The Ceramic compound shall be a two-part polymer/ceramic design for airless spraying, cold-curing, solvent free and include reinforcing with special fillers and extenders. The corrosion resistance below the surface of the coating shall be capable of withstanding ASTM salt spray test for over 3000 hours. Epoxy, enamel coatings or stainless-steel sheet covering a cast iron body will not be considered as equal to the specified coating system and will not be accepted.

2.10 MIXER SPARES

A. The units shall be supplied with the following spare parts for each mixer size:

1. One set of bearings.
2. One set of mechanical seals set.
3. One set of O-rings.

PART 3 EXECUTION

3.01 TESTING

A. The final acceptance of the equipment requires a field test for handling the specified fluid under specified conditions.

B. Furnish for each unit, certified performance curves that show efficiency, speed range, brake horsepower, at no extra charge.

C. Make available to the Owner without charge, all test records, whether test witnessing is required or not on the Data Sheet.

3.02 INSTALLATION

A. Provide stainless steel mounting bolts, washers, and nuts and install the equipment at locations indicated on the Drawings.

B. Install the equipment in accordance with the manufacturer's instructions and typical installation detail included in this section.

3.03 STARTUP

A. Before operating equipment, provide the services of a qualified manufacturer's service representative to inspect, operate, test, and adjust the equipment after installation.

B. Submit the manufacturer's representative's signed report describing in detail the inspection, tests and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance. The report must verity that the equipment conforms to the requirements of the Contract for the service intended and is ready for permanent operation. Provide copies of this report to be included in the installation, operation and maintenance manuals.

C. Included in the Inspection:

1. Soundness (without cracked or otherwise damaged parts).
2. Completeness of installation as specified and as recommended by manufacturer.
3. Correctness of setting, alignment, and relative arrangement of various parts of system.

D. Operate, test, and adjust equipment to prove that it is satisfactorily installed to operate under the intended conditions as specified.

E. Equipment will only be accepted after receipt of the manufacturer's representative's report.

F. Provide notice in writing at least 48 hours before manufacturer's representative is scheduled to perform these activities.

G. Modify or replace equipment or materials failing required tests.

H. Perform additional testing required due to changes of materials required by Supplier or as a result of failure of materials or construction to meet specifications.

I. Unconditionally guarantee the equipment to meet or exceed the design criteria detailed in this specification.

END OF SECTION

SECTION 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
2. ASTM International (ASTM):
   a. C177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   b. D638, Test Method for Tensile Properties of Plastics.
   c. D648, Test Method for Deflection Temperature of Plastics Under Flexural Load.
   d. D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   e. D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   f. D833, Standard Definitions of Terms Relating to Plastics.
   g. D1505, Test Method for Density of Plastics by the Density-Gradient Technique.
   h. D1525, Test Method for Vicat Softening Temperature of Plastics.
   i. D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
   j. D1622, Test Method for Apparent Density of Rigid Cellular Plastics.
   k. D1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   l. D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   m. D1940, Method of Test for Porosity of Rigid Cellular Plastics.
   n. D1998, Specification for Polyethylene Upright Storage Tanks.
   o. E84, Test Method for Surface Burning Characteristics of Building Materials.

1.02 DEFINITIONS

A. XLHDPE: Cross-linked high-density polyethylene.

1.03 DESIGN REQUIREMENTS

A. Manufacturer shall design bulk chemical storage tanks, including wall thickness and methods and locations of support and anchorage. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.

B. Tank manufacturer must be capable of providing UL Listing for Nonmetallic Aboveground Tanks for Chemicals.

C. The tank shall be a dual-wall as shown below in the Table. Where dual wall, the containment volume shall have a volume equal to or exceeding the nominal tank volume,

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Provide catalog cuts for all off-the-shelf items.
   b. Detailed fabrication drawings shall be scale drawings showing the relative size, configuration, location, materials of construction, and details of all equipment and materials to be furnished including the tanks, fittings, access ladders, supports, and tank holddown and support systems. Both plan and elevation views shall be provided. All piping terminal points shall be clearly shown and fully dimensioned.
   c. Resin used for each tank and all supporting specifications for resins.
   d. Foundation and Anchor Bolt Drawings: Drawings shall be provided that show all data and details required for design of the tank foundations including locations and dimensions for knockouts and embedded items, and the size, type, location, embedment and projection of anchor bolts.
   e. Complete design calculations for tanks, supports and appropriate accessories. Diagrams and calculations shall be provided that indicate all static and dynamic loads have been considered in the tank design. Reactions (uplift, shear, gravity loads) due to static and dynamic loading conditions due to wind and seismic loading conditions shall also be shown. on the submittal Drawings. Calculations for anchor bolt type, size, and location shall be indicated for the controlling dynamic load condition.

f. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.
g. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
h. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.
i. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a listing of procedures used in testing.
j. Installation instructions shall be completed, detailed, and sequenced instructions for original installation. Recommended methods for assembly and adjustment including all bolt torques shall be provided along with special precautions and the sequence of work. Rigging and lifting details shall also be included for all factory-fabricated assemblies and individual components weighing over 100 pounds.
k. All exceptions and any proposed revisions to the requirements of the Specifications shall be included with the Submittals.

2. Samples: Representative Samples of the high density cross-linked polyethylene with anti-oxidant resistant linear low density polyethylene liner tank shall be provided.

B. Informational Submittals:

1. Fabricator's Certificate of Compliance with fabrication requirements.
2. Quality Assurance Inspection:
   a. Initial QA Inspection Report.
   b. Certification of Factory Testing.
3. Special shipping, storage and protection, and handling instructions.
4. Fabricator's written/printed installation and tank support instructions.
5. Manufacturer's Certificate of Proper Installation.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Fabricator's Quality Assurance Supervisor: Minimum of 5 years' experience in the fabrication of polyethylene storage tanks of similar size and usage.

B. Tanks shall be manufactured by a firm with a nationally accepted quality standard (such as, ISO9001).

1.06 DELIVERY, STORAGE, AND HANDLING

A. All materials fabricated to this specification must be packaged, crated, or protected in such manner so as to prevent damage in handling and while in transit. Details of these procedures shall be the responsibility of manufacturer.

B. In addition, prepare and protect tanks for shipment as follows:

1. Mount tanks on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
2. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2 inches greater than the outside diameter of the flange.
3. Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all unflanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.
4. Do not ship components or other pieces loose inside the tanks.
5. Load tanks with at least 2 inches clearance between the tank (including fittings) and the bulkheads or bed of the vehicle.
6. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.
7. Nozzles or other fittings shall not be used for lifting.

1.07 SPECIAL GUARANTEE

A. Tanks shall have a minimum 2-year guarantee from the tank manufacturer, covering the complete cost of repair and replacement of the tanks (not including any costs associated with altering, removing, or demolishing the existing facility structure for such removal which shall be borne by Contractor) during the first 2 years of service, should leakage occur through the tank or the tank fittings, or should the tank or tank fittings show signs of fatigue or failure as determined by Engineer.

PART 2 PRODUCTS

2.01 GENERAL

A. All equipment specified herein shall be factory fabricated and assembled to the maximum extent possible requiring a minimum of field assembly. Field installation shall be limited to anchoring the tanks and making external piping connections.

B. All equipment specified herein shall be suitable for contact with the stored chemicals.

C. Like items of materials and equipment shall be the end products of one manufacturer in order to provide standardization for appearance operation, maintenance spare parts, and manufacturer's service.

2.02 MANUFACTURERS

A. Poly Processing Company.

B. Or approved equal.

2.03 SERVICE CONDITIONS

A. Location: Outdoors.

B. Tank Tag: 41TNK0401

C. Ambient Air Temperature Range: Minus 19 degrees F to 110 degrees F.

D. Relative Humidity: Up to 100 percent.

E. Operating Pressure: Atmospheric.

F. Stored Materials:

Stored Materials		
Equipment	**Chemical**	**Specific Gravity**
Liquid Alum Tank (41TNK0401)	49% $Al_2(SO_4)_3$	1.34
*Wall thickness calculations shall be based on tank contents with a specific gravity of 1.9.		

2.04 TANK DESIGN CRITERIA

A. Tank shall be a dual wall tank with integral secondary containment.

B. Seismic Load: Tanks should be designed in accordance with the seismic design criteria on Sheet 001-G-1005.

C. Wind Load: Tanks should be designed in accordance with the structural design criteria for wind loads as shown on Sheet 001-G-1005.

D. Live Load: 200 pounds per square foot.

E. Concentrated Load: 300 pounds.

F. Special Loads: Design tanks for dead loads from all attached piping.

G. Hydrostatic Load: For specific gravities of stored materials specified herein. Tanks shall be designed in accordance with the seismic design criteria on Sheet 001-6-005.

2.05 TANK CONSTRUCTION

A. Tanks specified herein shall be a dual wall tank using cross linked high-density polyethylene construction with interior anti-oxidant resistant linear HDPE liner and outer containment tank and integrally mounted flanged outlet (IMFO) and shall meet or exceed all requirements of ASTM D1998.

B. Tanks shall be vertical, flat bottom, dome top construction with translucent materials to allow observation of liquid level.

C. Tank manufacturer must be capable of issuing gel test results with 1/8-inch inner wall reading no less than 65 percent and outer wall no less than 90 percent gel. Entire thickness must be at least 80 percent gelled.

D. The XLHDPE tanks shall be constructed using the rotational molding process.

E. All resin used shall be virgin, crosslinked resin and no reground material may be added. The polyethylene resin shall be provided with a UV inhibitor offering the maximum available protection from UV degradation. The resin shall have a minimum of 0.3 percent UV inhibitor and provide a minimum UV protection value of UV-4.

F. Tanks shall be fabricated to the dimensions shown on the Drawings and as listed in the Tank Schedule:

Tank Schedule				
Chemical Name	**Minimum Capacity**	**Maximum OD Diameter***	**Total Tank Height***	**Wall Configuration**
Liquid Alum	750 gal	5’-0”	8’-2-½”	Dual Walled
*Tank sizes are nominal sizes.				

G. Materials shall meet or exceed the following properties:

Parameter	**ASTM Test**	**Requirement**
Density	D1505	0.944 - 0.946 gm/cc
Environmental Stress, Cracking Resistance (F50)	D1693	1,000 hrs
Tensile Strength, Ultimate (2" min.)	D638	2,600 - 3,000 psi

Parameter	ASTM Test	Requirement
Elongation at Break (2" min.)	D638	400%
Vicat Softening Point	D1525	240 degrees F
Flexural Modulus	D790	100,000 psi
Brittleness Temperature	D746	-130 degrees F
Heat Distortion Temp	D648	67 degrees C
Polyethylene Notch Test (PENT)	F1473	>1,000 hours

2.06 TANK SUPPORT AND RESTRAINT SYSTEM

A. Each tank and its associated attachments shall be structurally adequate for all tank design criteria specified herein.

B. Provide a minimum of four Type 316 stainless steel holddown lugs, complete with plate, anchor bolts, nuts, and washers for proper anchoring of the tank. Actual number of holddown lugs shall be calculated with the tank full.

C. All exposed metal surfaces not constructed of stainless steel shall be painted in accordance with and as specified in Section 09 90 00, Painting and Coating.

2.07 FITTINGS

A. Tank fittings and openings shall be provided as listed in the Fitting/Opening Schedule and located as shown on Drawings.

Fitting/Opening Schedule		
Service	**Type/Location**	**Diameter**
Fill	Flanged/Top	2 inch
Vent	Flanged/Top	3 inch
Overflow	Flanged/6" below tank top	2 inch
Discharge	Flanged at tank bottom	2 inch
LE 0401 Port	Flanged/Top	8-inch
LSH 0401 Port	Threaded/Top	2-inch

B. Provide fill pipe drop leg inside tank connecting to fill connection. Pipe drop leg shall extend down into tank interior and shall have a 45-degree elbow installed on its end to discharge to interior sidewall of tank. Drop leg shall be supported internally by a pipe support. Pipe support shall be a bolted fitting at tank sidewall.

C. Fittings shall be PVC compressive type, with long shank, deep cut threaded with dual wide nut assembly. End type of fittings for connection to facility piping shall be as shown in the Fitting/Opening Schedule.

D. All flanged fittings shall be gasketed with materials compatible with the chemical service.

E. Bolted fittings shall use Type 316 bolts with polyethylene-encapsulated heads and PVC external flanges.

F. All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be of metallic construction.

2.08 ACCESSORIES AND APPURTENANCES

A. All tank accessories and appurtenances shall be chemically compatible with the stored materials and shall be designed to withstand the hydrostatic pressure resulting from a full tank.

B. Calibration Tape: Calibration tape shall be self-adhesive, translucent tape calibrated in multiples of 50 gallons or less. Strips shall use black numerals and tick marks to denote gallonage.

C. Gaskets:

1. Material compatible with chemical service, low torque, full face, ASME B16.1 dimensions, two concentric, convex, molded rings between center hole and bolt hole circle.
2. Type: 1/4-inch thick, low torque, full face, ASME B16.1 dimensions.

D. Pipe Supports:

1. Provide pipe supports for the fill pipe, overflow pipe, and discharge pipe attached to the tank.
2. Spacing of pipe supports shall be as recommended by the fabricator, but shall not be greater than 5 feet on center.
3. Pipe supports shall allow removal of supported pipes.
4. Complete with Hastelloy C bolts, nuts, washers, and other necessary hardware for easy field assembly.

E. Lifting Lugs: Provide suitably attached for all tanks weighing over 100 pounds. Lifting lugs shall be bolted fittings in sidewall of tank. Bolted fittings shall be as specified herein.

F. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 3/4-inch diameter, or as shown and as specified in Section 05 50 00, Metal Fabrications.

G. Leak Detection Switch (41LSH0401):

1. Include sensor, switch and interconnecting cable.
2. Sensor: All plastic, corrosion resistant.
3. Switch:
   a. Toggle switch: Normal, Test and Silence positions.
   b. Input power: 120V ac.
   c. Switch Enclosure: NEMA 4X.
   d. Output: Dry contacts.
4. Manufacturer and Model: Poly Processing Polylevel switch and Levelpro LDS-YN sensor or approved equal.

2.09 SOURCE QUALITY CONTROL

A. General: The tank fabricators shall have a quality control procedure adequate to ensure that all fabrication complies with these Specifications.

B. Factory Tests:

1. Impact Tests: A representative sample from each tank shall undergo a factory impact test. Impact test must meet the requirements of ASTM D1998.
2. Gel Tests: A representative sample from each tank provided shall undergo a factory gel test, as prescribed by ASTM D1998.
3. Hydrostatic Leak Tests:
   a. Perform on each tank.
   b. Fill to overflow nozzle; allow to stand for 24 hours with no visible leakage.
4. Wall Thickness: Each tank shall have an actual wall thickness measurement taken at every 90 degrees, at each one foot elevation, up to three feet from the bottom of the tank.
5. Reports: Certify, by signature, the results of the factory testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with the manufacturer’s written instructions.

B. Contractor shall provide all supervision, labor, tools, construction equipment, incidental materials, and the necessary services required to complete the installation and testing of the equipment.

C. Accurately place anchor bolts using templates furnished by the manufacturer or as otherwise recommended by manufacturer and as specified in Section 05 50 00, Metal Fabrications.

D. Tanks shall be installed in such a manner that no stresses shall be applied to flanged outlet as per manufacturer's installation instructions.

E. Uniform and level surface contact shall be made between all tank bottoms and the support foundations by means of grouting. Tanks shall be set in wet grout tapered from a point 1 inch higher at tank center to the foundation edges. Initially, grouting shall be finished to leave no voids. Tanks shall be settled down squeezing out excess grout in such a manner as to leave no voids in the tank bottom/foundation interface. The grout shall not be used to support any load, only to fill irregularities in the tank bottoms and foundations. The in-place tanks shall not be exposed to any loads until the grout has hardened.

F. Bolt torques on gaskets shall be as recommended by the equipment manufacturer.

3.02 FIELD QUALITY CONTROL

A. Field Tests:

1. Hydrostatic Test: Storage tanks shall be filled with clean water to the overflow level after all connections have been made. There shall be no leakage, no signs of weeping, and no signs of capillary action over a period of 48 hours.
2. Quality control shall include a final inspection by Contractor and a written record of this final inspection.
3. After testing, the tanks shall be thoroughly cleaned and dried.

3.03 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and classroom designated by Owner for the minimum person-days listed for the services hereunder, travel time excluded:

1. 1 person-day for inspection and certification of the installation.

B. Manufacturer shall certify in writing:

1. Equipment has been provided in accordance with this specification.
2. Equipment has been installed in accordance with the manufacturer's recommendations and inspected by a manufacturer's authorized representative.

3. Proper mechanical connections have been made.
4. Equipment is ready for startup and operation.

3.04 CHEMICALS SUPPLIED BY CONTRACTOR

A. Fill storage tanks with potable water prior to functional and performance testing. Replace water with 49 percent upon completion of testing prior to Contract Closeout.

B. Coordinate with Owner to ensure delivered chemical adheres to Owner's specifications for the chemical.

END OF SECTION

SECTION 44 15 00
LOW SPEED MECHANICAL SURFACE AERATORS

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. Contractor shall furnish four low speed, fixed, mechanical surface aerators suitable for operation in the Process Bioreactors as shown on the Drawings. Each aerator shall consist of an adjustable frequency drive, drive motor, gear reducer, coupling, shaft, and open-type vane impeller. These surface aerators shall be supplied by the same manufacturer as the Section 44 16 00, Flow Control Gate, and the Section 43 22 56.01, Submersible Mechanical Mixers in order to ensure uniformity of responsibility for the performance of the 5-stage Bardenpho system as per the requirements in Section 44 44 44, Process Bioreactor System.

B. Equipment Names and Tag Numbers:

1. Surface Aerator No. 1-1, 1-2, 2-1, 2-2: 05AER1301, 05AER1401, 05AER1302, 05AER1402.

1.02 GENERAL

A. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

B. General Requirements: See Division 1, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

C. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

D. Adjustable Frequency Drive Requirements: Section 26 29 23, Low-Voltage Adjustable Frequency Drive System. Coordination shall include a letter verifying the compatibility of the AFDs with the motor and coordination of AFD sizing requirements.

E. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems.

F. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

G. All equipment and materials furnished under this Contract shall be constructed with due regard to safety of operation, accessibility, durability or parts, and shall comply with all applicable OSHA, state, and local safety requirements.

1.03 REFERENCES

A. American Gear Manufacturers Association (AGMA).

B. National Electrical Manufacturers Association (NEMA).

C. American Federation of Bearing Manufacturers Association (AFBMA).

D. American Society for Testing and Materials (ASTM).

E. American Welding Society (AWS).

F. Steel Structures Painting Council, American National Standards Institute (SSPC).

G. National Fire Protection Association (NFPA).

H. Underwriters Laboratories Inc. (UL).

1.04 SUBMITTALS

A. Shop Drawings:

1. Make, model, and weight of each major item of equipment (including motor, gear reducer, shaft, and impeller).
2. Complete catalog information, descriptive literature, Specifications, dimensions, and materials of construction for the aerator.
3. Certified factory test results documenting the Standard Oxygen Transfer Rate (SOTR) for the aerators and a copy of the test procedures used to generate the SOTR value/curve.
4. Estimate of the thrust and vibrational dynamics when the aerator is running at full load.
5. Motor data, in accordance with the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
6. Adjustable frequency drive data, in accordance with the requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

7. Written certification that the proposed aerators are approved for use on this Project and are guaranteed to meet the specified velocity requirements.

B. Quality Control Submittals:

1. Factory functional and performance test reports.
2. Manufacturer's certification that the factory finish system is identical to or exceeds the requirements specified herein.
3. Manufacturer's written instructions for performing a vibration analysis test.
4. Manufacturer's written installation, operation, and startup procedures including lubrication requirements.
5. Spare parts list to maintain the equipment for a period of 5 years.
6. Operation and Maintenance Manual.
7. List of procedures for the Contractor to follow while storing the equipment onsite prior to installation.

1.05 SPARE PARTS / EXTRA MATERIALS

A. Furnish for each size Aerator:

1. One oil sensing cutout switch.
2. One flexible motor coupling.
3. One cast iron split flange impeller coupling.

1.06 WARRANTY

A. The manufacturer shall provide a full warranty on all parts and labor for 60 months from acceptance by the Owner and in beneficial use.

PART 2 PRODUCTS

2.01 GENERAL

A. The aerator manufacturer shall be responsible to review the requirements specified in Section 26 20 00, Low Speed AC Induction Motors, and Section 26 29 23, Low Voltage Adjustable Frequency Drive System, and provide ADFs and motors which meets the requirements specified in these two sections.

B. The equipment Included in this Scope of Supply includes the following:

1. Four Adjustable Frequency Drives (AFD).
2. Four inverter duty motors.
3. Four gear reducers.

4. Four rag-less impellers, shafts, and couplings.
5. Jacking studs for insertion in the concrete, including leveling nuts.
6. Reducer base mounting plate.
7. All required assembly bolts and nuts.
8. Surface preparation and painting as specified.
9. Submittals and manuals.
10. Service as specified.

C. The mechanical surface aerators will be mounted on fixed platforms and specifically designed for application in the Process Bioreactors as shown on the Drawings to both oxygenate and mix the basin contents.

D. The Contract Drawings show the general arrangement of equipment, devices, and supports, based on preliminary drawings provided by the Bioreactor System Manufacturer, OVIVO. The Contractor shall verify that the Low Speed Mechanical Surface Aerators manufacturer's shop and installation drawings are coordinated with the Contract Drawings and it shall be responsible of the System Manufacturer for fully coordinating, in all respects, with the Contract Documents. Any modifications to the Contract Drawings required based on the System Manufacturer's requirements for changes shall pay for re-engineering cost and it be the responsibility of the Contractor and Bioreactor System Manufacturer for all associated costs. There will be no additional cost paid to the Contractor for any changes required.

2.02 EQUIPMENT MANUFACTURER

A. Ovivo.

B. WesTech.

C. Or approved equal.

2.03 AERATOR PERFORMANCE

A. The aeration equipment shall provide sufficient pumping to maintain an average channel velocity of no less than 1.0 fps with two aerators operating at full nameplate horsepower (75 horsepower per aerator) condition. An average velocity of at least 0.7 fps must be maintained with two aerators operating at minimum impeller submergence, each drawing no greater than 60 percent of full nameplate horsepower (45 horsepower per aerator). The aerators shall be capable of maintaining the required velocity throughout the full depth of the basins.

B. The aeration equipment shall be capable of operating at the specified liquid levels of mixed liquor in the Process Bioreactor so that oxygenation and power draw will vary as desired to respond to load variations to the plant.

C. The aeration equipment shall be capable of delivering an oxygen transfer efficiency of no less than 3.0 pounds O_2/horsepower-hour based on motor output power at standard transfer conditions.

D. The aerators provided under this section shall meet the following design conditions:

1. Each 75 horsepower aerator shall provide a minimum of 262 pounds oxygen per hour at standard conditions of 20 degrees C, aerating clean tap water having 0 mg/L dissolved oxygen, oxygen solubility coefficient (beta) equal 1.0, oxygen transfer coefficient (alpha) equal 1.0 and a pressure of one atmosphere.
2. Each 75 horsepower aerator shall provide a minimum of 116 pounds oxygen per hour at actual site conditions of 30 degrees C, mixed liquor suspended solids of 4,000 mg/L and having 2.0 mg/L dissolved oxygen, oxygen solubility coefficient (beta) equal 0.95, and oxygen transfer coefficient (alpha) equal 0.85. The mixed liquor suspended solids concentration shall not vary more than 10 percent greater or 10 percent less than the average mixed liquor concentration in the basin when measured at any point in the basin.
3. Site Conditions: (Reference final Drawings for Elevations, Elevations given are approximate)
    a. Liquid Surface at Annual Average Day Flow: 829.66-feet msl.
    b. Liquid Surface at Peak Hour Flow: 829.75-feet msl.
    c. Top of Aerator Platform: 836.75-feet msl. (Verify with Contractor prior to Shop Drawing production.)
    d. Nominal Mixed Liquor Depth: 14 feet.
    e. Weir Elevation: 829.50 feet. (Verify with Contractor prior to Shop Drawing production.)

2.04 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.05 ACCESSORIES

A. Equipment Identification Plate: 16-gauge Type 304 stainless steel securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch die-stamped block type black enamel filled equipment identification number and letters.

B. Lifting Lugs: For all equipment weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel, sized by the equipment manufacturer and provided by the Contractor.

2.06 PAINTING

A. The motors and gear reducers shall be factory prepared, and primed, and field finish-coated in accordance with Section 09 90 00, Painting and Coating, System No. 4.

B. The shafts and impellers shall be factory prepared and primed and field finished-coated in accordance with Section 09 90 00, Painting and Coating, System No. 2.

2.07 CONTROLS SYSTEMS

A. General: See Section 40 99 90, Package Controls System, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 99 90, Package Controls System.

B. Functional Requirements:

1. Provide motor thermal protection switch for all motors. Refer to Section 26 20 00, Low Voltage AC Induction Motors for thermal protection requirements.
2. Provide oil pressure switch for all gear reducers.

2.08 GEAR REDUCERS

A. Each gear reducer shall be of the helical gear type and shall be manufactured with horizontally split, 2-piece housing with a minimum service factor for all components of the reducers of at least 2.0 times the motor nameplate horsepower rating in accordance with applicable AGMA standards. The minimum B-10 bearing design life shall be 100,000 hours, except those attached directly to the output shaft which shall have a B-10 life of 250,000 hours. The efficiency shall not be less than 94 percent based on the gear reducer input horsepower. Bearing life shall be rated based on operating continuously at the rated full load horsepower and speed.

B. The gear reducers shall be designed for vertical output shaft operation and the housing shall be cast iron construction with provisions for the attachment of suitable lifting devices. Helical meshes are acceptable. Worm gearing shall not be used. Pinion and gear materials shall be left to the discretion of the manufacturer provided they are rated according to appropriate AGMA durability and strength requirements. The helical gear teeth shall be machined and then surface-hardened; pinion teeth shall be machined, case-carburized and then ground. Pinions shall be made of alloy steels. Shafting shall be made of medium carbon steel. Flame hardened gears will not be acceptable. All shafts shall be supported on tapered roller or double spherical roller bearings.

The gear reducer housing shall be sealed with a corrosion-resistant paint to provide maximum protection against moisture and contaminants. All gears shall be made from alloy steels with sufficient hardenability to obtain case and core properties meeting the requirements for grade 2 material in accordance with ANSI/AGMA 2001-C95. The steel alloy shall be selected and the heat treatment shall be controlled to obtain a microstructure that meets all the requirements for grade 2 material in accordance with ANSI/AGMA 2001-C95.

C. All gears shall meet the accuracy requirements for AGMA quality No. Q11 in accordance with ANSI/AGMA 2000-A88. Pitting resistance and bending fatigue resistance shall be rated in accordance with ANSI/AGMA 2001-C95.

D. Each gear reducer shall be mounted on a steel baseplate with Type 316 stainless steel bolts. The baseplate shall be mounted on four Type 316 stainless steel jack studs inserted in the equipment pad of the platform structure and adequately designed to withstand all normal operating loads. The jack studs shall have the capability to provide a total vertical adjustment of 6 inches. Because of the 6-inch vertical adjustment, the anchor bolt height above the equipment pad shall be greater than 6 inches to allow for the nuts and equipment pad.

E. Each gear reducer shall be equipped with a lower bearing housing. Additionally, the output shaft shall be designed to handle a radial bending moment load, applied at the centerline of the shaft while maintaining the 250,000-hour bearing life, of at least 26,900 pounds.

2.09 GEAR REDUCER LUBRICATION

A. The lubrication of the speed reducer shall conform to AGMA 9005-D94. A reliable lubrication system, externally accessible, shall be provided for the gears and bearings. The lubrication system shall include an internal mechanically driven oil circulating pump which incorporates a proven, reliable pressure gauge and pressure switch. Each electrical switch shall be wired to its respective aerator motor control center. External oil cooling will not be permitted. The unit shall be provided with a dipstick or sightglass to observe oil levels. An oil fill and drain lines shall be sufficient size to permit efficient functioning and shall be located on the gear unit in a position which is easily accessible from the bridge platform. The oil drain piping shall be installed so that a container may be placed under the drain discharge. The Contractor shall supply the first charge of run in oil for the reducers, and if necessary due to run time, the change of oil. The Contractor shall purchase the oil from a local firm selected by the Owner, in accordance with the information in the Operation and Maintenance Manual, to assure lubricant compatibility.

B. All grease lubricated bearings shall have seals to retain the grease. The low-speed shaft shall have grease lubricated bearings and shall have a dry well to prevent oil leakage. The dry well shall fully enclose the output shaft and extend into a groove on the underside of the output gear. The well shall be sealed to prevent oil intrusion by an oil seal. Additionally, the output end of the well shall include the upper and lower bearing seals and a separate oil seal. All grease lubrication pressure lines shall be fed from fittings accessibly located above the platform supporting the mechanism.

C. The housing shall be constructed of high tensile strength gray cast-iron conforming to ASTM A48 Class 30, minimum, with integral dry well construction to eliminate oil leakage at the output shaft and prevent loss of lubrication in the event of a seal failure. The housing shall be stressed relieved prior to machining. The housing shall be tested to preclude casting porosity or weld defects that could result in oil leakage. Lifting lugs shall be provided on the housing suitably located to enable safe removal of the combined electric motor and gear unit from the supporting platform. Removable inspection cover(s) or inspection port(s) shall be provided.

2.10 IMPELLERS AND COUPLINGS

A. The surface impeller shall be of a design for use in oxidation ditch systems and utilize a single surface impeller or a surface and submerged impeller connected to a common aerator shaft. The impeller design shall provide sufficient oxygenation and propulsion of the mixed liquor at all depths in the oxidation ditch at all aerators speeds.

B. The surface impeller shall operate at a maximum speed of 43 rpm. Each surface impeller shall be a rim-blade or open-vaned type with minimum eight equally spaced blades and constructed of 1/4-inch minimum steelplate. The impeller shaft shall be a hollow pipe of sufficient size and thickness to safely withstand the torque and hydraulic side forces imposed on the aerator impeller. The surface impeller shall present a minimum amount of edge perpendicular to the flow to minimize the attachment of solid materials. The impeller blades and pipe shaft shall be an integral, shop-welded unit requiring no field assembly or welding. The impeller shall be stable over the full design range of operation.

C. For the dual impeller design, the submerged radial impeller shall consist of radial pumping blades and hub that shall be an integral, shop-welded unit requiring no field assembly or welding. Each submerged radial impeller shall draw no more than 15 percent of the aerator nameplate horsepower at full speed and immersion.

D. The aerator shaft shall be attached to the gear reducer by a rigid, cast iron, split flange-type coupling. A retainer plate shall be provided for mounting to the end of the gear reducer output shaft to provide protection against disengagement of the coupling from the gear reducer output shaft. The split coupling shall be assembled with Grade 5 galvanized bolts.

E. All structural steel used in the fabrication of the aerator shall conform to the requirements of "Standard Specifications for Structural Steel" ASTM A36. All shop welding shall conform to the latest standards of the American Welding Society (AWS). Fabricated assemblies shall be shipped in convenient sections as permitted by carrier installations.

2.11 FACTORY FINISHES

A. Prepare, and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating System No. 4. Manufacturer's standard painting system may be used if similar to system No. 4 as approved by the Owner.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Refer to Section 01 91 14, Equipment Testing and Facility Startup.

B. Requirements for Factory Test, Field Test, and System Startup:

1. The motor and gear reducer assembly shall be trial fit at the factory and the reducer shall be run under no load conditions for a total of 4 hours. The gear reducer shall be run at full speed at no load for a minimum of 2 hours after the oil temperature has stabilized. The overall sound pressure level and lubricant temperature shall be recorded during steady-state operation. The coupling halves shall be factory mounted and aligned, and match marked for ease of onsite installation. The Contractor shall be responsible for assuring proper alignment and gap tolerance according to the manufacturer's recommendations, as set forth in the installation instructions.
2. Vibration Test: Test each unit for vibration after installation and the unit has passed the Alignment Test. Each motor and gearbox shall be tested in the X, Y, and Z direction at three different operating speeds and shall be bump tested. The motors shall meet the following vibration criteria:
   a. Vibration frequency less than 0.4 inch/second.
3. Vibration Test Report: Following the vibration test, a report shall be submitted which includes a detailed sound pressure emission analysis of each aerator and locations of all vibration readings.

4. Performance Test:
   a. At the Owner's option, an oxygen transfer test may be performed on the aeration equipment. If the test is required, all costs for performance of the test will be paid by the Owner except that the expenses of the aerator supplier's observer, if desired by the Manufacturer, shall be paid by the Manufacturer. The oxygen transfer test method will be as mutually agreed by the Engineer and aerator Manufacturer.
   b. In the event that the equipment furnished fails to meet the specified oxygen transfer rate, the equipment shall be modified as required until the required transfer rates are met. The Contractor and supplier shall be responsible for corrections to the Work and subsequent test runs until the defects are corrected.
   c. Fluid Motion Test: To verify compliance with the performance requirements of the aerators, channel velocity shall be measured using a suitable velocity meter at 16 points of cross-section of the channel. The location of flow measurement shall be unaffected by turbulence created by the aerator or turning sections of the basin. Submit testing procedures to the Engineer for approval prior to testing.
   d. After the speed reducer is installed and aligned, and the manufacturer's recommendations for initial startup have been implemented, the speed reducer shall be run at full speed and full load for a minimum of 2 hours after the oil temperature has stabilized. The speed reducer housing and shaft seals shall be checked for leakage of lubricant. Any leaks shall be corrected, and the temperature rise of the lubricant in the oil sump of the speed reducer shall not exceed 100 degrees F above ambient.
5. Test runs on the mechanical aerators shall be undertaken with water in the aeration basin filled up to the high-water elevation specified. The Contractor shall be responsible for providing sufficient water for filling the basins.
6. System Startup: Refer to Section 01 91 14, Equipment Testing and Facility Startup, for startup requirements.
7. Adjustable Frequency Drive Performance Test: Refer to Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

3.02 MANUFACTURERS' SERVICES

A. Manufacturer's Services for the Mechanical Surface Aerators can be found in Section 43 22 56.01, Submersible Mechanical Mixers.

3.03 SUPPLEMENTS

A. The supplement listed below, following “END OF SECTION” is a part of this Specification.

1. Induction Motor Data Sheet.

END OF SECTION

INDUCTION MOTOR DATA SHEET

Project: White House WWTP Improvements

Owner: City of White House, Tennessee

Equipment Name: Surface Aerator No. 1-1, 1-2, 2-1,2 -2

Equipment Tag Number(s): 05AER1301, 05AER1302, 05AER1401, 05AER1402

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark

Motor Horsepower: 75

Voltage: 460

Phase: 3

Frequency: 60-Hz

Synchronous Speed: 1,800 rpm

☐ Multispeed, Two-Speed:

_____ / _____ rpm

☐ Constant Horsepower

☐ Variable Torque

☒ Constant Torque

Winding: ☐ One ☐ Two

Guaranteed Minimum Efficiency at Full Load: _ percent

Guaranteed Minimum Power Factor at Full Load: __ percent

Service Factor (@ rated max. amb. temp.): ☒ 1.0 ☐ 1.15

Enclosure Type: TEFC

Mounting Type: ☐ Horizontal ☒ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up _____ Down _____

☒ Adjustable Speed Drive (AFD): See Section 26 29 23, Low Voltage Adjustable Frequency Drive System. AFDs must be suitable for constant torque application.

.

Operating Speed Range: 50% to 100% of Rated Speed

☒ Thermal Protection: Thermisters with Control Module

☒ Space Heater: 120 volts, single phase

☒ Oversize main terminal (conduit) box for motors

☒ Terminal for connection of equipment grounding wire in each terminal box

Additional Motor Requirements: ☒ See Section 26 20 00, Low Voltage AC induction Motors

Special Features:

Aerator motors shall be inverter type and suitable for use from an AFD source. The motor manufacture shall provide all special mounting hardware and structural supports to mount this motor vertically on the aerator gearbox.

SECTION 44 16 00
FLOW CONTROL GATE

PART 1 GENERAL

1.01 SCOPE

A. Contractor shall furnish one flow control gate per Process Bioreactor suitable for installation on the concrete wall of the bypass channel as shown on the Contract Drawings. The flow control gates, submersible mechanical mixers under Section 43 22 56.01, Submersible Mechanical Mixers, and the mechanical surface aerators under Section 44 15 00, Low Speed Mechanical Surface Aerators, shall be supplied by the same manufacturer in order to ensure uniformity of responsibility for the performance of the 5-stage Bardenpho system as per the requirements in Section 44 44 44, Process Bioreactor System.

B. Equipment Name and Tag Numbers:

1. Flow Control Gates: 05GTE2601, 05GTE2602.

C. The equipment furnished for each gate mechanism shall include: stand, actuator, rotating shaft, guide bearings, flow vane, fasteners and anchor bolts.

D. The flow control gate is designed to direct and control the flow from the Aeration Zone to the Pre-Anoxic Zone in accordance with the process design and operation and maintenance instructions for the system.

E. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall be 1/4-inch minimum steel thickness and reinforced as required. Type 316 stainless steel anchor bolts and Type 316 fasteners with necessary hex nuts and washers shall be provided for all parts of the gate assembly.

1.02 GENERAL

A. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

B. General Requirements: See Division 1, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

C. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

D. All equipment and materials furnished under this Contract shall be constructed with due regard to safety of operation, accessibility, durability or parts, and shall comply with all applicable OSHA, state, and local safety requirements.

1.03 REFERENCES

A. ASTM A36: Structural Steel Specification.

B. ASTM A316: Stainless Steel Bolt Specification.

C. AWS: American Welding Society Current Standards.

D. NEMA: National Electrical Manufacturers Association.

1.04 SUBMITTALS

A. Shop Drawings:

1. Certified Shop and Erection Drawings showing all important details of construction, dimensions, anchor bolt locations, and field connections.
2. Descriptive literature, bulletins, and catalogs of the equipment.
3. Installation, operation, and startup procedures including lubrication requirements.
4. Power and control wiring diagrams.
5. Total weight of the equipment with the weight of the single largest item identified.
6. A complete bill-of-materials for all equipment with the O&M Manual.

B. Quality Control Submittals:

1. Manufacturer’s installation, operation, and startup procedures.
2. Operation and Maintenance Manuals.

1.05 WARRANTY

A. The manufacturer shall provide a full warranty on all parts and labor for 60 months from acceptance by Owner for beneficial use.

PART 2 PRODUCTS

2.01 EQUIPMENT MANUFACTURER

A. Ovivo.

B. WesTech.

C. Or approved equal.

2.02 ACCESSORIES

A. Equipment Identification Plate: 16-gauge Type 304 stainless steel securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch die-stamped block type black enamel filled equipment identification number and letters.

B. Lifting Lugs: For all equipment weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel, sized by the equipment manufacturer and provided by the Contractor.

2.03 PAINTING

A. All nongalvanized and nonstainless steel surfaces shall be factory prepared, primed, and finish coated in accordance with Section 09 90 00, Painting and Coating System No. 2.

2.04 WORM GEAR REDUCER

A. The motor shall be 480 volt, 3-phase and specifically designed for actuator service. The motor will be of the induction type with class F insulation and protected by means of thermal switches embedded in the motor windings. Motor enclosure will be totally enclosed, non-ventilated.

B. Actuators shall be Rotork Controls and shall contain motor, gearing, manual over-ride, limit switches, torque switches, drive coupling, integral motor controls, position feedback transmitter and mechanical position indicator. See Section 40 27 02, Process Valves and Operators.

C. Actuator shall be NEMA 4 (watertight). All external fasteners on the electric actuator will be stainless steel. Fasteners on limit switch and terminal compartments shall be captured to prevent loss while covers are removed.

2.05 GATE COMPONENTS

A. The reducer mechanism shall be fitted to the gate shaft with a sleeve and key for ease of assembly and disassembly.

B. The reducer shall be supported on a steel stand that is anchored to the concrete floor by cinch Type 316 stainless steel anchors. The stand shall be of proper height to allow the operator a convenient grip on the handle for clockwise or counterclockwise turning.

2.06 ROTATING GATE ASSEMBLY

A. Each gate shall be constructed from 1/4-inch steel plate properly stiffened with rib extensions and end flares. Each gate shall include a revolving shaft assembly fixed between three guide bearings. The floor bearing shall be a thrust type alignment bearing supporting the entire weight of the unit. The upper guide bearing shall be an integral part of the support stand and shall be mounted just below the worm gear reducer. The center guide bearing shall be mounted just above the water surface on the lower part of the shaft and shall be field aligned after installation of all other components, assuring proper rotational capability.

B. The revolving shaft shall be supported at each end in such a manner that a slight vertical or horizontal misalignment shall not interfere with the smooth operation of the gate. The shaft shall revolve from the turning of the gear unit.

C. Each gate shall be designed to operate smoothly under the flow conditions existing in the Process Bioreactor. The gate shall include a wall stop bracket, complete with Type 316 stainless steel wall anchors.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each gate assembly shall be installed in accordance with the manufacturer’s written recommendations. The Contractor shall be responsible for assuring proper alignment and tolerances as set forth in the installation instructions.

B. Fabricated assembles shall be shipped fully assembled except for attachment of the gear reducer, stand, shaft, and guide bearings. The unit shall be designed to allow adjustment for concrete tolerances of plus or minus 1/2 inch. The unit shall be erected and lubricated in strict accordance with instructions from the manufacturer.

3.02 MANUFACTURERS' SERVICES

A. Manufacturer's Services for the Flow Control Gate can be found in Section 43 22 56.01, Submersible Mechanical Mixers.

END OF SECTION

SECTION 44 42 19.04
ROTARY POSITIVE DISPLACEMENT BLOWER

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gear Manufacturers Association (AGMA).
2. American National Standards Institute (ANSI).
3. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. National Electrical Manufacturers Association (NEMA).

1.02 DEFINITIONS

A. Absolute Discharge Pressure: Pressure in pounds per square inch absolute (psia) at the blower discharge flange in relation to Job Site barometric pressure.

B. Brake Horsepower (BHP): (Shaft) Standard curve horsepower required, corrected for pressure, temperature, and relative humidity at inlet conditions.

C. Discharge Pressure: Pressure in pounds per square inch gauge (psig) at blower discharge flange at rated capacity.

D. Inlet Cubic Feet per Minute (icfm): Volumetric rate of air at the inlet flange of the blower corrected to absolute pressure, temperature, and relative humidity. The pressure takes into account the inlet piping in filter pressure drops.

E. Pressure Rise: Pressure developed within the blower between the inlet and outlet flanges. It is the discharge pressure less the inlet pressure measured at the discharge and inlet flanges, respectively.

F. Standard Cubic Feet per Minute (scfm): Volumetric rate of air measured in standard cubic feet per minute at 68 degrees F, pressure of 14.2 psig, and relative humidity of 36 percent.

1.03 SYSTEM DESCRIPTION

A. Blower system, featuring rotary positive displacement blower(s) to supply air for the bioreactor re-aeration system.

1. Provide blower system, including, but not limited to, blowers, control panel, motors, drives, guards, drive couplings, baseplates, vibration isolators, supports, inlet silencers, discharge silencers, bypass silencers, relief valves, flexible connectors, noise enclosures, spare parts, outside air filter, and miscellaneous appurtenances as necessary.

1.04 DESIGN REQUIREMENTS

A. Design equipment with due regard to safety of operation, accessibility, and durability of parts, and complying with applicable OSHA, state, and local safety regulations.

B. Seismic Requirements: In accordance with Section 01 61 00, Common Product Requirements.

C. Each blower will receive outside air from a dedicated filter and discharge into a main air discharge header.

D. Intermittent and continuous operation in an outdoor environment.

E. Blower(s) shall start no more than four times per hour when operating in intermittent service.

F. Blowers shall meet rated performance and sound level when operating at a maximum gear tip speed of 3,750 feet per minute. Operating speed shall not exceed 80 percent of rated speed.

G. Maximum Sound Pressure Level: 85 dBA, factory calculated, with inlet and discharge silencers, measured without a sound enclosure.

H. Performance Requirements:

Design Conditions	
Design Capacity, scfm	247
Design Capacity, icfm	285
Maximum Capacity, icfm	340
Altitude, ft	863
Barometric pressure, psia	14.24
Inlet air temperature, degrees F (Guarantee Point)	100

Design Conditions	
Inlet air temperature range, degrees F	10 min to 110 max
Relative humidity, % (Guarantee Point)	90
Discharge pressure at compressor discharge flange, psia	7.5
Blower pressure rise required, %	65
Pressure relief valve setting, psig	9.0
Shaft brake horsepower, BHP[1,2]	10.76

[1]Includes main oil pump, if specified, and all gear and bearing frictional losses.

[2]Not to exceed motor nameplate horsepower at 1.0 service factor at the inlet air temperatures, pressure relief valve setting and altitude listed above.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Complete list of system components to be provided.
   b. Make, model, weight, and horsepower of each equipment assembly.
   c. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   d. Standard and specialized equipment assembly cuts.
   e. System layout, installation, and placing drawings for equipment, drivers, and bases.
   f. Performance data for each type of equipment that will show compliance with specification requirements stated herein.
   g. Horsepower demand over the operating range of the blower.
   h. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work.
   i. Motor: See requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
   j. Monitoring System:
      1) Catalog cuts of each blower control system component, including monitoring panel components.
      2) Wiring diagrams, including baseplate-mounted terminal junction box and equipment monitoring panel.
      3) Panel construction and face layout drawings.

k. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
l. Sound Enclosure: Complete description of sound enclosure and accessories.

2. Samples: Color samples for finish coating. If paint manufacturer of finish coat differs from manufacturer of prime coat, provide both manufacturers' written confirmation that materials are compatible.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
3. Factory calculated sound levels (dBA) of blower unit with silencer; and sound enclosure.
4. Identification of outside utility requirements for each component such as air, water, power, etc. Include operating parameters for required utilities.
5. Special shipping, storage and protection, and handling instructions.
6. Manufacturer's written installation instructions.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
9. Routine maintenance requirements prior to plant startup.
10. Test Reports:
    a. Factory test reports for blower and motor.
    b. Field test procedures.
11. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
12. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Oil, synthetic	10 gallons for two oil change intervals

Item	Quantity
Inlet Filters	Enough for 10 complete changes per unit
Flexible Coupling	One complete set per unit
Drive V-Belts	One complete set per unit
Special tools required to maintain or dismantle	One complete set for each unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General:

1. Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.
2. Manufacture spare parts to United States standard sizes and gauges.

B. Materials, equipment, and accessories specified in this section shall be products of:

1. Tuthill 4005 CP Series (3 lobe).
2. Or approved Equal.

2.02 COMPONENTS

A. Blower:

1. Rotary positive displacement type, belt driven by horizontal electric motor.
2. Casing: One-piece construction, ASTM A48/A48M, Class 30B close-grain cast iron strongly ribbed to prevent distortion at the specified operating conditions. Separate headplates of cast iron.
3. Bearings:
   a. Support shaft and impeller assembly by double-row spherical roller bearings sized for a minimum L10 rating of 100,000 hours.
   b. Drive End Bearings: Fixed to control axial location of impeller assembly.
   c. Bearings and Gears: Lubricated by a splash type lubrication system on both ends of the rotors.

d. Provide bearings with a positive lip type oil seal designed to prevent lubricant from entering airstream and a labyrinth seal on each shaft designed to reduce air leakage at point where shaft extends through headplate of blower casing.
e. Make further provision to vent area between the two sealing systems to atmosphere to relieve excessive pressure on seals.

4. Impellers:
   a. Provide impeller/shaft assemblies integrally cast from high-strength ASTM A395/A395M Type 60-45-15 ductile iron with a minimum tensile strength of 60,000 pounds per square inch.
   b. Straight, three-lobe involute type, rotating in opposite directions in a common casing without rubbing, liquid seals, or lubrication.
   c. Positioned by timing gears to maintain proper clearances.
   d. Mount impellers and timing gears on shafts supported by antifriction bearings, fixed to control the axial location of impeller/shaft in the casing.
   e. Statically and dynamically balanced by removing metal from impeller body.
   f. Positively timed by a pair of accurately machined and carburized steel spur gears hardened to 58-62 Rockwell alloy timing gears manufactured to comply with AGMA. Gears mounted on shafts with tapered fit and secured by a locknuts.
5. Shafts:
   a. Ductile iron, integral with impellers.
   b. Machine labyrinth seals into shaft to minimize air leakage.
6. Belt Drive:
   a. V-belt drive with automatic belt tension device.
   b. Minimum service factor of 1.4.
   c. Designed not to exceed allowable overhung load limits of blower and motor.
   d. Provide belt guard with acoustical treatment.

B. Motor:

1. Squirrel-cage ac induction type, meeting requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
2. Motor Horsepower: 15.
3. Nominal Speed: 1,750 rpm, constant.
4. Rated Voltage: 460 volt, three-phase, 60 Hz.
5. Enclosure Type: TEFC as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
6. Inverter duty rated.
7. Drive: V-belt drive.

8. Motor Efficiency: Premium efficiency as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
9. Service Factor: 1.25.

C. Blower Support:

1. Baseplate: Cast iron or fabricated steel mounted on concrete equipment pad as shown on Drawings.
2. Support Stand: Designed by manufacturer and reinforced to withstand anticipated loadings of blower, motor, inlet and discharge silencers, and associated piping.
3. Factory mount blower and motor as a package.
4. Provide vibration isolators to limit transmission of vibration to anchor points at floor.

2.03 ACCESSORIES

A. Blower Inlet Filter: Dry-type inlet air filter.

B. Inlet, Discharge Silencers:

1. Designed to reduce pulsation from rotary lobe blowers at blower operating timing gear speed.
2. For timing gear speeds below transition speeds, use a multi-chambered reactive type silencer, and for timing gear speeds at or above transition speed, use a multi-chambered reactive and absorptive type silencer packed with hair-felt packing.
3. Inlet/Outlet Air Velocity: 2,000 feet per minute, maximum.
4. Pressure Loss: 6 inches of WC maximum, through silencer at design flow rate.
5. Inlet and outlet flanges shall match the piping size shown on Drawings and blower flanges.
   a. Flange Drilling: 125-pound ANSI standard.
6. Provide drain coupling and plug.

C. Flexible Connectors:

1. Pressure spool, single arch, expansion joint type with 125-pound ANSI flanges, sized to match blower flanges.
2. Operating Temperature Rating: 200 degrees F.
3. Install on each blower at inlet and outlet flange.
4. Thrust restraint rods on discharge if not otherwise restrained.
5. Manufacturers and Products:
   a. Mercer; Style 500.
   b. General Rubber; Style 101.
   c. Or approved equal.

D. Check Valve:

1. Dual-plate, metal hinged wafer type for each blower; installed in blower discharge piping downstream of silencer and relief valve.
2. Cast iron body, stainless steel pin and spring, and two semicircular bronze or stainless steel plates.
3. Seat: Viton or Silicone for high temperature operation.
4. Elastomeric hinges will not be allowed.

E. Safety Relief Valve:

1. Sized to relieve entire discharge flow without overloading blower.
2. Furnish one for each blower.

F. Noise Enclosure:

1. Total Noise Enclosure: 85 dBA maximum noise level at 1 meter.

G. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

H. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component.

I. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.04 INSTRUMENTATION AND CONTROLS

A. Provide a pressure switch for use in motor control center-based protection from high pressure

1. Accuracy: Plus or minus 1.0 percent of full scale.
2. Setpoint: Adjustable, 15 to 100 percent of range.
3. Ingress Protection: NEMA 4X.
4. Enclosure Material: Epoxy coated aluminum.
5. Diaphragm: Buna N, Viton, Teflon or stainless steel.
6. Output: SPDT dry contacts, rated for 5 amps, minimum at 120 volts AC.
7. Manufacturer and Model: Ashcroft B series, or approved equal.

B. Shop/Factory Finishing: Furnish manufacturer’s standard baked enamel finish, color as selected.

2.05 SOURCE QUALITY CONTROL

A. Blower Performance Test:

1. Notify Engineer at least 7 days prior to performing test.
2. Perform on the blower actually furnished in accordance with manufacturer's established criteria.
3. Test each blower for a minimum of 1 hour after stabilization at conditions near the performance ratings for mechanical integrity and flow performance.
    a. Perform at or above specified performance pressure rise.
    b. Tolerance on Flow: Plus or minus 4 percent, after correction to rated conditions.
4. Measure power consumption using a calibrated wattmeter.
5. Test Report: Confirm capacity and power, complete with data and calculations used in the test.

B. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Install one check valve in the blower discharge piping, downstream of the silencer and safety relief valve.

C. Anchor Bolts: Accurately place using templates furnished by manufacturer and as specified in Section 05 50 00, Metal Fabrications.

D. Install blower package on vibration isolators and anchor bolts in strict accordance with manufacturer's written instructions.

3.02 FIELD QUALITY CONTROL

A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

B. Functional Test: Prior to facility startup, conduct on each Blower System, assisted by manufacturer's representative, for correct rotation, proper alignment and connection, quiet operation, and satisfactory specified performance.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for post-startup training of Owner's personnel.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 44 42 24.01
SECONDARY CLARIFIER MECHANISM
(SPIRAL SCRAPER TYPE)

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Bearing Manufacturers Association (ABMA).
2. American Gear Manufacturers Association (AGMA):
   a. 2001, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   b. 2004, Gear Materials, Heat Treatment and Processing Manual.
   c. 6022, Design Manual for Cylindrical Wormgearing.
   d. 6034, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
   e. 9005, Industrial Gear Lubrication.
3. American Institute of Steel Construction (AISC).
4. American Iron and Steel Institute (AISI).
5. American Society of Mechanical Engineers (ASME): B29.100, Precision Power Transmission, Double-Pitch Power Transmission, and Double-Pitch Conveyor Roller Chains, Attachments, and Sprockets.
6. American Water Works Association (AWWA): C200, Steel Water Pipe – 6 In. (150 mm) and Larger.
7. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code – Steel.
   b. QC 1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A148/A148M, Standard Specification for Steel Castings, High Strength, for Structural Purposes.
   d. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   e. A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength.
   f. A536, Standard Specification for Ductile Iron Castings.
9. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. MG 1, Motors and Generators.

10. The Society for Protective Coatings (SSPC): SP 7, Brush-off Blast Cleaning.
11. Underwriters Laboratories, Inc. (UL): 674, Standard for Safety, Electric Motors and Generators for Use in Hazardous (Classified) Locations.

1.02 DEFINITIONS

A. Alarm Torque: 90 percent of Design Running Torque.

B. Certified Welding Inspector (CWI): As defined in AWS QC 1.

C. Cutout Torque: 120 percent of Design Running Torque.

D. Design Running Torque: Torque used to select size, strength, and type of materials and components for mechanism and drive system, and at which or below will provide continuous 24-hour per day clarifier operation for period of not less than 20 years at design torque condition and rotational speed specified herein, without damage, permanent deformation or overload, and equal to 50 percent on overload device scale. Design Running Torque is applied at output of the low speed final reduction unit.

E. Slenderness Ratio: Ratio of unbraced length to least radius of gyration.

F. Submerged Metal: Metal below gear head drive and plane 18 inches above weir elevation indicated.

G. Ultimate Torque: 200 percent of Design Running Torque and below which no portion of mechanism will be damaged if operated for only short period of time (a few seconds) and equal to 100 percent on overload device scale. Ultimate Torque is applied at output of the low speed final reduction unit.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Make, model, weight, and horsepower.
      2) Descriptive literature, specifications, dimensional layout, identification of materials of construction, and specialized equipment assembly cuts.
      3) Painting/Coating System(s): Manufacturer’s descriptive technical catalog literature and specifications.
      4) Seismic anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

b. Detailed Drawings:
   1) Structural, mechanical, and electrical showing equipment fabrications and interface with other items including dimensions, size, and locations of connections to other work, and weights of associated equipment.
   2) Structural and Mechanical: Details of influent column, center torque cage, center pier, walkway bridge, influent well, return sludge collection box, rotating rake arm trusswork, scum skimmer, and scum trough.
   3) Diameter of ball race.
c. Design Details:
   1) Running, Alarm, Cutout, and Ultimate Torque ratings of drive unit assembly.
   2) Ultimate Torque load capabilities of drive unit assembly, torque cage, and rotating rake arm trusswork.
d. Certification of Structural Calculations: Letter of certification for structural design of mechanism, signed and sealed by Registered Professional Engineer.
   1) Copies of detailed structural design calculations shall not be submitted for review. If submitted, calculations will be returned without review.
e. Structural Loads: Static, dynamic, and torque reaction loads to be transferred into structure at center column (if applicable) and access bridge support locations.
f. Details of torque sensing and load indication device.
g. External utility requirements such as air, water, power, and drain for each component.
h. Functional description of internal and external instrumentation and controls to be supplied, including list of parameters monitored, controlled, or alarmed.
i. Power and control wiring diagrams, including terminals and numbers.

B. Informational Submittals:

1. Designer’s qualifications.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Certificates:
   a. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
   b. Manufacturer’s certificate that coating system(s) meet or exceed specified requirements.
4. Special shipping, storage and protection, and handling instructions.
5. Welder/welding operator qualifications.
6. Welding inspector credentials.

7. Welding Inspector's Report.
8. Test procedures.
9. Test results, reports, and certifications.
10. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
11. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
12. Service records for maintenance performed during construction.

1.04 QUALIFICATIONS

A. Designer: Registered Professional Engineer.

B. Welder/Welding Operator: In accordance with AWS D1.1/D1.1M.

C. Welding Inspector: Certified in accordance with AWS QC 1, and having prior experience with welding codes specified.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

Item	Quantity
Gaskets, O-rings, keys, dowels, and pins	One complete set
Shear pins	Six
Flexible wipers and seals used in scum collection assemblies	Two
Scum skimming arm blade pivot bearing	Two
Drive chain and/or belts (if used)	One
Springs used in scum collection assemblies	Two
Special tools required to maintain or dismantle scum collection assemblies, drive unit except for low speed main bearing, but including that required for removal/insertion of main bearing race balls	One complete set
Lubricants	As required for 1 year of continuous operation

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eimco Water Technologies (EWT), Ovivo.
2. WesTech Engineer.
3. Evoqua.
4. Or approved equal.

2.02 SERVICE CONDITIONS

A. Material Handled: Mixed liquor produced by an activated sludge process and resulting from municipal wastewater.

B. Influent Liquid Temperature Range: 35 degrees F minimum to 85 degrees F, maximum.

C. Influent Mixed Liquor Solids Concentration: 3,000 mg/L, maximum, dry weight basis.

D. Influent pH Range: 6.5, minimum to 8.0, maximum.

E. Return Sludge Solids Concentration Range, Dry Weight Basis: 3,000 mg/L, minimum, 6,600 mg/L, average, 20,000 mg/L, maximum.

F. Site Conditions:

1. Mechanism and bridge design shall be in accordance with conditions and requirements stated in Section 01 61 00, Common Product Requirements.
2. In addition, design shall accommodate the following Site conditions:
   a. Exposure: Ultraviolet radiation of sun.
   b. Ambient Temperature Range: Minimum -5 degrees F to 105 degrees F, maximum.
   c. Ambient Humidity Range: Minimum 10 percent to 98 percent relative humidity condensing, including rain and ice.

2.03 MANUFACTURED UNITS

A. Provide one unit, each meeting performance and design requirements as specified below.

B. General:

1. Suitable for installation in 50-foot diameter by 11 foot – 10-inch sidewall water depth (SWD) clarifier having floor slope of as shown on Drawings.
2. Center pier supported, center drive type.
3. Furnished complete, including drive motor, gearing, bridge, center column, center influent well, flocculation well, bridge, walkway, platforms, handrail, skimmer mechanism and scum trough, and other necessary parts, including anchor bolts.
4. Direction of Mechanism Rotation: Clockwise.
5. Scum Baffles, Effluent Weirs and Launder Covers: Provided by clarifier mechanism manufacturer in accordance with Section 44 42 28, Weir and Baffle Plates.

C. Performance Requirements:

1. Collect and convey settled sludge to center solids hopper.
2. Collect, convey, and discharge floating scum from surface of clarifier to defined area at outside perimeter of unit.
3. Operate satisfactorily under the following conditions:

	Design Flow Rates			
	Minimum	**Average**	**Normal Maximum**	**Peak Instantaneous 1 unit out of service**
Return Sludge Flow Rate (mgd)	0.33	0.67	0.748	0.748
Clarified Effluent Flow Rate (mgd)	0.33	0.67	1.33	2.0
Influent Mixed Liquor Flow Rate (mgd)	0.67	1.34	2.0	2.748

D. Design Requirements:

1. Gears, Bearings Chains and Sprockets shall be located above clarifier water surface.
2. Drive Mechanism: Easy removal of internal gears, balls, and strip liners without walkway bridge removal.
3. Mechanism Construction: Welded, except at locations requiring periodic field adjustment and as approved.
   a. Welded Joints: Seal welded in shop.
   b. Welding: Conform to AWS D1.1/D1.1M requirements.
   c. Incorporate impacts of seal welding on structural design of mechanism, if any, into design.

4. Stresses: Maximum 90 percent of material yield strength at Ultimate Torque load in members.
5. Maximum Slenderness Ratio: 200 for compression member and 240 for tension member.
6. Design Running Torque: 12,100 foot-pounds minimum.
7. Rotational Speed: Between 0.5 to 0.75 feet per second.
8. Capable of withstanding, without failure or permanent deformation of any part, Ultimate Torque rating as defined herein.

2.04 CENTER PIER AND INFLUENT COLUMN

A. Steel: ASTM A36/A36M, 18-inch minimum inside diameter, wall thickness not less than 1/4 inch, extending continuously from clarifier base slab.

B. Ports:

1. Four in top of column to release liquid flow and entrapped scum. Size and location determined by manufacturer.
2. Sized to limit velocity to 2.0 feet per second at peak flow.

C. Minimum 1-inch thick flange at base of pier for anchoring to clarifier foundation by not less than eight anchor bolts; size as determined by manufacturer. Coordinate influent column with influent pipe as shown on Drawings.

2.05 INFLUENT STILLING WELL

A. Steel plate, ASTM A36/A36M, minimum 3/16-inch thick and minimum 1/4-inch thick shapes.

B. Energy dissipation baffles or equivalent to ensure uniform flow distribution. Simple discharge ports in center pier or influent column will not be considered adequate.

C. Stilling Well Configuration:

1. Minimum diameter of 8 feet -7 inches.
2. Extend minimum of 6 inches above and 4 feet below static liquid level in clarifier.
3. Scum Release Ports: Minimum four per the manufacturer’s standard.

2.06 CENTER DRIVE UNIT ASSEMBLY

A. Ultimate Torque Rating: Not less than 2.0 times Design Running Torque.

B. Electric Drive Motor: In accordance with Section 26 20 00, Low-Voltage AC Induction Motors and Induction Motor Data Sheet located in Supplements following End of Section.

C. Primary Speed Reducer:

1. Horizontally mounted cylindrical-worm or helical-worm gear motor type with gears supported by antifriction bearings. Connect to secondary speed reducer via chain system with drive sprocket directly mounted on its output shaft.
2. AGMA 6034.
3. Service Factor: Minimum 1.25 applied to the input horsepower of the speed reducer when the Center Drive Unit is operating at the Design Running Torque specified herein.
4. Overhung Load Rating: Exceed chain pull by minimum 1.75 based upon Ultimate Torque.
5. Oil Fill, Drain and Level Indicator Devices, and Lubricant: AGMA 9005.

D. Chain Drive (if used):

1. Roller Chain: Standard, ASME B29.100.
2. Connect drive sprocket on primary speed reducer to driven sprocket on secondary speed reducer input shaft.
3. Steel Sprockets: Minimum of 12 teeth.
4. Chain:
   a. Service Factor: Minimum 4.0.
   b. Power Transmission Rating: 1.75 times input Hp of chain drive when center drive unit is operating at specified Ultimate Torque.

E. Secondary Speed Reducer:

1. Cylindrical-Worm and Worm-Gear Type: Shafts supported by antifriction bearings and output shaft directly driving pinion gear of low speed main bearing assembly.
2. Load Capacity and Torque Rating: AGMA 6034.
3. Design: AGMA 6022.
4. Service Factor: Minimum 1.25 applied to input Hp of speed reducer when center drive unit is operating at specified Design Running Torque.
5. Output Shaft: One-piece output extending through worm-gear and low speed main gear drive pinion without intermediate couplings.
6. Worm: Steel, heat treated, AGMA 2004, ground and polished.
7. Worm-Gear: Centrifugally cast, high silicon bronze copper alloy, or ductile iron.
8. Bearings: ABMA L-10, life of 180,000 hours minimum.
9. Oil Fill, Drain and Level Indicator Devices, and Lubricant: AGMA 9005.
10. Enclosure: ASTM A48/A48M, Class 40 minimum housing, and registered fit mounted to gear head drive platform.

F. Low Speed Final Reduction Unit:

1. Enclosed turntable, balls in main bearing annular radial thrust raceway type, balls in compression and renewable strip liners.
   a. Ring Gear: Internal or External toothed, spur pinion gear driven, attached to secondary speed reducer output shaft.
2. Low Speed Gearset:
   a. Designed and Rated: AGMA 2001.
   b. Power Rating:
      1) Lower of pitting resistance and bending strength ratings for pinion and gears.
      2) Based upon continuous 24 hours per day service at Design Running Torque for 200,000 hours minimum.
      3) Include the ability to withstand, without failure or permanent deformation, the Ultimate Torque Rating.
   c. Spur Pinion Gear:
      1) Steel: Heat treated; integral with or keyed to its shaft.
      2) Wall Thickness (Above Keyway): Minimum depth of one tooth.
   d. Ring Gear:
      1) Solid one-piece or split construction of ductile (nodular) iron (ASTM A536), cast steel (ASTM A148/A148M), or heat-treated alloy steel.
      2) Split Gear Construction:
         a) Machined, minimum two alignment dowels, joined with high strength galvanized steel bolts.
         b) Allowable Stresses (Calculated): Reduced to 85 percent joint efficiency for split gear construction.
      3) Bolt to center torque cage that supports and rotates collection mechanism.
   e. Teeth: Full-depth, AGMA 2001; stub-pitch and undercut gear teeth not acceptable.
3. Main Bearing:
   a. Ball Raceway Diameter: Minimum 30.0 inches, low unit ball load and stability without guide shoes or steady bearings.
   b. Raceways and Balls: ABMA L-10 life of minimum 200,000 hours when operating continuously at Design Running Torque.
   c. Load Carrying Balls:
      1) Steel: Chrome alloy, hardened to 60-65 Rockwell C.
      2) Diameter: Minimum 1-1/2 inches. If all balls are load-carrying, 1-inch diameter balls are acceptable.
      3) Crushing Strength: Minimum 120,000 pounds.
   d. Spacer Balls (if required): 1/16 inch lesser diameter than, and of same material as, load carrying balls.

e. Balls: Field replaceable without access walkway removal.
f. Raceways:
1) Four vacuum degassed high carbon steel renewable liner strips force fit (pin or capscrew attachments not acceptable) into base and ring gear, and specially hardened to 38-46 Rockwell C. Strips shall have minimum dimensions of 1/4 inch thick by 1/2-inch wide.
2) Deep grooved, fully contoured design, match bearing balls. Heat-treated steel, minimum tensile strength of 120,000 psi, hardness of 250-300 Brinell, and surfaces heat treated to 55-60 Rockwell C.

4. Ring Gear, Pinion Gear, and Main Bearing Ball Races:
a. Oil bathed and steel dust shield and felt seal protected.
b. Oil Fill, Drain and Level Indicator Devices, and Lubricant: AGMA 9005.
c. Casing with manual condensate drain.
5. Oil filling and level pipe, drain plug, and sight gauge. Attach pipe to turntable bottom within base center for easy access.

G. Turntable Base and Housing:

1. Bolt to center column, support entire rotating collector mechanism, transmit mechanical design strengths, support main bearing assembly, and one end of access walkway, and form center platform for convenient access to drive unit components.
2. Platform: 32-inch minimum clearance walking and working surface outside drive unit components mounted at platform.
3. Cast Iron: Grey, ASTM A48/A48M, Class 40 minimum.
4. Mechanism Overload Device.
5. Mechanical or Hydraulic: Actuate integral contacts to indicate impending overload and shutoff drive motor at predetermined loads.
a. Impending Overload Contact (Alarm Torque): Actuate at 90 percent of Design Running Torque.
b. Motor Shutdown Contact (Cutout Torque): Actuate at 120 percent of Design Running Torque.
c. Shear Pin Snap
d. Contacts: Single-pole, double-throw rated 5 amps, 120V ac.
e. Enclosure: NEMA 250, Type 4X, Type 316 stainless steel or cast aluminum.
6. Indicating Pointer: Indicate relative load on graduated scale up to Ultimate Torque.
7. Provide shear pin device or backup motor cutout switch to protect drive unit in case of control system failure.
8. Contacts shall be wired to local control panel specified herein.

2.07 ACCESS WALKWAY AND SUPPORT BRIDGE

A. General: Provide access walkway from side of clarifier to center drive unit and access platform around center drive unit.

B. Support System:

1. Beam type bridge construction rigidly supported on center pier and at access end on clarifier wall with thermal expansion compensating anchorage.
2. Diagonally cross brace and space beams as necessary to carry loads and produce required clear walkway width. Extend full radius.

C. Bridge Design:

1. Maximum Vertical Deflection: 1/360 of span under uniform 50 pound per square foot of walkway surface live load, plus mechanism dead load, plus bridge dead load. Camber for 1/3 live load plus dead load.
2. Maximum Horizontal Deflection: 1/360 of span under uniform horizontal loading of 50 pounds per linear foot and under torsional loadings from the center drive unit under Ultimate Torque mechanism loading.
3. Horizontal and vertical design live loads need not be applied simultaneously.
4. Walkway Surface Elements: Do not utilize to reduce calculated bridge deflections.
5. Steps:
   a. Provide as necessary at outboard end of bridge to allow access from walking surface adjacent to clarifier at elevation 828.00.
   b. Equally spaced to provide equal risers at maximum 7 inches from access landing to bridge surface.
   c. Stair Tread:
      1) 12 inches with 1-inch nosing to provide effective 11-inch tread.
      2) Attach to web of bridge support beams.
      3) In accordance with Section 05 53 00, Metal Gratings, and fabricated of same grating as walkway system.

D. Surface:

1. Material: Aluminum grating as specified in Section 05 53 00, Metal Gratings.
2. Thickness: As specified in above referenced Specification.
3. Width: Extend minimum to guardrail/handrail supports.

E. Width:

1. 36 inches minimum clear between guardrails/handrails.
2. 30 inches minimum clear working space around center drive unit.

F. Guardrails:

1. In accordance with Section 05 52 16, Aluminum Railings.
2. Extend along both sides of bridge and around center platform.
3. Use standard premanufactured wall bracket units to attach top and intermediate rails to bridge elements.

G. Toeboards:

1. In accordance with Section 05 52 16, Aluminum Railings.
2. Anodized Aluminum: 4 inches high by 1/4-inch minimum thickness.
3. Fasteners: Type 316 stainless steel.
4. Locate around center platform perimeter and full length of both sides of access walkway.

2.08 CENTER TORQUE CAGE

A. All-welded steel, ASTM A36/A36M, box truss design, minimum 3 feet square and components minimum 1/4-inch thick.

B. Supports and rotates influent stilling well, rake arms, and skimming devices, and fastens to main ring gear with machine screws or bolted connections.

C. Designed with sufficient strength and rigidity such that with 60/40 percent load imbalance at Ultimate Torque Load, no member will be stressed to a level beyond allowable maximums set forth in AISC Specifications.

D. Connections to Rake Arms: Adjustable and bolted.

2.09 RAKE ARMS

A. Full radius, all-welded steel triangular or diagonally braced box truss design that supports and rotates spiral sludge scraper blades, and skimming devices. Support from center torque cage. Use of tie rod supports is not acceptable.

B. Quantity: Two.

C. Sludge Scraper Configuration: A spiral blades. Orient each blade at an angle to the direction of travel. Provide sufficient length and space as necessary to effectively move sludge from one spiral blade to the next toward center of clarifier with each pass.

D. Strength and Rigidity: Confirm that at Ultimate Torque no member will be stressed to a level beyond maximums allowed by current AISC Specifications.

E. Do not use rake arms to place grout but may be used to provide final screeding of grout topping after manual placement of the grout. Manufacturer shall coordinate with Contractor regarding limitations in use of rake arms for final screeding of grout topping.

F. Truss Width: Same as center torque cage or as needed to adequately support rake.

G. Deflection:

1. Maximum Allowable Vertical Deflection: 0.25 inch at cutout torque.
2. Maximum Allowable Horizontal Deflection: L/200 at cutout torque.
3. Truss shall be specifically designed to meet the above deflection limitations under the loadings unique to the scraper configuration used. Compliance with above deflection limits shall be confirmed during torque testing as described herein. Mechanism shall be field modified as necessary to meet deflection limits.

H. Steel: ASTM A36/A36M, elements.

I. Squeegees:

1. Materials: 27-gauge spring brass or 20-gauge Type 304 stainless steel.
2. Attached to stainless steel sludge scraper blades.
3. Bolts, Nuts and Washers: Type 316 stainless steel.
4. Vertical Alignment: Between 1/4-inch minimum and 3/4-inch maximum clearance above grouted clarifier bottom.

J. Counterweight Assembly: Designed by mechanism manufacturer to balance weight of scum skimmer components or other appurtenances as necessary of one of following designs:

1. Welded steel box filled with proper quantity of steel punchings and topped with 2 inches minimum of grout.
2. Multiple steel plates of various thicknesses and quantities supported by baseplate and forming a stack bolted together by at least two Type 304 stainless steel bolts.

2.10 SCUM SKIMMING SYSTEM

A. Mechanically collect and discharge surface scum from annular space between center influent stilling well and outer perimeter scum baffle, with positive means for moving scum from influent well to outer clarifier surface.

B. Skimming Arm and Skimmer Blade Assemblies:

1. Support from rake arms.
2. Quantity: One.
3. Supports: Maximum 10-foot centers.
4. Bolted Connections: Permit plate removal.

C. Influent Well Scum Arms: One.

D. Skimming Arm:

1. Extend tangentially from, but not necessarily attached to, center influent stilling well continuously outward to skimmer blade assembly at perimeter of clarifier.
2. Steel: ASTM A36/A36M, plate and shapes, minimum thickness 1/4 inch.
3. Extend plate from 3 inches above to 8 inches below static liquid level (weir invert elevation) in clarifier.

E. Skimmer Blade Assembly:

1. Traps scum at perimeter scum baffle and discharge it into scum trough.
2. Hinged, adjustable unit designed such that when passing over scum trough bottom, blade edge is always in contact with trough even if trough is not horizontal or plumb.
3. Lockout Device: Permits unit to be raised and maintained out of liquid.
4. Blade:
   a. Extend full width of scum trough.
   b. Bottom and Edges: Replaceable neoprene seal strips to ensure continued entrapment and discharge of scum into scum trough.
   c. Inner and Outer Edges: Suitable, separate wearing surfaces.
5. Adjustable, spring-loaded device, minimum applied force of 5 pounds, or flexible neoprene wiper to constantly force seal with perimeter scum baffle.

F. Scum Trough Assembly:

1. One per clarifier, including horizontal submerged shelf and inclined beach.
2. Steel: ASTM A36/A36M, plate and shapes, minimum thickness 1/4 inch.
3. Radial Width: Minimum four.
4. Circumferential Length (Including Inlet and Outlet Beaches): Minimum 8 feet.
5. Inlet Inclined Beach Length: Minimum 65 percent of total circumferential length of trough.

6. Trough Opening: Minimum 12 inches wide, sloped bottom, with 6-inch outlet.
7. Support from basin and launder wall and connect to scum baffle with adequate supports.
8. Support of skimming blade as it passes over scum trough opening shall be provided by support bars over opening.
9. Support Bars: Maximum of three per scum trough, sized to provide adequate support for skimmer blade.
10. Containment/Training Baffle Assembly:
    a. At inside perimeter edge.
    b. Extend minimum 6 feet in front of shelf/beach leading edge.
    c. Extend 1 foot below and 8 inches above static liquid level (weir invert elevation) in clarifier.
    d. Support from basin wall.
11. Provide 6-inch Schedule 40 pipe connection for connecting to 6-inch scum line passing through clarifier wall to scum well. Use appropriate transition coupling to connect from scum trough nozzle to scum line.

G. Mechanically collect and discharge surface scum from annular space between center influent stilling well and outer perimeter scum baffle with positive means for moving scum from influent well to outer clarifier surface.

H. Skimming Arm and Skimmer Blade Assemblies:

1. Support from center cage at feedwell.
2. Quantity: One.

I. Influent Well Scum Arms: One.

J. Skimming Arm:

1. Provide either a structural steel truss assembly or a fabricated tube assembly connected to center cage and cantilevered from rotating feedwell.
2. Locate tie rods to allow adjustment of skimmer arm as well as to resist horizontal forces.
3. Extend plate from 3 inches above to 3 below static liquid level (weir invert elevation) in clarifier.

K. Skimmer Blade Assembly:

1. Equip each skimmer arm with hinged 3/8-inch 65 durometer neoprene wipe blade extending full width of arm.
2. Fasten neoprene blade to arm with stainless steel fasteners with steel backup bars.

L. Scum Trough Assembly:

1. Fabricate full radius scum trough from 1/4-inch steel plate and support from tank wall and influent well.
2. Design trough and support structure for dead loads plus a 200-pound point load at feedwell end of trough with no more than 1/2-inch deflection.
3. Provide 8-inch wide trough with a uniformly sloped bottom to allow scum to discharge towards tank wall. Provide 6-inch Schedule 40 pipe connection for connecting to 6-inch scum line passing through clarifier wall to scum well.

2.11 SCUM BAFFLES

A. Fiberglass Reinforced Plastic(FRP) plate in accordance with Section 44 42 28, Weir and Baffle Plates.

B. Minimum 3/16-inch thickness.

C. Configuration and Mounting Details: As shown on Drawings.

2.12 WEIR PLATES

A. FRP plate in accordance with Section 44 42 28, Weir and Baffle Plates.

B. Minimum 3/16-inch thickness.

C. Configuration and mounting details shall be as shown on Drawings.

2.13 LAUNDER COVERS

A. FRP launder covers shall be provided in accordance with Section 44 42 28 Weir and Baffle Plates.

2.14 DISSIMILAR METALS

A. Isolate dissimilar metals or connectors to prevent direct contact and electrical conductivity.

1. Use 1/8-inch thick continuous neoprene gasket to insulate aluminum grating, checker plate, and handrail post bases from access walkway support bridge and other components.
2. Use insulating washer and Teflon sleeves at bolted connections.

2.15 ACCESSORIES

A. Anchor Bolts: Provide coated Type 316 stainless steel bolts, sized by equipment manufacturer and at least 1/2 inch in diameter or as shown, in accordance with Section 05 50 00, Metal Fabrications. Coating as specified in Section 09 90 00, Painting and Coating.

B. Equipment Identification Plates: 16-gauge, Type 304 stainless steel, securely mounted on drive unit and control panel in readily visible location with 3/8-inch high engraved block type equipment identification number and letters.

2.16 FABRICATION

A. Fabricate bridge beam or stringer sections in continuous unbroken pieces.

B. Shop fabricate and assemble mechanism components in largest sections practicable and permitted by transportation carrier regulations.

C. Divide large assemblies such as center torque cage, rake arms, influent well, access walkway bridge, into flanged sections. Field assembly shall use bolted connections. No field welded connections are allowed. Provide Type 316 stainless steel fasteners. Apply appropriate antiseize compound to the threads during assembly. Do not assemble bolted connections until the final coating system has been applied to mating surfaces and cured.

D. Hot-Dip Galvanize After Fabrication: Steel access walkway support/bridge system in accordance with Section 05 50 00, Metal Fabrications. Field cutting or welding of galvanized parts will not be permitted.

E. Welded Construction:

1. Mechanism component interfaces that are not field bolted connections shall be seal welded in shop.
2. Welding: Comply with AWS D1.1/D.1.M for procedures, appearance, and quality of welds, and methods used in correcting welding.

F. Shop/Factory Finishing:

1. Shop prime ferrous metal in accordance with and as specified in Section 09 90 00, Painting and Coating, for submerged surfaces and for nonsubmerged, nongalvanized surfaces. If coating system is self-priming, first coat of system may be applied as a shop prime coat provided the recoat time will not be exceeded prior to field finish coating. Alternatively, a compatible primer by same coating manufacturer may be shop-applied to avoid recoat time limits.

2. Exposed metal surfaces of motors, gear reducers, assemblies shall be factory prepared, primed and finish coated in accordance with Section 09 90 00, Painting and Coating.
3. Surfaces inaccessible after erection, shall be prepared, primed, and finish coated prior to erection.
4. Shop-applied and field-applied coatings shall be by same manufacturer to ensure compatibility.

2.17 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. CWI shall be present whenever shop welding is performed and shall:

1. Monitor conformance with approved welding procedure specifications.
2. Monitor conformance of welder/welding operator qualifications.
3. Inspect weld joint fit-up and provide in-process inspection.
4. Provide 100 percent visual inspection of welds in accordance with AWS D1.1/D1.1M, Paragraph 6.9.
5. Maintain records and prepare report confirming results of inspection.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Weir Plate Installation: In accordance with Section 44 42 28, Weir and Baffle Plates.

C. Field assembly of mechanism shall not require field welding. If field welding is required to correct deficiencies, comply with applicable requirements of AWS D1.1/D1.1M. Clean and repair coated areas following field welding in accordance with coating system manufacturer's recommendations.

D. Anchor Bolts: Locate using steel templates furnished by manufacturer and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

A. Paint ferrous metal in accordance with and as specified in Section 09 90 00, Painting and Coating. Field-applied coatings shall be by same manufacturer as shop prime to ensure compatibility. Prepare shop primed mechanism for field finish coating by brush-off blasting in accordance with SSPC SP 7. Prime exposed metal following brushoff blasting using same material as factory prime coat prior to finish coating.

B. Touchup any damaged coatings on metal surfaces of motors, gear reducers, assemblies using same coating as was factory applied, in accordance with Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests:

1. Conduct on each mechanism.
2. Operate Mechanism: For continuous 24 period without malfunction.

B. Performance Test:

1. Conduct on each completed assembly in accordance with accepted test procedures.
2. Perform to confirm mechanical and structural compliance with specified torque requirements.
3. Conduct static torque test on mechanism:
   a. With the clarifier drive shut off, connect a load measurement device to each rake arm at a specific radial distance from the center using nylon straps, and attach the other end of each of the two loading assemblies to a temporary anchor installed in either the clarifier wall or floor.
   b. Apply a load to the rake arm by tightening both assemblies using a come-along or similar device. Both arms shall be loaded simultaneously.
   c. Convert loadings as read on the load measurement devices to torque using the following formula (which assumes both arms are loaded simultaneously):

$$T = P_1 * D_1 + P_2 * D_2$$

Where:

T	=	torque, ft-lb
P1, P2	=	Load applied at each connection point, lb (should be equal)
D1, D2	=	Radial distances on rake arms to attachment points (should be equal)

   d. Set the alarm and cutout torque switches at the corresponding back-calculated loadings, and measure the clarifier mechanism deflection against the specified limits.

e. If mechanism deflection exceeds specified limits, structurally modify in the field as necessary to meet limits. Submit modification approach to Engineer for approval prior to implementation. Field weld and repair coatings shall be in accordance with this Specification.

4. Record scale indications and/or mark scale for alarm and cutout torques.
5. Submit test report containing results.
6. Replace shear pins after torque testing is completed.
7. Manufacturer may suggest alternate testing procedure, subject to Engineer's approval.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner for minimum person-days listed below, travel time excluded:

1. 3 person-days for installation assistance and inspection.
2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or Site training.
4. 2 person-days for facility startup.
5. 1 person-day for post-startup training of Owner's personnel. Training shall not commence until accepted detailed lesson plan for each training activity has been reviewed by Engineer.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENTS

A. Supplement listed below, following "End of Section," is a part of this Specification.

1. Induction Motor Data Sheet.

END OF SECTION

INDUCTION MOTOR DATA SHEET	
Project: White House Wastewater Treatment Plant Improvements	
Owner: City of White House	
Equipment Name: Secondary Clarifier No. 3	
Equipment Tag Number(s): 06SCM0203	
Type: Squirrel-cage induction meeting requirements of NEMA MG 1	
Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.	
Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.	
Motor Horsepower: 1/2	Guaranteed Minimum Efficiency at Full Load: ____ percent
Voltage: 480	Guaranteed Minimum Power Factor at Full Load: ____ percent
Phase: 3	Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15 1.15
Frequency: 60	Enclosure Type: TEFC
Synchronous Speed: 1800 rpm	☐ Multispeed, Two-Speed: N/A / ____ rpm
☒ Thermal Protection: yes	Winding: ☒ One ☐ Two
Space Heater: volts, 120V single-phase	Mounting Type: ☐ Horizontal ☐ Vertical
	☐ Vertical Shaft: ☐ Solid ☐ Hollow
	☐ Vertical Thrust Capacity (lb): Up ____ Down ____
	☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems. N/A
	Operating Speed Range: ____ to ____% of Rated Speed N/A
	☐ Variable Torque
	☐ Constant Torque
Additional Motor Requirements: ☐ See Section 26 20 00, Low-Voltage AC Induction Motors.	
Special Features:	
Breathers and drains for moisture removal.	

SECTION 44 42 28
WEIR AND BAFFLE PLATES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA): F102, Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles, and Mounting Brackets.
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   c. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   d. A276, Standard Specification for Stainless Steel Bars and Shapes.
   e. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   f. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
   g. C581, Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service.
   h. C920, Standard Specification for Elastomeric Joint Sealants.
   i. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
   j. D570, Standard Test Method for Water Absorption of Plastics.
   k. D638, Standard Test Method for Tensile Properties of Plastics.
   l. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   m. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detailed description of laminate and type of reinforcing to be used.
   b. Manufacturer's drawings showing dimensions of the items and accessories being provided.
   c. Complete information regarding specific resin to be used.
2. Sample: Manufacturer's 6-inch square sample of fiberglass reinforced plastic laminate of same construction, nominal thickness, and color as materials specified.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, and stating the following:
   a. Reinforcing material used will provide suitable chemical resistance.
   b. Resin is suitable for the environmental conditions intended and the fabrication technique proposed.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site properly packaged for ease of handling and to minimize damage during shipping.

B. Handling and storage of items provided hereunder shall be in strict accordance with manufacturer's printed instructions. Care shall be taken not to damage components and accessories.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization of appearance, operation, maintenance, and manufacturers' services.

B. Weirs, Baffles and Launder Covers shall be provided as a complete system for installation by the Contractor.

C. Coordinate weir, baffles and launder covers configuration with equipment, such as a scum skimmer, that will physically interface with weirs, baffles and launder covers to ensure proper functioning of system.

2.02 APPROVED MANUFACTURER'S

A. Manufacturers:

1. NEFCO, Inc., Palm Beach Gardens, FL.
2. MFG Water Treatment Products Company, Union City, PA.
3. Warminster Fiberglass, Southampton, PA.
4. Or approved equal.

2.03 MATERIALS

A. Fiberglass:

1. Match-die molded fiberglass, 1/4-inch minimum thickness, in accordance with AWWA F102.
2. Resin: Except as modified by this specification, conform to ASTM C581:
   a. Type I: Isophthalic polyester only.
   b. Shall not contain fillers or thixotropic agents, except as may be required, and shall conform to resin manufacturer's recommendations.
      1) Glass Content: 20 percent to 30 percent.
      2) Inorganic Fillers: No less than 40 percent of resin mixture.
   c. Coloring: Pigmented gel-coat containing ultra-violet blocking agent; manufacturer's standard color.
   d. Sufficient thixotropic agents to form a paste to seal machined or cut edges.
   e. Reinforcement:
      1) Commercial grade glass, made specifically for use in fiberglass reinforced plastic, and having a coupling agent providing a compatible bond between the glass reinforcement and the resin.
      2) Weight and density may be varied to obtain necessary resin-glass ratio and structural strength for the specified service.
   f. Mold Surfaces: Reinforced with surfacing mat, followed by minimum of 3 ounces of chopped strand mat, in a minimum of two layers, with no other product introduced between layers.
   g. Exposed Surfaces:
      1) Resin-rich, 10 mils to 20-mils thick with Type C surfacing mat, silane finish, and styrene-soluble binder.
      2) Glass fibers shall not be exposed.
      3) Chopped strand and chopped strand mat shall be Type E glass with silane finish and styrene-soluble binder.
      4) Minimum Glass Content: 30 percent by weight.

h. Laminates:

Property (70 Degrees F)	ASTM Standard	Value
Ultimate Tensile Strength, psi	D638	7,500 minimum
Flexural Strength, psi	D790	16,000 minimum
Flexural Modulus, psi	D790	800,000 minimum
Water Absorption	D570	0.2% in 24 hours
Impact, foot-pounds	D256	10

i. Barcoal Hardness: ASTM D2583; minimum 90 percent of resin manufacturer's minimum specified hardness for cured, nonreinforced resin.
j. Allowable cosmetic defects: As defined in AWWA F102.
k. Final Laminate:
   1) Thickness: Within plus or minus 10 percent of nominal laminate thickness.
   2) Tolerance: Plus 1/16 inch; minus 0 inch of minimum specified thickness.
   3) Void Content (Completed Laminate): Maximum 2-1/2 percent of laminate by volume.

3. Manufacturers:
   a. MFG Water Treatment Products Company, Union City, PA.
   b. Warminster Fiberglass, Southampton, PA.
   c. NEFCO, Inc., Palm Beach Gardens, FL.
   d. Or approved equal.

B. Stainless Steel:

1. Plate, Baffles, and Supports: ASTM A167 and ASTM A276, minimum 5/16-inch thick.
2. Fasteners: ASTM A193/A193M and ASTM A194/A194M, Type 316.

2.04 WEIRS AND BAFFLE PLATES

A. Weir and scum baffle plates shall be constructed of fiberglass plate in accordance with the details shown on the drawings. Fiberglass materials shall be as specified above.

2.05 LAUNDER COVERS

A. The launder cover shall consist of a system of molded fiberglass panels that are attached together to form a continuous cover over the launder trough, weir and scum baffle within the treatment tank. The cover shall be designed and manufactured to inhibit incident sunlight from striking the surfaces of the launder and weir. Each cover section shall be molded of UV-protected

fiberglass and shall be opaque to sunlight. Individual sections shall be a minimum of four feet in length and curved to follow the curvature of the tank. The cover shall extend over the trough and weir as far as possible and may extend to a point immediately inside the scum baffle so long as the cover does not interfere with the skimmer sweep arm. The cover shall be designed such that adjacent panels fit together properly and the completed cover, when installed, forms a rigid structure and has a well-engineered and professional appearance.

B. The cover shall be designed to open away from the operator and toward the center of the tank. Each cover segment shall consist of two sections, a fixed mounting section and a hinged cover section connected by a continuous stainless steel hinge. The Mounting Section shall provide a rigid mount for the cover and is fastened to the weir wall with stainless steel brackets as shown in the contract drawings. The mounting section extends inward to a point just inboard the scum baffle. The hinged cover section extends outward toward the tank wall and swings open to allow inspection and maintenance of the launder and weir. In the closed position, the cover section rests on an FRP support flange attached to the inner wall of the tank.

C. Provision shall be made to lock the cover in the closed position for safety and security. This shall be accomplished by means of an easily operated latch mechanism that secures the hinged cover section to the support flange. Handles or lift rings may also be required for some panels. A means of limiting the travel of the hinged cover section, in the form of a restraint cable or tether, may also be provided to protect against damage. Covers with inspection hatches or cleanout doors are unacceptable.

D. The hinged cover sections shall also be designed such that alternating sections have integral tabs at each side which rest on the adjacent section, insuring that the seams between panels are covered and enabling the alternate panels to open independent of every other panel.

E. Provision shall be made to support the cover in such a manner that the panels are held securely in place, with the panels hinged to provide access to the launder and weir for inspection and maintenance. cover supports that cantilever from the outer effluent launder wall without support at the weir wall are unacceptable. Neither the cover nor the means used to support it shall interfere with effluent flow over the weir or within the trough. Cover supports shall not impede personnel from entering and traversing the launder.

F. Where the circumference of the trough is interrupted by a bridge-support or another obstacle, a fixed panel(s) shall be installed over the trough beneath the support such that the surface of the cover is continuous around the entire tank.

Alternatively, vertical panels may be installed on both sides of the bridge supports to block out sunlight.

G. The cover system shall be designed to withstand common wind and snow loads but shall not be intended as a “walk-on” cover designed to support the weight of plant personnel. Adequate stiffeners shall be integral to each panel, but panels reinforced with balsa or foam cores are not acceptable.

H. The tether or restraint cable shall consist of a length of stainless steel cable secured to the tank wall and the hinged cover section by means of stainless steel eyebolts. The length of the cable is selected to limit the travel of the cover.

I. The latch/handle shall be a spring-loaded mechanism with a positive detent positioned to indicate the closed/locked position of the handle. The latch is activated by pressing down on the spring-loaded handle and turning it.

2.06 APPURTENANCES

A. Gasket: Closed-cell neoprene, 50 durometer, 1/4-inch thick.

B. Sealant:

1. Polyurethane base, single-component, moisture curing, ASTM C920, Type S, Grade NS or P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and products:
   a. Sika Chemical Corp.; Sikaflex-1a.
   b. Mameco International; Vulkem 45.
   c. Or approved equal.

C. Anchoring: Type 316 stainless steel adhesive anchors as specified in Section 05 50 00, Metal Fabrications.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in strict accordance with the manufacturer’s written instructions.

B. FRP Plates: Sand all cut edges or drilled holes greater than 3/8 inch in diameter, and seal with a nonair-inhibited resin solution, as recommended by resin manufacturer.

C. Install weir plates such that weir crest is level with a maximum variation of 1/16 inch throughout its entire length.

D. Gasket:

1. Install between weir plate and concrete wall, extending from bottom of weir plate to the top of the wall.
2. Gasket shall be continuous along entire length of weir plate, except at scum trough where a joint is allowed.
3. Joints: Butt type, using adhesive recommended by gasket manufacturer for submerged service.

E. Sealant:

1. Clean and prepare concrete and weir plate surfaces in accordance with sealant manufacturer's recommendations.
2. Application:
   a. In accordance with manufacturer's instructions.
   b. Completely cover the interface between the weir plate and mounting surface over the full height of the weir plate.
   c. Apply sufficiently to completely fill any gaps between the weir plate and the supporting wall surface.
   d. Clean excess sealant that is forced from between the weir plate and supporting wall as the plate is tightened against the wall surface to provide a neat installation.
   e. Clean all adjacent surfaces of smears or soiling.

3.02 TESTS AND INSPECTION

A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

B. Functional Test: Demonstrate proper installation of weir plate for both water tightness and level, prior to placing unit into service, by filling unit with water to the weir crest elevation. Make adjustments as necessary to meet specification.

END OF SECTION

SECTION 44 42 41
GRIT REMOVAL SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Hydraulic Institute Standards (HIS).
4. National Electrical Manufacturers' Association (NEMA): MG 1, Motors and Generators.
5. Underwriters Laboratory (UL): 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 SCOPE OF WORK

A. Supplier shall furnish all labor, materials, equipment, and controls appurtenances required to furnish and install a complete and operable grit removal system as specified herein and as shown on Drawings.

B. Contractor's responsibilities shall include, but are not limited to, procurement, unloading/receipt at the jobsite, storage, handling, coordination, installation, and startup. The cost of procurement, submittal coordination, delivery scheduling, receiving/unloading, proper storage, installation, startup and testing shall be included as part of the Contractor's Base Bid amount.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed Structural, Mechanical, and Electrical Drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment.
   d. External utility requirements such as air, water, power, drain, etc., for each component.
   e. Power and control wiring diagrams, including terminals and numbers.

f. Shop Drawings identified in Section 40 99 90, Package Control Systems.
g. Shop and Field Painting Systems Proposed: Include Manufacturer's descriptive technical catalog literature and specifications.
    1) Where system proposed is different from that specified or where, in the manufacturer's opinion, the coating system(s) exceed(s) requirements specified, submit complete technical literature of the proposed system(s) to Engineer for review.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's written/printed installation instructions.
3. Manufacturer's Certificate of Compliance, in accordance with Division 1, General Requirements.
4. Certification that factory-applied coating system(s) is identical to requirements specified.
5. Routine maintenance requirements prior to plant startup.
6. Manufacturer's Certificate of Proper Installation in accordance with Division 1, General Requirements.
7. Operation and Maintenance Data: As specified in Division 1, General Requirements.
8. Service records for maintenance performed during construction.
9. Performance test procedures and sample test log.
10. Test Results: Control panel for proper operation, construction, electrical connection, and function.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage spare parts and special tools:

1. One set of bearings for the grit classifier.
2. One complete set of special tools required to maintain or dismantle unit.

B. Delivery: In accordance with Division 1, General Requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT TAG NUMBERS

A. Grit Concentrator: 02CONC5201.

B. Grit Cyclone and Classifier: 02CLSFR5601.

C. Automated Valves: 02PCV5101, 02PCV5301, 02FV5101, 02FV5501.

D. Grit Pump: 02PMP5001.

E. Control Panel: 02LCP0101.

2.02 MANUFACTURERS

A. All system components specified below shall be provided by the Grit Concentrator manufacturer.

B. Materials, equipment, and accessories specified in this section shall be products of:

1. Grit Concentrator: Hydro International Water & Wastewater, Hillsboro, or approved equal.
2. Grit Pump: Weir Specialty Pumps, Salt Lake City, UT or approved equal.
3. Grit Cyclone and Classifier: Weir Specialty Pumps, Salt Lake City, UT or approved equal.
4. Unit Responsibility: All of the equipment specified herein shall be furnished by a single manufacturer. The manufacturer shall be completely responsible for the proper design of selection of all system components. All equipment shall perform as specified and the completed installation shall operate in accordance with the requirements of the Drawings and Specifications. The manufacturer shall ensure that all equipment specified herein are integrated to function properly.

2.03 SUPPLEMENTS

A. See supplements to this section for additional product information.

2.04 EQUIPMENT DESCRIPTION

A. General:

1. The complete unit shall consist of a grit concentrator, a grit pump, a grit cyclone mounted on a grit classifier mechanism. Provide structural frames, mounting brackets, and piping transitions for a complete operational unit.
2. Valves provided as part of the grit removal system shall conform to Section 40 27 02, Process Valves and Operators.
3. Instruments and control components furnished as part of the grit removal system shall conform to Section 40 99 90, Package Control Systems.

4. Equipment furnished under this section (excluding the control panel) shall be suitable for Class I, Division 2, indoor environment. Refer to the Electrical Drawings for additional information on classified locations. All motors, actuators, solenoids, and instruments shall be suitable for installation within a Class 1, Division 2 area. Connections from the control panel to equipment in the classified space shall be appropriately sealed to prevent gases from entering the local control panel via the conduits to the various loads.

B. Grit Concentrator:

1. Total Number of Units: One.
2. Service Conditions:
   a. Total Wastewater Flow per Grit Concentrator:
      1) Minimum (Startup): 1.0 mgd.
      2) Maximum Month Average Daily Flow: 2.0 mgd.
      3) Peak Hydraulic Capacity Required: 4.0 mgd.
   b. Located in a concrete tank, size as indicated on the Drawings. The tank size is fixed. The Manufacturer shall verify that the tank, weirs, and tank approaches are suitable for the performance required.
   c. Grit Characteristics:
      1) Type: Typical municipal wastewater grit characteristics and quantities.
      2) Size: 65 to 200 mesh.
      3) Specific Gravity: 2.65.
      4) Quantity: 1 to 3 cubic feet per million gallons.
   d. Performance Requirements:
      1) Capture and remove all grit 105 micron (150 mesh) or larger with a specific gravity of 2.65 or greater.
      2) Unit shall have no more than 12 inches of head loss at peak flow of 4.0 mgd.
3. Operation:
   a. The grit concentrator shall be placed in a concrete tank and receive the incoming screened flow. The grit concentrator shall provide sufficient surface area to remove the specified grit particles from the specified peak flow and concentrate the grit in a sump at the bottom of the unit. The de-gritted effluent from the grit concentrator shall be weir discharged as shown on the Drawings.
   b. The grit concentrator shall be characterized by a controlled boundary layer flow to enhance settleable solids concentration and removal.

c. The grit concentrator shall be all-hydraulic consisting of self-cleaning corrosion resistant, non-metallic trays with no moving parts within the unit.
d. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.
e. Water shall be continuously supplied to the solids underflow sump.
f. Provide manufacturer's standard influent distribution header to enhance hydraulic flow patterns.

4. Construction:
   a. Grit concentrator trays shall be constructed with a minimum 1/4-inch thick UV stabilized low density polyethylene (LDPE) on the pans and sidewalls.
   b. The stack of trays shall securely fit into a Type 316 stainless steel support frame. The support frame shall fit and secure to the bottom of the concrete tank.
   c. A stainless steel grit collector shall be provided with the grit concentrator for collection and removal of settled solids to the grit cyclone.
   d. All pipe flanges shall conform to ANSI B16.1 Class 125 bolt patterns.
5. Size: 6-foot diameter.
6. Number of Trays per Unit: Six.
7. Surface Area per Unit: 170 square feet.
8. Process Connections:
   a. One 4 inch flanged grit slurry (underflow) connection for grit removal.
   b. One 1-inch NPT threaded W3 connection for supplying fluidizing water.

C. Grit Pump:

1. The grit pump shall have a rated capacity of 250 gpm at 25 feet TDH.
2. The pump shall be designed to pump a grit slurry from a municipal wastewater treatment facility.
3. Pump component materials shall be as follows:

Pump Materials

Part Designation	Material
Case, Impeller, Replaceable Suction Flange	ASTM A 532 Class I, Type A, Hardened BRH 650 high chrome iron
Bearing Frame, Stuffing Box	ASTM A 278 Class 30 Cast Iron
Wear Plate	ASTM A 532 Class III, Type A high chrome iron BRH 650
Shaft	ASTM A108, Grade 1141

Shaft Sleeve	ASTM A 582 Type 416 Stainless Steel
Stuffing Box (for packed pumps)	ASTM A 48 Class 30 Cast Iron
Packing Gland	ASTM A 278 Cast Iron
Lantern Ring	ASTM B 505 Bronze or Teflon`
Packing	Braided, Graphited Teflon
Fasteners	ASTM A 276 Type 316 Stainless Steel
Base	ASTM A 36 Steel

4. Pump frame shall be of heavy duty cast iron construction, accurately machined to assure alignment of bearings and pump shaft. Frame shall have cast feet, with bolting holes for attachment to the baseplate. The lower section of the backhead casting shall form a reservoir to catch and contain seal leakage, with a plugged NPTF discharge connection.
5. Pump case shall be cast in two pieces, including a replaceable suction wear casting. A replaceable wear plate, protecting the back of the impeller, shall be provided. Mating surfaces shall be register fit for precise alignment of components. Casing shall assemble with lugged bolts on the front and rear mating surfaces.
6. Pump impeller shall be cup-type, configured such that there is not impingement wear imposed on the pump casing at the impeller periphery. Impeller shall be attached to the shaft through a tapered bore having two flats 180 degrees apart and shall be secured with a impeller lock screw and locking plate.
7. Pump impeller shall be of cup design such that the deepest portion of the vane is not located at the vane tips and the tips are surrounded by a thick sectioned rim of one inch minimum thickness.
8. Shaft shall be machined straight and true, polished over the entire length, and with the drive end keyed for a sheave or coupling. Impeller end shall be tapered to match the impeller bore. A hardened wear sleeve shall be provided through the stuffing box. Sleeve shall be sealed and mechanically locked to the shaft to preclude intrusion of the process fluid and slippage of the sleeve on the shaft.
9. Radial and thrust bearings shall be sized for a minimum B-10 life of 100,000 hours. Bearing lubrication shall utilize oil, with a constant level oiler. Each end of the bearing housing shall have a cast cover, with replaceable cartridge lip seal.
10. Shaft seal shall be a packed stuffing box, with a minimum of four packing rings and one lantern ring. Packing shall be adjusted by means of a gland, adjusted by two bolts on opposing sides. Packing shall be enclosed in a cast housing, attached to the bearing frame/backhead. Stuffing box shall have plugged NPTF flush and relief ports.
11. Pump shall have suction and discharge connections compatible with ANSI/ASME B16.1, Class 125 cast iron pipe flanges.
12. Motors:

a. Motors shall be as specified in Section 26 05 26, Grounding and Bonding for Electrical Systems of these Specifications and as indicated in Table 1 of this section.
b. The motor shall be sized to be non-overloading throughout the entire pump range.
c. Motors shall be 15 hp TEFC, 460 v, 3 phase 60 hz designed for continuous operation under full load, 40 degree C ambient, with minimum Class F insulation. Motor service factor shall be 1.15 non-VFD.
d. Motor bearings shall be grease lubricated and bearing housings shall have lubrication and relief fittings.

13. Power Transmission:
a. Pump shall be driven by the motor through a sheave and belt configuration, utilizing adjustable ratio sheaves. Belt and sheave system shall have a 1.5 safety factor based on the motor nameplate horsepower.
b. Drive components shall be enclosed in an OSHA-compliant protective steel guard. Guard shall have removable components allowing access to the belts and sheaves for maintenance.

D. Grit Cyclone:

1. Heavy-duty cast-iron volute feed chamber with cylindrical and conical sections of steel and aluminum to reduce overhung weight.
2. Line each section with replaceable neoprene liner; construct cyclone so each liner section can be replaced independently.
3. Involuted feed entry with a minimum 4-inch inlet and a 6-inch outlet with adapter pieces to fit the piping layout shown. Connections shall be 125-pound, ANSI FF cast-iron flanges.
4. Cyclone Vortex Finder:
a. Abrasion-resistant alloy with approximate hardness of 500 Brinell.
b. Provide hinge and quick disconnect clamp between apex assembly and lower core section to allow cleaning apex without disconnecting cyclone piping.
c. Tap inlet for a 1-inch NPT gauge connection.
d. Provide diaphragm protected pressure gauge.
5. Maximum Design Flow: 250 gpm.
6. Maximum Allowable Underflow from Cyclone: Not to exceed 15 gpm.
7. Required Design inlet pressure:7.5 psi.
8. Bottom Cone: Hinged to provide easy access for cleaning, without disconnecting any piping.
9. Size: 10 inches, minimum.

E. Classifier:

1. General:
    a. Designed to maintain necessary velocities, to retain organic matter in suspension, and remove nonorganic material of a size retained on a 150-mesh screen at design flow.
    b. Capable of removing substantially all 150-mesh grit having a specific gravity of 2.65 or greater from the underflow of the cyclone.
2. Settling Tank:
    a. Full-flare configuration.
    b. Minimum Pool Area at Maximum Water Level: 8.3 square feet.
    c. Minimum Weir Length: 2 feet.
    d. Screw Speed: 12 rpm maximum.
    e. Construct tank of 1/4-inch Type 316 stainless steel plate, reinforced and mounted on stainless steel supports at a slope not more than 3-1/2 inches per foot.
    f. Design settling compartment where grit separation takes place, with minimum full-water depth of 150 percent of screw diameter.
    g. Weir Overflow: Discharge into launder box equipped with a screw type nozzle or victaulic fitting for connection to drain.
3. Screw and Trough:
    a. Trough: Type 316 stainless steel construction.
    b. Screw Size: 12 inch.
    c. Heavy-walled, pipe shaft, Type 316 stainless steel construction.
    d. Shaft shall be suspended between bearings at each end. There shall be sufficient clearance between screw and tank so that a build-up of sand or grit will provide a bed for the screw, eliminating tank wear.
    e. Type 316 stainless steel flights shall be continuously seal welded to shaft and provided with replaceable wear shoes per manufacturer’s standard.
    f. Support lower end of screw by bearing housed in watertight enclosure.
        1) Sealed bronze, sleeve type bearing, running completely submerged in oil, requiring only yearly inspection and oil change.
        2) Internal parts of bearing sealed from outside contamination using floating satellite seals.
        3) Provide manual lifting device attached to lower bearing to allow spiral and bearing to be raised.
4. Speed Reducer:
    a. connected to upper end of screw conveyor using flanged, rigid coupling.
    b. Torque shall be transmitted by rollers and capable of withstanding shock loadings of 500 percent rated loading.

c. Cyclodrive: Take radial and thrust loads from shaft. At maximum load provide minimum B-10 bearing life of 50,000 hours. Connect to motor with constant-speed V-belt drive.

F. Valves and Accessories:

1. The system shall be furnished with the following accessories:
   a. One 1-inch bronze solenoid valve(21FV5501) (V940) to start/stop system water flow rate to the grit classifier.
   b. One 1-inch bronze ball valve(V200) to regulate flow to the grit classifier.
   c. One 1-inch bronze ball valve (V200) to regulate flow to the Grit Concentrator (Headcell).
   d. One 1-inch bronze solenoid valve(V940) to start/stop flow to the Grit Concentrator (Headcell).
   e. Two 1-inch rotameters with a capacity of 0 to 20 gpm for the head cell and 0-5 gpm for the classifier.
   f. Two 1-inch self-contained pressure reducing valve (V711) for plant water pressure reduction, Fisher 95 series or approved equal (02PCV5101, 02PCV5301).

G. Motor and Reducer Assembly: Pivot at shaft center line so screw assembly can be raised.

H. Removable Trough Cover: Type 316 stainless steel, over full length of screw trough.

2.05 INSTRUMENTATION AND CONTROL

A. General:

1. See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. All instrumentation, control, and electrical components provided under this section, including panel fabrication and color coding of lights and switches, shall comply with the requirements of Section 40 99 90, Package Control Systems.
2. See Section 40 91 00, Instrumentation and Control Components, for requirements for instrumentation provided in this section. Instrumentation provided in this section shall be suitable for installation in classified locations.

B. Control Panel (02LCP0101):

1. One control panel shall be furnished, completely pre-wired and tested. Control panel shall be PLC-based and shall include an operator interface terminal (OIT). The panel will be located in an unclassified area. The

panel shall have a UPS. The control panel shall be NEMA 250 Type 4X fabricated using Type 316 stainless steel and shall operate on 480V, three-phase, 60-Hz power. The dimensions of the control panel shall not exceed 48 inches wide by 12 inches deep by 72 inches high.

2. The control panel shall include a surge protection device (SPD) on the incoming 480V power feed. Additionally, the control panel shall also include an integral control power transformer that is located internal to the control panel. Inclusion of the control power transformer external from the control panel will not be considered.
3. The control panel shall include an integral main circuit breaker that can be operated from the front face of the control panel and can be locked in the open position for maintenance purposes.
4. The control panel shall contain a motor starter and all timers, switches, indicator lights, and other components necessary to operate the following provided equipment:
    a. One grit pump: 02PMP5001.
    b. One grit classifier: 02CLSFR5601.
    c. Two solenoid valves: 02FV5501, 02FV5101.
5. Operator Controls and Indicators:
    a. CONTROL POWER ON pilot light.
    b. EQUIPMENT RESET push button.
    c. Controls and indicators for equipment including, but not limited to:
        1) Grit Pump ON/OFF/AUTO selector switch.
        2) Grit Classifier ON/OFF/AUTO selector switch.
        3) OPEN/CLOSE/AUTO selector switch for each solenoid valve.
        4) Grit Pump ON and FAIL indicating lights.
        5) Grit Classifier ON and FAIL indicating lights.
    d. Sequence initiation switch or pushbutton.
    e. Sequence terminate switch or pushbutton.
    f. Controls to enable repeat cycle timer operation of system and adjust cycle interval.
6. External Interfaces:
    a. Discrete Outputs:
        1) Grit removal in AUTO: True when all equipment in AUTO.
        2) Fail: Incorporate all component and system failures.
        3) Pump On.
        4) Pump Forced off: Pump in OFF position.
        5) Classifier On.
        6) Classifier Off: Classifier in OFF position.
7. Functional requirements:
    a. Repeat cycle operation or response to sequence initiate request to function when grit pump, grit classifier and classifier water valve are all in AUTO.

1) Repeat cycle timer to reset on manual sequence initiation.
2) Sequence terminate request.

b. Basic Sequence:
1) The Headcell flush valve(02FV5301) shall operate continuously on an adjustable time delay initially set at 1 minute open every 10 minutes whenever the grit pump is off and whenever the grit pump is operating.
2) Open classifier water supply valve (02FV5901).
3) Start classifier.
4) Open grit pump seal water valve.
5) Start grit pump.
6) Stop grit pump.
7) Close grit pump seal water valve after an adjustable 1 to 3 minute delay.
8) Stop classifier.
9) Stop classifier water supply valve after an adjustable 1 to 5 minute delay.

c. Provide operator adjustable delays between each step.
d. Failure of classifier water supply valve or seal water supply valve shall immediately stop pump.
e. Failure of pump during sequence shall immediately move the sequence to the close flush valve step.
f. Sequence terminate request shall immediately move the sequence to the close flush valve step.

2.06 UTILITY REQUIREMENTS

A. Non Potable Water:

1. Each Grit Concentrator(Headcell) shall require an adjustable supply with a maximum of 20 gpm clarified non-potable water at a regulated 50 psig plus or minus 5 psi.
2. The Grit Cyclone and Grit Classifier combination shall require clarified non-potable water supplied at a regulated 50 psig plus or minus 5 psi. The water requirements are 1 to 5 gpm for sluicing water.

B. Electrical: The system shall require one 480V ac, three phase electrical service connection to the control panel to operate.

2.07 WELDING

A. Welded connections subjected to submerged conditions shall be seal welded.

2.08 ACCESSORIES

A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Equipment Identification Plates: Provide 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer and furnished by Contractor, 5/8-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.09 MATERIALS

A. All stainless steel used for the fabrication of the equipment shall conform to the following standards:

1. Plate and Sheet: ASTM A167 and ASTM A240.
2. Bar: ASTM A276 and ASTM A479.
3. Tube: ASTM A312.

2.10 FACTORY FINISHING

A. Factory prepare, prime, and finish coat all exposed and submerged metalwork surfaces, except stainless steel, in accordance with System No. 4 and System No. 2, respectively, as specified in Section 09 90 00, Painting and Coating.

B. All stainless steel surfaces shall be acid passivated after welding in accordance with ASTM A380 and ASTM A967.

2.11 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s written instructions.

B. Anchor Bolts: Accurately place using templates furnished by manufacturer and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

A. Touchup painting to correct defects in factory coating shall be made in accordance with respective coating and painting systems specified in Factory Finishing of this section.

3.03 FIELD QUALITY CONTROL

A. Functional Tests:

1. Alignment: Prior to facility startup, test complete assemblies for correct rotation, proper alignment and connection.
2. Operate for a continuous 3-hour period without malfunction.

B. Performance Tests:

1. Grit Performance Tests shall be done in the field (in-situ). The specified performance must be met before the equipment is accepted and considered substantially complete. All costs associated with these field tests shall be paid by the Equipment Supplier.
2. Performance shall include, but not be limited to, conformance to the operating parameters defined in specification Section 01 45 33, Special Inspection Observation and Testing. The Equipment Supplier shall be allowed a minimum of 60 calendar days to demonstrate compliance with all operating parameters and to make modifications.
3. Two grit performance tests of four-hour duration under approximately steady-state conditions shall be performed.
4. Tests will be conducted with actual plant influent flow. The flow shall be monitored and recorded throughout the test period. The plant influent flow shall be measured by with plant influent flowmeters.
5. Test Equipment:
   a. One Grit Collector unit.
   b. One Grit Cyclone Separator unit.
   c. One Grit Classifier / Dewatering unit.
   d. Sampling ports, samplers, and sampling barrels sized to capture a particle of less than a 50 micron with a specific gravity of 2.6 (3.2 gpm/ft2 loading rate). The sampling barrels, all necessary hoses and connections to install the sampling equipment shall be provided by the Contractor for the duration of the test.
6. Samples will be taken at the following points:
   a. Grit collector influent.
   b. Grit collector effluent.
   c. Dewatered grit.
7. Sampling of the grit collector influent and effluent shall be done with an isokinetic vertically-integrated sampler.

8. The influent and effluent samples shall each be fed tangentially and continuously into separate settling barrels with an overflow of no more than 3.2 gpm per square foot of surface area. This insures capture of all 50 micron and larger, 2.65 S.G. grit particles in the samples. At the end of the test interval allow a quiescent settling period (2.3 minutes per foot of barrel depth) and then decant the basin. Collect the settled solids for analysis. Where there is insufficient endemic grit in the influent feed, seeding may be used. Seed material shall be of a gradation and settling velocity to match the characteristics of the endemic grit and be mutually agreeable to the Engineer and Manufacturer. The seed sand shall be wetted prior to introduction into the flow.
9. Each settled solids sample shall be composited for laboratory testing and evaluated according to Standard Method procedures. Samples shall be evaluated at an independent test facility approved by the Owner.
10. The two settled solids samples will be analyzed to determine Total Solids (TS), Volatile Solids (VS) and Fixed Solids (FS). Laboratory testing of the two dewatered grit samples will include wet sieve analysis of the settled solids using 75, 106, 150, 212, and 300 micron (200, 140, 100, 70 and 50 mesh) sieves. Measurement of the solids retained on each sieve including pan dry weights before and after muffle furnace burning of the organics will be documented.
11. The analytical methods for the solids analysis are:
    a. Total Solid per Standard Methods 2540G.
    b. Volatile Solids per Standard Methods 2540G.
    c. Sand Equivalent Size (SES).
12. The percent grit removal of grit particles 75, 106, 150, 212, and 300 micron shall be determined from SES and sieve analysis data collected by the test procedures on each of the three samples taken concurrently at the sampling ports.
13. Grab samples of the dewatered grit shall be collected during each 4 hour test period for solids analysis. Multiple dewatered grit samples from the grit pile generated by each 4 hour test period shall be composited for laboratory analysis and evaluated according to Standard Method procedures. Samples shall be analyzed at an independent test facility mutually approved by the equipment manufacturer and Owner.
14. The analytical methods for the solids analysis are:
    a. Total Solid per Standard Methods 2540G.
    b. Volatile Solids per Standard Methods 2540G.
    c. Paint Filter test per US EPA Method 9095B.
15. The equipment manufacturer shall prepare a final report summarizing all test data and results. The report shall include a mass balance calculation of the grit removal efficiency of the grit collector based on the amounts and size distribution of grit collected in the grit collector influent and effluent sampling containers.

16. Remedies: If the grit removal system fails to satisfy the specified grit removal requirements, the system shall be modified as required to produce an installation that will satisfy the requirements. The equipment shall be completely retested after modification. Modifications shall be provided, and retesting shall be performed by the independent testing laboratory or firm at no additional cost to the Owner. All modifications, including structural or electrical modifications, necessary to accommodate the modified equipment shall be made at no additional cost to the Owner.
17. If the modified system does not meet the required performance parameters after two additional performance tests, the Equipment Supplier shall pay a one-time charge. For each percentage measured removal less than the guaranteed removal rate, the charge shall equal to two percent of the total equipment cost. The guaranteed removal rate is all grit 105 micron (150 mesh) or larger with a specific gravity of 2.65 or greater. The one-time charge shall be based on the actual performance of the equipment and will include a 5 percent buffer for testing irregularities.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for facility startup.
4. 1 person-day for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.

B. See also requirements in Division 1, General Requirements.

3.05 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Supplement 1, Induction Motor Data Sheets.

END OF SECTION

INDUCTION MOTOR DATA SHEET

Project: White House WWTP Improvements

Owner: City of White House

Equipment Name: Grit Pump

Equipment Tag Number(s): 02PMP5001

Type: Squirrel-cage induction meeting requirements of NEMA MG 1 Design B

Manufacturer: Weir Specialty Pumps or approved equal

Hazardous Location: ☒ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: 15

Voltage: 480

Phase: 3

Frequency: 60

Synchronous Speed: 1800 rpm

☐ Thermal Protection: _____

Space Heater: 120 volts, single-phase

Guaranteed Minimum Efficiency at Full Load: ____ percent

Guaranteed Minimum Power Factor at Full Load: ____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Enclosure Type: EXP

☐ Constant Speed: 1800 rpm

Winding: One

Mounting Type: Horizontal

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up ____ Down ____

☒ Adjustable Speed Drive: See Section 26 29 23, Low Voltage Adjustable Frequency Drive Systems. No

Operating Speed Range: 50 to 100% of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: See Section 26 20 00, Low Voltage AC Induction Motors.

Special Features: Motor should be suitable for Class I, Division 2.

INDUCTION MOTOR DATA SHEET

Project: White House WWTP Improvements

Owner: City of White House

Equipment Name: Grit Classifier

Equipment Tag Number(s): 02CLSFR5601

Type: Squirrel-cage induction meeting requirements of NEMA MG 1 Design B

Manufacturer: Hydro International or approved equal

Hazardous Location: ☒ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: 0.5

Voltage: 480

Phase: 3

Frequency: 60

Synchronous Speed: 1800 rpm

☐ Thermal Protection: _____

☒☐ Space Heater: 120 volts, single-phase

Guaranteed Minimum Efficiency at Full Load: ____ percent

Guaranteed Minimum Power Factor at Full Load: ____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Enclosure Type: EXP

☐ Multispeed, Two-Speed: ____ / ____ rpm

Winding: ☐ One ☐ Two

Mounting Type: ☐ Horizontal ☐ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up ____ Down ____

Adjustable Speed Drive: See Section 26 29 23, Low Voltage Adjustable Frequency Drive Systems.

Operating Speed Range: 50 to100% of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: See Section 26 20 00, Low Voltage AC Induction Motors.

Special Features: Motor should be suitable for Class I, Division 2.

SECTION 44 42 56.03
VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. American Petroleum Institute (API):
   a. 610, Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries.
   b. 670, Machinery Protection Systems.
3. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A536, Standard Specification for Ductile Iron Castings.
   c. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
4. Hydraulic Institute Standards (HIS):
   a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
   b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
5. National Electrical Manufacturer’s Association (NEMA): MG 1, Motors and Generators.
6. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.

2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.
4. Pump maximum downthrust or upthrust in pounds.
5. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of components.
6. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, and materials of construction lists.
7. Baseplate drawings with leveling jackscrew details, anchor bolt and sleeve details, and minimum foundation installation and leveling requirements.
8. Power and control wiring diagrams, including terminals and numbers.
9. Complete motor nameplate data, as defined by NEMA, motor manufacturer, including motor modifications.
10. Factory finish system.
11. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements that factory finish system is identical to requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer’s printed installation instructions.
5. Factory test data for each pump shall be submitted, reviewed, and approved by Engineer prior to shipment of equipment.
6. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

9. Manufacturer's Certificate of Proper Installation, in accordance with Section 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. Complete set packing.
2. Complete set bearings.
3. Complete set gaskets and O-ring seals.
4. Complete set of shaft sleeves.
5. Complete set keys, dowels, pins, etc.
6. Complete mechanical seal.
7. Impeller wear ring.
8. Bowl wear ring.
9. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Adjustable Speed Drives:

1. Where required, furnish coordinated operating system complete with pump, driver, and speed controller.
2. Coordinate pump and motor requirements with adjustable speed drive manufacturer and be responsible for the following:
   a. Torsional vibration of rotating assembly and related stresses.
   b. Motor thermal rating.
   c. Structural design of pump and motor assembly.
   d. Drive capacity for actual motor's nameplate current rating being supplied.
   e. Minimum motor speed rating for required corresponding torque.

B. Lateral and Torsional Vibrations:

1. Pump and motor assembly shall have no natural frequencies within 20 percent of operating speed range.
2. Fundamental critical speed of rotating assembly shall be no less than 50 percent above the rated speed.

2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.03 SHAFT SEALS

A. Sealing system for vertical turbine pump shafts shall be mechanical seal or packed stuffing box as indicated in pump data sheet.

B. Mechanical Seal Requirements:

1. Nonfretting type requiring no wearing sleeve for shaft.
2. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through seal area.
3. Split Type:
    a. Requiring no field assembly other than assembly around shaft and insertion into pump or balanced cartridge design in conjunction with a spool type spacer coupling as specified in pump data sheet.
    b. Nonshaft O-rings: Ball and socket type requiring no gluing.
    c. Initial seal installation at factory shall be with nonsplit seal faces; spare seals and spare kits to have split faces.
    d. Unless otherwise specified, capable of 400 psig service, be self-aligning, self-centering, and single.
    e. Manufacturer and Product: A.W. Chesterton Company; No. 442 or approved equal.
4. Arrangement shall allow removal of seal without disturbing pump or driver.
5. For clear water services and solids up to 5 percent by weight, face combination shall be hard/soft. Otherwise, hard/hard faces shall be used.
6. Design such that dynamic O-ring moves towards a clean surface as face wears and springs are not in pumped fluid.
7. Stationary seal face shall be spring loaded to provide self-aligning despite stuffing box misalignment.
8. Where cartridge type mechanical seals are specified:
    a. Single, balanced, flexible stator design.
    b. Capable of 600 psig service.
    c. O-ring secondary seals and setscrew drive with three-point centering to ensure 0.003-inch maximum perpendicularity of rotary face to shaft.
    d. Gland shall have flush port and be affixed to equipment with adjustable tabs to fit irregular bolt patterns.
    e. Manufacturers and Products:
        1) A.W. Chesterton Company; 155.
        2) Crane; 1B.
        3) Or approved equal.

9. Seal Materials:
    a. Metals:
        1) Loaded Parts Over 0.060-inch Cross Section: Type 316 stainless steel minimum.
        2) Thinner Parts (springs): Hastelloy-C, Alloy 20, AMS5876 Elgiloy, or other alloy that is not vulnerable to chloride stress corrosion or approved equal.
    b. Elastomers: Fluorocarbon Viton preferred, unless seal manufacturer recommends ethylene propylene for service conditions.
    c. Faces: Homogeneous construction. Surface treatments and plated faces are unacceptable.
        1) Acceptable hard faces include nickel bound tungsten carbide, self-sintered silicon carbide, reaction bonded silicon carbide, or graphitized silicon carbide. Silicon carbide is preferred because of its higher pressure-velocity capability.
        2) Acceptable soft face is carbon-graphite, either Union Carbide 658RC or Purecarbon P8412 or approved equal.
10. Seal Environmental Controls:
    a. Pipe seal flush port drain to wetwell or hub drain as shown on Drawings with 1/8-inch orifice plate in the line. Provide venting of seal chamber.
    b. Mechanical seals for anything other than clear water services shall be fitted with Enviroseal SpiralTrac Version F, N, or D, installation Type I as recommended by A.W. Chesterton Company or approved equal.
        1) Provide fluid circulation in seal chamber that removes frictional heat from mechanical seal.
        2) Convey particulate matter and contaminants for removal by conveying them from bore to shaft by means of integral machined spiral.
        3) Remove particulate matter from seal chamber, without seal flush water, through integral machined exit groove.
    c. Material of Construction: Type 316 stainless steel.
    d. Connect mechanical seal to water purge supply where indicated on Drawings.

C. Packing Requirements:

1. Stuffing Box:
    a. Tap to permit introduction of seal liquid.
    b. Hold a minimum of five rows of packing and a lantern ring.
    c. Face attached.

d. Box and shaft shall be suitable for field installation without machining or other modifications of mechanical seal specified herein for applicable pump and operating conditions.

2. Packing Rings:
   a. Three asbestos free die-molded packing rings of braided graphite material free of PTFE.
      1) A.W. Chesterton Company; 1400R for nonpotable water services or approved equal.
   b. Three die-molded rings of braided PTFE material.
      1) A.W. Chesterton Company; 1725 that is NSF/ANSI 61 acceptable for potable water services or approved equal.
   c. Glands:
      1) Two-piece split construction.
      2) Fit impeller end of packing with A.W. Chesterton Company; Enviroseal SpiralTrac, Version P, packing protection or approved equal.
3. Where pumped fluid is clear water:
   a. Pump discharge run through 1/8-inch orifice for packing lubrication. Otherwise, provide seal water flow control and monitoring as detailed on Drawings.
   b. External Seal Water Flow: 5 gallons to 30 gallons per hour flow rate, plus or minus 10 percent accuracy.
   c. Manufacturer and Product: A.W. Chesterton Company; SingleFlow or approved equal.
4. Shaft Sleeve:
   a. Fit section of shaft or impeller hub that extends through or into stuffing box with replaceable stainless steel sleeve with a Brinell hardness of not less than 500.
   b. Sleeve shall be held to shaft to prevent rotation.
   c. Gasketed to prevent leakage between shaft and sleeve.
   d. Thickness: 3/8-inch minimum.

2.04 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.05 FACTORY FINISHING

A. Prepare and prime and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.06 SOURCE QUALITY CONTROL

A. Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Test Report: Include test data sheets and curve test results.

C. Functional Test: Perform manufacturer's standard motor test on equipment.

D. Performance Test:

1. Conduct on each pump at rated speed.
2. Perform under simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Test Log: Record the following:
    a. Total head.
    b. Capacity.
    c. Horsepower requirements.
    d. Flow measured by factory instrumentation and storage volumes.
    e. Average distance from suction well water surface to pump discharge centerline for duration of test.
    f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
    g. Calculated velocity head at the discharge flange.
    h. Bowl head.
    i. Driving motor voltage and amperage measured for each phase.
5. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

F. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.

C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 62 00, Nonshrink Grouting. Remove wedges after grout is set and pack void with grout.

E. Connect suction and discharge piping without imposing strain to pump flanges.

F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

A. As specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:
   a. Test with unit installed and in normal operation, and discharging to connected piping systems at rates between low discharge head and high discharge head conditions specified, and with actual building structures and foundations provided shall not develop vibration exceeding 80 percent of limits specified in HIS 9.6.4.
   b. If unit exhibits vibration in excess of limits specified, adjust or modify as necessary. Unit that cannot be adjusted or modified to conform as specified shall be replaced.
3. Flow Output: Measured by plant instrumentation and storage volumes.
4. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
5. Test for continuous 3-hour period.

6. Test Report Requirements: In accordance with HIS 14.6.

B. Performance Test: In accordance with Hydraulic Institute Standards.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 4 person-days for installation assistance and inspection.
2. 2 person-days for functional performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or Site training.
4. 1 person-day for facility startup.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.

1. Pump Data Sheet.

END OF SECTION

VERTICAL TURBINE PUMP DATA SHEET, 44 42 56.03

Tag Numbers: 32PMP0101, 32 PMP0102

Pump Name: W3 System Pumps

Manufacturers and Product:
(1) Flowserve Worthington
(2) Fairbanks Morse
(3) Weir Floway
(4) ITT Goulds Pumps
(5) Pentair Aurora Layne Verti-Line
(6) Or approved equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): water

Pumping Temperature (Fahrenheit): Normal 50 Max 80 Min 40

Total suspended solids (mg/L) <5

Min. NPSH Available (Ft. Absolute): 3

Altitude (Feet above Mean Sea Level): 825

Ambient Temperature (degrees F.): 30-90

Location: Indoor (Y/N): N Outdoor (Y/N): Y

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 150

Total Dynamic Head (Ft): Rated: 250

BHP at Rated Point: 12.5

Min. Pump Hydraulic Efficiency at Rated Capacity (%): 76

Max. NPSH Required at Rated Capacity (Ft. Absolute): 4.5

Max. Pump Speed at Rated Capacity (rpm): 1,800

Adjustable (Y/N): Y

DESIGN AND MATERIALS

Pump Type: Open Line Shaft

Bowl: Cast iron

Bowl Bearings: Bronze backed rubber

Column: AWWA A53 Grade B Steel

Line Shafting: 1" Carbon Steel Lineshaft, 5ft Section

Line Shaft Bearings: Fluted synthetic rubber with bronze, ASTM B584 C90500, shells

Discharge Head:

Type: LADC

Material: Ductile Iron, ASTM A536, Grade 60-40-18

Discharge Nozzle Size (inches): 4 Flange Standard/Class: 125#

Impeller Material: Type 316 SS

Shaft Sealing: Packing (Y/N) N Mechanical (Y/N) Y

Type: Cartridge

Coupling:

Manufacturer Standard (Y/N) Y

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 15 Voltage: 460 Phase: 3

Synchronous Speed (rpm): 1,800

Service Factor: All

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC ___X CISD-TEFC _____ TEWAC _____ WPI _____ WPII _____

Mounting Type: Vertical Hollow Shaft X_____ Nonreverse Ratchet (Y/N) _____

REMARKS _____

_____

_____

SECTION 44 42 56 06
GRINDER-TYPE, SUBMERSIBLE PUMP

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. Conform to Division 1, General Requirements.

B. Contractor shall furnish grinder type, submersible pump and appurtenances as specified. Pumps shall be installed in new Clarifier No. 3 and shall replace existing pumps in Clarifiers Nos. 1 and 2. Pump shall be specifically designed to pump scum and waste solids and cutting and macerating solids for flow through small diameter piping without plugging. Materials shall be pumped and macerated a by the pump as an integral part of pumping action. Provide equipment from the named Supplier as outlined herein.

1.02 INTENT OF SECTION

A. This section covers supply, delivery, Site storage, installation, testing and placement into operation of pumping equipment and includes motors, drives, control equipment, supports and all appurtenances necessary for an operating system.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Complete attached pump datasheet.
   b. Hydraulic calculations for the head required by pump.
   c. General layout of each pump unit complete with motor and drive showing anchor bolt locations, casing position, direction of rotation and electric motor terminal box location.
   d. Cross-sectional details of pump and pump seal with complete cross-referenced materials list.
   e. Baseplate with anchor bolt details.
   f. Performance curves including head, capacity, efficiency, net positive suction head and power expressed in kilowatts.
   g. Details of impeller size, pump RPM, and solid sphere passing capacity.
   h. Dimensional drawings of motors and drives, including full output power in kilowatts, rpm, and slip.
   i. Electrical wiring diagrams.

j. Control cabinet arrangement and mounting details.
k. Details of storage requirements.
l. Sample warranty.

B. Informational Submittals:

1. Quality Control Submittals:
   a. Performance affidavit.
   b. Certified, nonwitnessed, shop test results for all pumps.
   c. Manufacturer's installation manuals.
   d. List of recommended spare parts with current prices and anticipated delivery times.
   e. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Provide a five year warranty and a performance affidavit for equipment to be furnished in accordance with this Specification.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General:

1. The following Specifications do not purport to cover all details entering into the design of pumping units required, but rather to call attention to certain special features.
2. Provide workmanship, materials, and methods of construction that conform to best practice and highest standard of the industry.
3. Supply and install units complete in all particulars and ready for operation.
4. Design and proportion all parts to have liberal strength, stability, stiffness, and to be specially adapted to the conditions of service.
5. Tailor pump capacities and impeller diameters to actual pump speeds imparted by pump drives. Base pump capacities on motor speed.
6. Provide pumping units that satisfy the performance specified for the service indicated. Pumps may be certified on water, however, pumps will not be accepted until performance specified is demonstrated on the service indicated.

B. Materials, equipment, and accessories specified in this section shall be products of:

1. Pentair/Myers Pump Model WGL20F.
2. Hydromatic.
3. Or approved equal.

2.02 SERVICE CONDITIONS

A. Pump specified in this section will be pumping scum from a secondary clarifier. Pump shall meet the performance requirements shown at the end of the section.

2.03 PUMP CONSTRUCTION

A. Provide solids handling pump especially constructed for pumping scum from a secondary clarifier from an activated sludge treatment process treating municipal wastewater.

B. Casing:

1. ASTM A48, Class 30 cast iron.
2. Pump discharge shall be 1-1/4 inch.

C. Impeller:

1. Recessed type.
2. Cast Iron.

D. Shredding Ring:

1. Shredding Ring shall be Type 440 Stainless steel.
2. Shredding Ring shall have a Rockwell hardness of 58-60.

E. Pump Shafting:

1. Pump shaft and impeller shall be supported by ball bearings.
2. Type 416 stainless steel.

F. Pump Mechanical Seal:

1. Double tandem mechanical seals carbon and ceramic upper seal.
2. Tungsten carbide lower seal.

G. Stainless Steel Nameplates: Attach to pump and drive motor giving manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.

2.04 SUBMERSIBLE ELECTRIC MOTOR

A. Provide oil-filled submersible motor in accordance with Division 26, Electrical.

B. Submersible motor shall include the following:

1. CSA and UL approved.
2. Suitable for connection to 230 Volt, 60 Hertz, single phase power supply.
3. Class F Insulation.
4. Motor shall be provided with high temperature switch and moisture intrusion switch. Neither high temperature or moisture intrusion switch shall require special relay to be installed in motor control circuitry.
5. Frame shall be cast iron, and hardware and shaft shall be stainless steel.

2.05 SURFACE PREPARATION AND PAINTING

A. All wetted non-stainless parts shall be SSPC-SP5 white metal sandblast.

B. Finish coat all surfaces with a total of 8 mil minimum dry film thickness of the manufacture's standard two-part epoxy coating system.

PART 3 EXECUTION

3.01 FIELD TESTING

A. Field test pump in presence of Engineer or Owner's representative to demonstrate that installation is correctly completed and each pump is operating satisfactorily without vibration or cavitation.

B. Field test shall be supervised by pump manufacturer's representative.

C. Engineer requires 72 working hours written notice prior to such tests.

D. Field test pump with water prior to or during testing of process equipment. Perform second field test on specified service fluid during initial process startup. Contractor to provide a temporary water supply to scum well for testing.

E. Supply required metering devices and gauges necessary to demonstrate pump performance. Supply and install gauge connections as required.

F. Test results must be properly documented and presented to Engineer.

G. Successful field tests done on water shall not constitute acceptance of pumping unit. Pump will be accepted only after successful performance tests on specified service.

3.02 SUPPLEMENTS

A. The supplement listed below, following "END OF SECTION," is part of this Specification.

1. Grinder Type, Submersible Pump Data Sheet.

END OF SECTION

GRINDER TYPE, SUBMERSIBLE PUMP DATA SHEET, 44 42 56.06

Tag Numbers: 06PMP0503, 06PMP0501, 06PMP0502

Pump Name: Scum Pump No. 3, Scum Pump No. 1 and Scum Pump No. 2

Manufacturer and Model Number: (1) Pentair/Myers WGL20F

(2) Or approved equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Secondary Clarifier Scum

Pumping Temperature (Fahrenheit): Normal: 70 deg F Max 85 deg F Min 40 deg F

Specific Gravity at 60 Degrees F: 0.9-1.05 Viscosity Range: 1.0-100 cps

pH: 7-9

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Minimum diameter solid pump can pass (inches): N/A

Min. NPSH Available (Ft. Absolute): 32 ft
Suction Pressure (Ft): Max 12 ft Rated 4 ft

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 40 Secondary: 67

Total Dynamic Head (Ft): Rated: 56 Secondary: 20

Maximum Shutoff Pressure (Ft): 86

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 40

Max. Pump Speed at Rated Capacity (rpm): Constant (Y/N): 3450 rpm
Adjustable (Y/N): N

DESIGN AND MATERIALS

Pump Type: Submersible, Grinder Type

Volute Material: Cast Iron ASTM A48. Cl 30
Pump Casing Material: Cast Iron ASTM A48, cl 30

Motor Housing Material: Cast Iron ASTM A48, Cl 30

Elastomers: Nitrile Rubber

Fasteners: Stainless Steel

Impeller: Type: Double-Shrouded Non-Clog (Y/N): _____ Other: _____
Material: Cast Iron ASTM A48

Shaft Material: Type 440 stainless steel

Base Elbow: N/A

Double Mechanical Seal (Y/N): Y Bearing Life (Hrs): 40,000

DRIVE

Horsepower: 2 Voltage: 480 Phase: 3 Synchronous Speed (rpm): 3450

Enclosure: EXP

CLASSIFICATION: Class 1, Group D, Division 1

Other Features: _____

Moisture Detection/Seal Leak Switch (Y/N): Y

Thermal Protection Embedded in Windings (Y/N): Y

REMARKS: _____

SECTION 44 42 56.10
SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Bearing Manufacturers' Association (ABMA).
2. Hydraulic Institute Standards.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
4. Occupational Safety and Health Administration (OSHA).

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
   d. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
   e. Power and control wiring diagrams, including terminals and numbers.
   f. Complete motor nameplate data, as defined by NEMA, motor manufacturer.
   g. Factory finish system data sheets.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions.
3. 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.
4. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for each pump:

1. Complete set gaskets and O-ring seals.
2. Complete set of shaft sleeves.
3. Complete mechanical seal.
4. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. The pump manufacturer shall coordinate pump requirements with adjustable frequency drive manufacturer for the RAS pumps.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller. The AFDs shall control the pumps and shall be located in the MCC in the RAS/WAS pump station.

C. Acceptable Manufacturers:

1. The Manufacturer shall be a company specializing in manufacture, assembly, and field performance of self-priming centrifugal pumps with a minimum of five years of experience.
2. Acceptable pump manufacturer's:
   a. Weir Specialty Pumps.
   b. Gorman Rupp.
   c. Or approved equal.

2.02 SUPPLEMENTS

A. Specific performance and material requirements are attached to this section as supplements.

2.03 ACCESSORIES

A. Where shown in Supplemental data, provide Adjustable Frequency Drives(AFD) per the requirements od Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

B. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

C. Lifting Lugs: Provide lifting lugs for equipment items weighing over 100 pounds.

D. Provide OSHA-approved coupling guard for direct coupled or belt driven pumps.

E. Anchor Bolts: Anchor bolts shall be Type 316 stainless steel, sized by equipment manufacturer.

2.04 FACTORY FINISHING

A. The manufacturer shall provide a factory prime coat compatible with the finished field coating specified in Section 09 90 00, Painting and Coating.

2.05 SOURCE QUALITY CONTROL

A. Factory Test Report: Include test data sheets and curve test results.

B. Functional Test: Perform manufacturer’s standard.

C. Factory Performance Testing:

1. Provide Factory Performance Testing In accordance with Hydraulic Institute Standards.
2. Testing shall include result at ten different operating points with results for flow in gpm, Total Dynamic Head in feet, efficiency in percent, Power in Horsepower,
3. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

D. Motor Test: See Section 26 05 01, Electrical.

E. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.

C. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout of the proper category. Remove wedges after grout is set and pack void with grout.

E. Connect suction and discharge piping without imposing strain to pump flanges.

F. Anchor Bolts: Accurately place using equipment templates.

3.02 FIELD FINISHING

A. Finish equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:
   a. Test with unit installed and in normal operation and discharging to the connected piping systems at rates between low discharge head and high discharge head conditions specified, and with actual foundations provided shall not develop vibration exceeding 80 percent of the limits specified in HIS 9.6.4.

b. If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.
c. Confirm proper operation of air release valve.

3. Flow Output: Measured by plant instrumentation.

B. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

C. Performance Test:

1. Conduct on each pump
2. Test for continuous 3-hour period without malfunction. During test operate WAS pumps at maximum flow. Operate RAS pumps at maximum flow for 2 hours and minimum flow for 1 hour.
3. Log flow, discharge pressure and motor amperage.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 0.5 person-day for installation assistance and inspection.
2. 0.5 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or Site training. Videotape the training session in accordance with Section 01 43 33, Manufacturers' Field Services.
4. 1 person-day for facility startup.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.

1. Supplement 1, RAS Pumps 1, 2, and 3 Data Sheet.
2. Supplement 2, WAS Pumps 1, 2, and 3 Data Sheet.

END OF SECTION

SELF-PRIMING CENTRIFUGAL PUMP DATA SHEET, 44 42 56.10

Tag Numbers: 21PMP2001, 21PMP2002, 21PMP2003

Pump Name: RAS Pumps 1, 2, and 3

Manufacturer and Model Number: (1) Weir Specialty
(2) Gorman-Rupp
(3) Or approved equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Return Activated Sludge
Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 60
Specific Gravity at 60 Degrees F: 1 Viscosity Range: 1.0
Min. NPSH Available (Ft. Absolute): 20

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 520

Total Dynamic Head (Ft): Rated: 23

Min. Hydraulic Efficiency (%): 55%

Maximum Shutoff Pressure (Ft): 32

Max. Pump Speed at Design Point (rpm): 900

Constant Speed (N): ____

Variable Speed (Y): ____

PERFORMANCE REQUIREMENTS AT SECONDARY DESIGN POINTS

Capacity (US gpm): 900 Capacity (US gpm):

Total Dynamic Head (Ft): 13 Total Dynamic Head (Ft):

Min. Hydraulic Efficiency (%): 45 Min. Hydraulic Efficiency (%):

DESIGN AND MATERIALS

Casing: Class 30 Gray Iron
Impeller: Semi-open type, CD4MCu Hardened metal

Impeller shaft: 17-4PH Stainless Steel or Alloy Steel 4150

Replaceable wear plate: Wear Resistant Alloy(BHN 400)

SELF-PRIMING CENTRIFUGAL PUMP DATA SHEET, 44 42 56.18

Removable adjustable cover plate: Gray iron 30

Flap valve: Neoprene with nylon and stainless steel Type 316 reinforcing

Seal Plate: Stainless Steel Type 316

ABMA L 10 Bearing Life (hours): 40,000 Bearing Lubrication: Oil

Suction and discharge Flanges: #125 gray iron

Gaskets/O-rings: Buna-N

Pressure relief valve: Brass

Mechanical seal: Cartridge type, oil-lubricated, double floating, self-aligning. Silicon Carbide faces. SST 316 stationary seat. Viton elastomer. SST 18-8 cage and spring.

Drive type: Belt Drive.

Base-plate: Carbon steel.

Automatic Air Release Valve

DRIVE MOTOR (See Section 26 05 01, Electrical.)

Horsepower: 7.5 Voltage: 460 Phase: 3 Synchronous Speed (rpm): 900

Inverter Duty (Y/N) Yes

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: TEFC

Mounting Type: Horizontal

Space Heater: No

Thermal Protection: Thermostat

Drive Type: Variable Speed Belt Drive

REMARKS: Provide premium efficiency motor.

SELF-PRIMING CENTRIFUGAL PUMP DATA SHEET, 44 42 56.10

Tag Numbers: 21PMP2101, 21PMP2102, 21PMP2103

Pump Name: WAS Pumps 1, 2, and 3

Manufacturer and Model Number: (1) Weir Specialty Pump cutter plate
(2) Gorman-Rupp
(3) Or approved equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Waste Sludge

Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 60

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1.0 – 1.02

Min. NPSH Available (Ft. Absolute): 20

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 250

Total Dynamic Head (Ft): Rated: 20

Min. Hydraulic Efficiency (%): 44%

Maximum Shutoff Pressure (Ft): 27

Max. Pump Speed at Design Point (rpm): 890

Constant Speed (Y):

Variable Speed (N):

PERFORMANCE REQUIREMENTS AT SECONDARY DESIGN POINTS

Capacity (US gpm): 450 Total Dynamic Head (Ft): 14.5 Min. Hydraulic Efficiency (%): 45

DESIGN AND MATERIALS

Casing: CD4MCu

Impeller: Semi-open type, CD4MCu Hardened metal

Impeller shaft: 17-4 PH stainless steel or Alloy Steel 4150

Replaceable wear plate: CD4MCu Hardened metal

SELF-PRIMING CENTRIFUGAL PUMP DATA SHEET, 44 42 56.18

Removable adjustable cover plate: Gray iron 30

Flap valve: Neoprene with nylon and stainless steel Type 316 reinforcing

Seal Plate: Stainless Steel Type 316

ABMA L 10 Bearing Life (hours): 40,000 Bearing Lubrication: Oil

Suction and discharge Flanges: #125 gray iron

Gaskets/O-rings: Buna-N

Pressure relief valve: Brass

Mechanical seal: Cartridge type, oil-lubricated, double floating, self-aligning. Silicon Carbide faces. SST 316 stationary seat. Viton elastomer. SST 18-8 cage and spring.

Drive type: Belt Driven

Base-plate: Carbon steel

Automatic Air Release Valve

DRIVE MOTOR (See Section 26 05 01, Electrical)

Horsepower: 5 Voltage: 460 Phase: 3 Synchronous Speed (rpm): 900

Inverter Duty (Y/N) No

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: TEFC

Mounting Type: Horizontal

Space Heater: No

Thermal Protection: Thermostat

Drive Type: Constant Speed Belt Drive

REMARKS: Provide premium efficiency motor.

SECTION 44 43 30
EFFLUENT FILTER SYSTEM

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Work of this section includes furnishing the Effluent Filter System, including two filters and all appurtenant work to be installed at the Disk Filters No. 1-2 as shown on the Drawings and described herein. The Work also includes furnishing, installing, and programming of control system equipment, including the PLC, operator interface, and control panel as shown and specified.

B. Equipment Tag Numbers:

1. 07FDD0501: Filter Disk Drive No. 1.
2. 07FDD0502: Filter Disk Drive No. 2.
3. 07PMP0301: Backwash Pump No. 1.
4. 07PMP0302: Backwash Pump No. 2.

1.02 GENERAL

A. Like items of equipment provided hereunder shall be the end products of one manufacturer to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

B. General Requirements: See Division 1, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

C. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

D. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems.

E. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each control function, connection, communications, or equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

F. All equipment and materials furnished under this Contract shall be constructed with due regard to safety of operation, accessibility, durability or parts, and shall comply with all applicable OSHA, state, and local safety requirements.

G. The design of the equipment as shown on the Drawings is based upon the equipment from the first named manufacturer under Paragraph Manufacturer in this Specification. The arrangement is meant to be representative and does not preclude Vendors from submitting their standard equipment providing it meets the requirements detailed within this specification. If Contractor does not select the first Manufacturer, any changes to the design because of the selection shall be the responsibility of the Contractor. Contractor shall reimburse the Owner for any cost incurred by the Owner because of the selection.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures, and Section 40 99 90, Package Control Systems. The following specific information shall be provided:

1. Complete manufacturer's descriptive information and Shop Drawings for all equipment, material, and devices furnished.
2. Catalog information and cuts for all manufactured items, including control system components, highlighted to show actual items proposed to be provided.
3. Provide a statement confirming that the disk materials selected is resistant to free chlorine.
4. All interconnections and interface requirements, dimensions and locations of all major elements of the Effluent Filter System, and critical locations and clearance requirements.
5. Shop Drawings or equipment drawings, including dimensions, size and location of connections to other work, and weight of equipment.
6. Installation and location drawings for equipment.
7. Complete set of user manuals, fully documented ladder logic listings, function listing for function blocks not fully documented by ladder logic listings, cross-reference listings, operator interface configuration documentation, list of spares, and test equipment for the programmable controller.
8. Supporting calculations for equipment, associated supports and anchorage designed by equipment manufacturer. All equipment and associated supports shall be designed and stamped by a structural engineer registered in the State of Tennessee.

9. Letter of Certification by equipment manufacturer stating that all welding meets ASME 9 or AWS D18.3/D18.3M Specification for Welding of Tanks, Vessels and other Equipment in Sanitary (Hygenic) Applications as modified herein.
10. Calculations, signed and sealed by a professional engineer registered in the State of Tennessee, for the structural design of any manufacturer provided walkways and equipment anchorage.
11. Panel construction and dimensional panel layout drawings. Each panel component shall be shown and clearly identified. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces. Control system submittals shall be in accordance with Section 40 99 90, Package Control Systems.
12. Detailed proposed procedure for conducting the functional and performance field tests.
13. Hydraulic profile and calculations demonstrating compliance with specified hydraulic criteria (e.g. loading rates). Provide a statement confirming that the proposed filters fit within the plant hydraulic profile presented in the Contract Drawings.
14. Motor information to be submitted in accordance with Section 26 20 00, Low-Voltage AC Induction Motors.
15. Operation and Maintenance Manual and Maintenance Summary: In conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.
16. Provide confirmation of drain pipe sizing based on the recommend backwash schedule. Manufacturer to coordinate with the Contractor.

1.04 WARRANTY

A. The manufacturer shall provide a full warranty on all parts and labor on the longer of the two following options, as a minimum 60 months from acceptance by the Owner or 72 months from shipment, whichever occurs first.

PART 2 PRODUCTS

2.01 GENERAL

A. Service Factors: The following minimum service factors for equipment design shall be provided:

1. Gears and Gear Drives: 1.15.
2. Inverter duty rated motors: 1.0.
3. Non-Inverter Duty rated Motors: 1.15.

B. Safety Devices: The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other federal, state, and local health and safety regulations.

C. Flanges and Pipe Threads: Comply with ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B1.20.1.

D. Bearings: Conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA). Except where otherwise indicated, bearings of process equipment shall have a minimum L-10 life expectancy of 40,000 hours.

E. Equipment Identification Plates: 16-gauge, Type 304 stainless steel, securely mounted on each separate equipment component and control panel in readily visible location. Plate shall bear 3/8-inch high die-stamped block type black enamel filled equipment identification number and letters.

2.02 MANUFACTURERS

A. Basis of Design, materials, equipment, components and accessories specified in this section shall be products of the listed manufacturer(s):

1. Veolia Water Technologies, Inc. dba Kruger Hydrotech.
2. Westech.
3. Or approved equal.

B. The Drawings show the Veolia Hydrotech Filter and this Specification section describes the Hydrotech Filter. Alternate manufactures as listed above shall be considered.

C. Dimensions and elevations provided on the Drawings may vary depending on manufacturer. Contractor to coordinate all dimensions and installation requirements with the equipment manufacturer. Any changes to the design based on selection of alternate manufacture shall be the responsibility of the Contractor and at no cost to the Owner. Design changes shall be subject for review and approval by the Engineer.

2.03 SERVICE CONDITIONS

A. Design Requirements:

1. Filters will receive municipal secondary clarified effluent from a treatment plant (i.e. Activated Sludge Process in BNR Configuration).
2. Average Flow Capacity, per Filter: 1.0 mgd.
3. Peak Flow Capacity, per Filter: 2.0 mgd.
4. Peak flow(1 unit out of service): 4.0 mgd.
5. Maximum Hydraulic Loading, Per Filter: 3.55 gpm/sf. (Both units in service).

6. Maximum Hydraulic Loading 7.1 gpm/sf. (One unit in service).
7. The average backwash reject water volume shall not exceed 3.0 percent of the influent volume under average flow conditions (1.0 mgd/filter) and an influent TSS of 10 mg/L.
8. Filter Influent Suspended Solids (average):
   a. Average: 10 mg/L.
   b. Peak: 20 mg/L.
9. Filter Influent Chlorine Concentrations: 0.5 to 1 mg/L (i.e. temporary/emergency chlorination).
10. Effluent Temperature: 18 to 28 degrees Celsius.
11. Ambient Temperature: Minus 5 to 37 degrees Celsius.
12. Maximum Filter Headloss during Average Flow Capacity: < 12 inches.*
13. Maximum Filter Headloss during Peak Flow Capacity: < 18 inches.*

*Filter headloss shall be calculated across the complete filter unit including disk media and all pertinent channels and weirs (e.g. influent, effluent, etc.).

2.04 PERFORMANCE REQUIREMENTS

A. The effluent filters shall be capable of filtering plant effluent with the flow rates and characteristics summarized in Article Service Conditions, to produce the following effluent characteristics:

1. Effluent Suspended Solids: < 5 mg/L.
2. Compliance is based on analysis of 24-hour flow paced composite sample.
3. Should the influent characteristics fall outside the limitations stated in Article Service Conditions, all performance requirements shall be deemed to be met.
4. Meeting the performance requirements is contingent on the upstream process providing influent to the filters with characteristics suitable for filtration, i.e., particles of sufficient size and strength to allow retention on the 10 micron filter media.

2.05 EQUIPMENT AND MATERIALS

A. Materials: The materials for the filter system components shall be suitable for installation in municipal wastewater effluent with the characteristics, as listed in Article Service Conditions. Materials for specific components shall be as listed herein. It shall be the responsibility of the Manufacture to fabricate components from materials suitable for installation in the service conditions listed, whether materials are specified or not.

B. Package Filter Systems:

1. Provide two filter in-channel systems, with cloth media disk filter systems to be installed in a concrete structure with dimensions as shown on the Drawings. Each filter assembly shall consist of cloth disks, filter drive assembly, and automatic backwash system. All piping and components integral to the filter unit shall be provided by the effluent filter system manufacturer. A backwash pump shall be provided for each filter.
2. Each filter shall be provided with a local PLC control panel providing local and automatic filter system control.
3. The filter system supplier shall provide all supports and anchor bolts required to install all the equipment and components provided in this section.
4. Filter Disks: Each filter shall be provided with at least ten filter disks with space for an additional two disks that can be added to meet future loading requirements. Disks shall be segmented to allow media to be changed on each segment.
5. The cloth media shall have nominal 10 micron openings and be woven polyester material resistant to chlorine (at 1.0 mg/L). Filter panels shall consist of plastic or stainless steel frames with woven polyester media attached. Each panel shall be equipped with an EPDM rubber gasket that is fitted to and provided integral to the media frame to provide a water tight seal between the panels and disk segments. Designs that use stick-on adhesive compressible gaskets as seals between media panels, disk segments, or cassettes shall not be accepted due to lack of durability and potential for compromised effluent quality.
6. The effective filter surface area shall be 391.8 square feet per filter or more.
7. Drive Mechanisms(07FDD0501, 07FDD0502): The drive assembly for each filter unit shall operate during backwash cycle. The drive assembly have a steel chain. Gears shall be AGMA Class I design and shall meet all AGMA requirements. The motors shall be TEFC, 1.5 HP, 460-volt, 60-Hz, three-phase. Provide safety guards as necessary to meet OSHA requirements.
8. Backwash Cleaning System: Each filter shall have a backwash system including backwash collection troughs, backwash supply manifolds with stainless steel nozzles, and automatic backwash sequence controls. The backwash system components shall be minimum Type 304 stainless steel with stainless steel hardware. The backwash spray header located between the disks shall be Type 316L stainless steel. The backwash nozzles shall be self-cleaning to prevent nozzle plugging from small particles.

9. The spray system shall include a wye strainer with a 50-mesh screen element and a manually operated bypass that can divert backwash flow around the strainer. A pressure 0-120 psi pressure gauge gauges shall be located on each side of the strainer. All piping, valves, fittings and strainer shall be stainless steel. The manufacturer shall furnish the wye strainer, bypass valves, piping and pressure gauge for installation by the Contractor.
10. Backwash Pumps(07PMP0301, 07PMP0302): Backwash pumps shall be multi-stage centrifugal pumps. The pumps shall be rated for 82 gpm and be capable of providing a 110 psi discharge pressure to the spray headers system. The pump shall have a 10 HP, 460 volt, 3 phase, TEFC motor. The pumps shall be rated and designed for outdoor service Pumps shall have mechanical seals rather than packing.
11. The backwash drain shall be provided with a manually operated plug valve with a flanged body so each filter backwash drain can be isolated from the common header pipe.
12. The Manufacturer shall size and provide all Type 304 stainless steel anchor bolts necessary to anchor their equipment in-place.
13. Filter Disk Tank: Each filter shall be installed in a concrete tank provided by the Contractor. The tanks shall include all necessary internals and weirs.
14. Filter Unit Cover: Each unit shall be furnished with a GRP (Glass fiber Reinforced Plastic) lockable cover to prevent algal growth and to eliminate the presence of filter flies. One side of the cover shall have a single access lid that can be opened to allow operator access to all the disks and backwash nozzles. Designs that require both sides of the filter cover(s) to be opened to access filter media and/or backwash nozzles shall not be acceptable due to operator inconvenience and the requirement for additional footprint and access platform. The lid must include an assembly that provides the following: mechanical advantage to assist personnel in lifting the lid, full support of the lid when in the open position, and mechanical resistance/support when lowering the lid. This feature is important for ease of access and improved operator safety. Designs that incorporate removable lids, sliding lids, or propped lids (without mechanical lifting mechanism) will not be accepted.
15. Elevated platforms: Any elevated platforms attached to or necessary to maintain the equipment or shown to be provided by the equipment manufacturer shall be provided by the equipment manufacturer. Any Manufacturer provided access stairs, platforms or walkways shall be designed, signed and sealed by Tennessee professional engineer:
    a. Any manufacturer provided access walkways, platforms and stairs shall meet applicable OSHA Requirements.

b. Manufacturer provided walkways, grating, and handrails shall meet the requirements of all regulatory agencies and Design Criteria on Drawings. Any Manufacturer provided grating and platforms shall be designed for the required minimum live load 50 PSF plus actual equipment loads (if applicable).
c. Any Manufacturer provided walkways shall be constructed of aluminum and aluminum handrails designed and constructed in accordance of requirements of Section 05 52 00, Metal Railings, and aluminum grating designed and constructed in accordance of requirements of Section 05 53 00, Metal Gratings.
d. Dissimilar metals shall be isolated by use of 1/4–inch thick neoprene rubber pad.

16. All steel components shall be provided in accordance with Section 05 50 00, Metal Fabrications.

2.06 EXTRA MATERIALS

A. Tools: The Work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts: Provide for 5 years of operation including spare disk cloth material and lubricants.

2.07 FABRICATION

A. Shop Assembly: Shop-fabricate and assemble components in largest sections practical.

B. Shop/Factory Finishing: Shop prime and finish coatings shall conform to the requirements of Section 09 90 00, Painting and Coating. All carbon steel components shall be coated with system No. 2. Other ferrous surfaces including tank exterior shall be coated with system No. 4. Stainless steel components shall not require a coating. Manufacturer standard coating system may be acceptable if comparable to specified coating systems, subject to Engineer approval.

C. Welding shall be per AWS D18.3 or ASME 9 and as follows:

1. Butt joints shall be CJP (complete joint penetration).
2. All welded connections designed to prevent the passage of water shall be seal welded.

3. Field welding of stainless steel will not be permitted.
4. Finished Welds and Adjacent Zones shall meet WF-4 per AWS D18.3, Annex B or as specified in ASME 9.

2.08 ELECTRICAL

A. General: Conform to the requirements of Division 26, Electrical. 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 of these Specifications

B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Section 26 05 05, Conductors, and NFPA 70. Insulation shall be rated 600-volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Section 26 05 33, Raceways and Boxes. Raceways shall be installed in accordance with Section 26 05 33, Raceways and Boxes and NFPA 70.

D. Motors: Motors shall be provided as specified for the individual equipment in Article Equipment and Materials.

E. Backwash pump motor starters: Provide motor shall be provided in accordance with Division 26, Electrical.

F. The disk drive motor shall be powered using a variable frequency drive. The VFDs shall be provided by the manufacturer and located within the factory control panel. VFDs shall be a Square D Altivar 320 or approved equal and suitable for operating temperatures to 140 degrees F.

2.09 INSTRUMENTATION AND CONTROLS

A. General: See Section 40 99 90, Package Controls System, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 99 90, Package Controls System.

B. Panels:

1. Provide the following Local Control Panel for each filter: 07LCP0101 for filter 1 and 07LCP0102 for filter 2.
2. Material: Anodized aluminum or Type 316 stainless steel.
3. NEMA Rating: 4X.
4. Panel Size: By manufacturer subject to review and approval by Engineer.
5. Motor starters for pumps and VFD for the drive disk drive motor shall be incorporated into the panel.

C. Power Supply: Panel shall be capable of operating on 480 volt ac power.

D. Operator Controls and Indicators: Provide the following panel mounted operator controls and indicators:

1. Hand/Off/Remote hand switches for the following equipment:
   a. Disk Drum Drive 1.
   b. Disk Drum Drive 2.
   c. Backwash Pump 1.
   d. Backwash Pump 2.
2. Equipment ON indicating light for the following equipment:
   a. Disk Drum Drive 1.
   b. Disk Drum Drive 2.
   c. Backwash Pump 1.
   d. Backwash Pump 2.
3. Panel mounted Operator Interface Unit (OIU): Required; refer to Section 40 99 90, Package Control System, for OIU requirements.

E. External Interfaces (Discrete status signals to SCADA only):

1. Filter system Operational.
2. Filter system Fail.
3. Filter system in Backwash.
4. HIGH level.
5. Backwash pump forced OFF
6. Filter disk drive forced OFF

F. Instrumentation:

1. Provide the following instrumentation as part of the effluent filter system package:
   a. Level switches.
   b. Pressure: Switches, and elements.
2. Provide any additional instruments required for satisfactory operation, such as proximity switch.

G. Functional Requirements:

1. The control panels shall contain the local controls for each filter's components.
2. Each control panel shall provide automatic filter system control and operator interface. The filter system supplier shall provide each panel complete with programmable controllers (PLC), operator interface, all input/output hardware, and operations programming required for complete filter system operation.
3. The following operator interface functions and displays shall be provided at the local control panel:
    a. System Status (ON/OFF/OPEN/CLOSED for all controlled elements).
    b. System Auto/manual status.
    c. Provide for ON/OFF/AUTO operation of the filter system components including any automated valves and backwash pump.
4. Manual ON/OFF control shall be independent of the PLC.
5. When in AUTO mode, the filter system valves will receive OPEN/CLOSE signals and the pumps will receive RUN signals from their respective control panels.
6. Backwash Cycle: The backwash cycle shall be independently initiated by a level switch, by a timer setting or by manual operator initiation. The disk drum drive unit and the backwash pump shall be activated, and any required electrically actuated valves open in sequence to accomplish backwashing of the filter. It shall be possible to make both level controlled and timer backwash operating modes active at any given time.
7. Each filter shall provide continuous filtration during backwash pumping cycles.
8. All status information, motor runtimes, and alarms shall be displayed on the operator interface unit. All timer and counter values shall be adjustable at the operator interface unit.

H. Special Requirements:

1. The following items either emphasize or waive certain requirements of Section 40 99 90, Package Controls System.
    a. The panel shall be fabricated in accordance with UL508A and bear a UL508A label.
    b. The indicating lights shall be NEMA 4X rated and shall include LED bulbs.
    c. The indicating lights shall include push-to-test circuitry.
    d. Breather vents and drains are not required.
    e. Door handle shall be the 3-point latching mechanism type.

2. Each motor shall have the following alarm conditions:
   a. Motor fail to start: This failure occurs when the motor is called to start and the motor running feedback has not been received within 5 seconds.
   b. Unauthorized Motor Status: This condition occurs when the motor start feedback is received for at least 5 seconds in the absence of PLC-issued motor start command.
3. Any valves shall have the following alarm conditions:
   a. Fail to open within specified time when required.
   b. Fail to close within specified time when required.
4. Each valve shall be provided with separate open/close signals.

2.10 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments:

1. Test control panels identical to that furnished.
2. Perform manufacturer's standard tests on equipment.
3. Motor Tests: See Section 26 20 00, Low Voltage AC Induction Motors.
4. Simulate and test PLC logic to ensure compliance with the filter system functional requirements.

PART 3 EXECUTION

3.01 GENERAL

A. Packaged Equipment: When any system is provided as prepackaged equipment, coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.02 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Refer to the Standard Details furnished in Volume 4 of these Contract Documents for installation details for control panels, transmitters, and instrumentation. Where none are provided, use the manufacturers' standard for the application.

C. After the equipment has been placed into operation, the manufacturer's representative shall make all final adjustments for proper operation.

D. Lubricants: The installation includes oil and grease for initial operation.

E. Anchor bolts shall be Type 304 stainless steel, 1/2-inch diameter (minimum).

3.03 FACTORY TESTS AND ADJUSTMENTS

A. Test all control panels furnished for the Project.

B. Perform manufacturer's standard tests on equipment.

C. Motor Tests: See Section 26 20 00, Low-Voltage AC Induction Motors, of the Bid Documents for the Project.

D. Simulate and test PLC logic to ensure compliance with the filter system functional requirements.

3.04 FIELD QUALITY CONTROL

A. Testing: Provide a plan for performance testing for Engineer review. Products shall be field-tested for compliance with the indicated requirements.

B. Functional Testing: Testing shall include 24 hours continuous operation of the filters.

C. Performance Testing: Performance testing shall be completed in two parts. The first part will involve the testing of the hydraulic performance of the filters and the second will include the testing of the suspended solids removal.

1. The Owner shall provide all routine test equipment, including instruments, analyzers, etc., required to sample and test the effluent filters. Any specialized instruments or analyzers shall be provided by the Manufacturer.
2. The Owner will provide all water and electrical power to conduct the performance tests. Water for testing shall be secondary clarifier effluent. The cost of all laboratory tests required to confirm the performance of the filters for the initial performance test on each filter cell will be borne by the Owner. If a retest is required due to failure of equipment, functionality or in performance attributed to the manufacturer, then the Manufacturer shall pay for all subsequent laboratory tests and added manufacturer provided service time.
3. Hydraulic Performance Testing: Hydraulic Testing will be completed following functional testing and shall include 72 hours of continuous filter operation at normal plant operating conditions. The Contractor shall also demonstrate filter operation at peak design flow conditions.

4. Solids Performance Testing: The solids performance test shall consist of each filter cell being tested during plant startup to verify that the effluent suspended solids concentration will be in accordance with Article Performance Requirements. The following information and frequency of testing shall be provided and recorded:
   a. Filter influent flow: Continuous measurement.
   b. Filter influent suspended solids: Hourly flow composited samples.
   c. Filter effluent suspended solids: Hourly flow composited samples.
5. Filters shall be tested independently and run continuously for 72 hours with no exceedances of the effluent suspended solids limit of 5.0 mg/l for the test period. Filters can be tested concurrently if the manufacturer provides adequate testing equipment and personnel. If the filter cannot meet the effluent suspended limit, the filter cell shall be retested for an additional 72-hour period. If, after the retest, the filter cannot meet the effluent suspended solids criteria, the Manufacturer shall be given 10 days in which to perform at its sole expense, any supplemental testing, equipment adjustments, changes or additions and request an additional retest of the filter cell.

D. Witnesses: The Owner and the Engineer’s Consultant (at the option of either) reserve the right to witness field tests.

3.05 MANUFACTURERS' SERVICES

A. Manufacturer's Services and Certificate of Proper Installation: Provide manufacturer's services and Manufacturer's Certificate of Proper Installation in conformance with the requirements of Section 01 43 33, Manufacturers' Field Services, in the Bid documents. Manufacturer’s representation shall provide inspection of equipment installations, field inspection of equipment before startup and the executed copies Manufacturers services and Certificate of Proper Installation exclusive of specified services for “Instruction of Owner’s Personnel.”

B. The manufacturer shall provide factory trained representation for a minimum of two site visits of at least three full working days each, excluding travel time, for installation inspection, startup, training, and operational/maintenance assistance.

END OF SECTION

SECTION 44 44 13.01
CHEMICAL METERING PUMPS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
2. Hydraulic Institute Standards.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data on pumps, including curves showing flow rate verses pump speed setting (in percent) at specified maximum speed.
   d. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, pumped chemical characteristics, pipe connection sizes, pump materials of construction, testing requirements, and appurtenances to be provided with pumps.
   e. Detailed dimensional drawings for pump and driver, including mounting requirements and piping connection sizes and locations.
   f. Power and control wiring diagrams, including terminals and numbers.
   g. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
   h. Manufacturer's materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.

i. Factory finish system.
j. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements**,** that factory finish system is identical to requirements specified herein.
3. Factory Functional Test Reports special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. Ten complete pump assemblies including pump head, drive unit and integral controls.
2. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. The pumping system package shall consist of a triplex, skid mounted chemical pumping system that includes pumps, piping, valves, and controls on a pre-assembled skid package.

B. The chemical metering system shall be completely self-contained and designed to safely feed metered amounts of the chemical listed below.

C. Acceptable Manufacturers:

1. The Manufacturer shall be a company specializing in manufacture, assembly, and field performance of peristaltic metering pumps and chemical metering pump system packages containing one or more pumps with a minimum of 5 years of experience.
2. The metering pumps shall be Qdos 30 manufactured by Watson Marlow or approved equal.

2.02 PUMP

A. Pump Construction:

1. Pumphead:
   a. Pump head shall be a tool-free cartridge-style peristaltic pump technology. The pumphead must be serviceable as a single replaceable component.
   b. Max Rating: Discharge pressure rating is 100 psi.
   c. Max Suction Rating: Self priming with a maximum suction lift capability of 30-foot vertical water column.
   d. Housing Construction: Corrosion resistant and high impact resistant glass filled PPS or PPE/PS.
   e. Geometry: Pumphead shall consist of sealed track housing with in-line porting. Suction and discharge ports shall be 180 degrees apart with bottom suction and top discharge.
   f. Rotor: Pumphead rotor shall be constructed of glass filled Nylon, sealed within the track housing, and supported by its own bearings. Peristaltic occlusion level shall be factory set to ensure flow accuracy of plus or minus 1 percent and repeatability performance of plus or minus 0.5 percent and shall not require any field adjustment.
   g. Contact Materials: All pumphead components in the fluid path must be materials specified by the manufacturer as compatible with the process fluid.
2. Leak containment/detection: In the event of peristaltic element failure, the leak sensor shall shut the pump down immediately with all process fluid contained within the sealed pumphead.
   a. Sensor Type: Utilize non-contacting optical sensor. Sensor shall not come in contact with the process fluid, shall contain no moving parts, shall not depend on the capacitance of the process fluid, shall not require fluid to leak out of the pump housing for engagement, nor shall require any sensitivity or calibration adjustment.

b. Alarm: Sensor shall shut down the pump, give a visual indication on the drive controller, and if specified shall provide an output general alarm signal.
c. For operator and environmental safety, pumps which do not have leak containment, leak sensor, and shutdown are not acceptable. For additional overpressure safety, sealed pumphead shall have a controlled drain-to-waste port.

3. Tube Material: Santoprene or approved equal.
4. Port Connections: Pumphead shall utilize polypropylene compression fittings.

3. Drive:
   a. Rating: Continuous 24 hour operation, 45 degrees C ambient.
   b. Voltage: Drive shall be suitable for 100 - 240V ac, 50 - 60Hz, 1-Phase with an internal switch-mode power supply. Supply 9-foot length mains power cord with standard 115V ac three-prong plug.
   c. Max drive power consumption: 190VA.
   d. Enclosure: NEMA 4X constructed out of corrosion and impact resistant engineering plastic, 20 percent Glass filled PPE/PS. By nature of the environmental conditions, painted or unpainted metallic housing including Type 316 stainless steel are not acceptable. Enclosure shall house the drive motor and all control circuitry in one integrated unit.
   e. Direct coupled pumphead with fully protected drive.
4. Pumphead shall direct couple mount to the controller via a splined drive shaft and shall be locked in place by two tool-free thumbscrews or lever mechanism.
5. Pumphead shall be fully sealed to prevent any contamination of the controller or drive shaft by process fluid.
6. Pumphead shall contain its own rotor bearings and not impart an overhung load on its pump shaft.
7. Pumpheads shall be supplied mounted to the left or right side of the drive enclosure as specified in the Drawings. If not specified, pumpheads shall mount to right side of the enclosure.
8. Drive shall stop rotation and give visual alarm in the event the pumphead is removed.
   a. Drive Motor: Brushless dc motor with integral gearbox and closed loop tachometer feedback.
   b. Circuitry complete with temperature and load compensation protection.

B. Chemical Metering Pump Controls:

1. Manual Control Interface:
   a. Pumps must meet the following minimum requirements for human-machine interface (HMI) manual operator functionality. Pumps not meeting this minimum functionality will not be accepted.
   b. Display: Backlit graphical TFT Display capable of up to eight lines of text with up to twenty six 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.
   c. Keypad: Keypad for start, stop, speed increment, speed decrement, rapid prime, and programming.
   d. Flow Units: Programmable in either ml/min or gallons/hour.
   e. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.
   f. Auto Restart: Feature to resume pump status in the event of power outage interruption.
   g. Multilingual Menu: Include programming menus in nine languages, including at a minimum English, Spanish, and French.
   h. 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. Signal must be trimmable and speed scaleable over any part of the drive speed range. Pump shall be programmable to either increase pump speed or decrease pump speed against an increasing Analog 4-20 mA signal.
   c. Run/Stop Input: Either 5-24V industrial logic, dry contact or powered 110V ac contacts as shown per the process and instrumentation drawings.
   d. Status Outputs: Two status outputs 24V dc Open Collector, 24V dc Status relay, or 110V ac Status Relay as required by the process and instrumentation drawings software configurable to indicate the following:
      1) General Alarm status.
      2) Running/Stopped status.
      3) Manual Mode status.

4) Analog Mode status.
5) Contact Mode status.
6) Fluid Level status.
7) Leak Detected status.

e. Speed Analog Output: Analog 4-20Ma.

3. HMI, analog connections, and mains power shall be accessible from the front or side of the enclosure.

D. Factory Coatings: Non-stainless metallic components shall receive an epoxy factory coating suitable and resistant to the chemical service being pumped.

2.03 CHEMICAL METERING SKID

A. Chemical Metering Skid General Description:

1. The Alum chemical metering pump 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 inches 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 piping for each pump shall include one pressure relief valve(s); one diaphragm protected pressure gauge(s); and all required piping, isolation valves, calibration column and supports as required to support the pumps and piping. The pump(s) shall be piped to provide service to the main chemical feed point points.
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 jobsite.
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.

B. Accessories:

1. Calibration Columns: 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 provide 300 mL.
2. Diaphragm Protected Pressure Gauges:
    a. Liquid filled pressure gauges with isolators shall be provided for indication of system pressure in the suction piping and the discharge piping of each metering pump. Industrial quality all Type 316 stainless steel gauges shall be utilized. The isolators shall have housings compatible with the pumped fluid. Isolation diaphragm shall be Teflon. The process connection shall feature a stainless steel reinforcement ring not in contact with the chemical. 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.

2.04 PIPING AND VALVES

A. Polyvinylchloride (PVC) Pipe:

1. Pipe and fittings shall be manufactured of Rigid Poly Vinyl Chloride (PVC) Schedule 80. 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. All fittings shall be injection molded of PVC fitting compound of cell classification 12454-B and of CPVC fitting compound of cell classification 23447-B as described in ASTM D1784 Standard Specification for Rigid Poly Vinyl chloride Compounds.
4. 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.
5. 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.
6. Dimensions and tolerances of sockets shall conform to PVC 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.
7. Waterways shall be smooth and commercially free of flash and irregularities. On tees and 90 degree elbows, bond lines shall not coincide with the maximum stress area (crotch).
8. 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. Valves:

1. Ball Valve:
   a. Ball Valves: All Ball Valves, sizes 1/2 inch to 4 inches, shall be of true union design with two-way blocking capability. All O-rings shall be EPDM or FPM based on chemical being pumped. 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. The ball valves shall have a pressure rating of 230 psi for sizes 1/2 inch to 3 inches and 150 psi for 4 inches at 70 degrees F. Ball Valves must carry a two-year guarantee. Ball valves shall be equal to Hayward TB series as manufactured by Hayward Flow Control or approved equal.
   b. Ball Check Valves: All Ball Check Valves, sizes 1/2 inch to 2 inches, shall be of true union design with one direction blocking capability. All O-rings shall be EPDM or FPM based on chemical being pumped. Seats shall have elastomeric backing cushion of the same material as the valve seals. The ball valves shall have a pressure rating of 230 psi for sizes 1/2 inch to 3 inches Ball Check Valves must carry a two-year guarantee. Ball valves shall be equal to Hayward series as manufactured by Hayward Flow Control or approved equal.
2. Pressure Relief Valves: 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 pump suction line leading back to the storage tank.

2.05 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect pumps for required construction, electrical connection, and intended function.

B. Functional Test: Perform manufacturer’s standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s printed instructions.

B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

A. Damaged factory coatings shall be repaired with same coating applied at the factory.

3.03 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Functional and Performance Test:

1. Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.
2. Test each pump using potable water to demonstrate minimum and maximum flow capacity and pump control features.
3. Confirm pressure relief valve setpoint.
4. Confirm no leakage in piping.
5. Operate pumps showing both manual and automated flow paced control over full operating range of pump.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or Site training.
4. 1 person-day for facility startup.
5. 1 person-day for post-startup training of Owner's personnel. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENTS

A. Supplement listed below, following "End of Section," are part of this Specification.

1. Data Sheet: Pump and Motor.

END OF SECTION

CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01

Tag Numbers: 41PMP0101, 41PMP0102, 41PMP0103

Pump Name: Alum Feed Pumps Nos 1, 2, and 3

Manufacturer and Model Number: (1) Watson Marlow Qdos 60

(2) Or approved equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 49% Liquid Aluminum Sulfate(Alum)

Pumping Temperature (Fahrenheit): Normal: 70 Max 105 Min 10

Liquid pH: 2

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 0

Altitude (ft msl): 830 Area Classification: Unclassified

Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 8.0. Minimum: 0.01

Maximum Discharge Pressure (psig): 100

Relief Valve Setting (psig/as recommended): 25

Max. RPM(rpm): Mfr. (1)125 Mfr. (2)

DESIGN AND MATERIALS

Pump Type: Single Head(Y/N) Y

Wet End Material: Glass Filled PPS or PPE/PS Tube Material:

Calibration Cylinder: Quantity: 3 Material: PVC Units: mL Capacity: 2000

DRIVE MOTOR

Drive motor is manufacturer's standard and internal to pump rated for NEMA 4X service

Power: 190 VA Voltage: 120V ac Phase: 1 Synchronous Speed (rpm): 125

TESTING

Pump Tests: Factory Functional (Y)	Factory Performance (N)
Field Functional (Y)	Field Performance (Y)
Motor Test: Short Commercial (Y)	Other

REMARKS

SECTION 44 44 17
UV DISINFECTION SYSTEM

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Work of this section includes furnishing, installing, and testing the UV disinfection system as shown on the Drawings and described herein.

B. Unit Responsibility: The Work requires that the UV Disinfection System be complete with all accessories and appurtenances (including, but not limited to UV lamps, UV lamp sleeves, lamp holders, UV reactors, UV intensity monitoring, UV transmittance monitoring, power distribution centers, ballasts, UV control and instrumentation system, automatic cleaning system, safety equipment, and spare parts for the UV disinfection system) be the product of one manufacturer or approved equal.

C. Low pressure-high intensity 45-degree vertical lamp UV disinfection systems are acceptable. The acceptable manufacturer and equipment model of UV disinfection is:

1. Wedeco Duron 12 i 1 – 3 x 1 eW eL.
2. Or approved equal.

1.02 GENERAL

A. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

B. General Requirements: See Division 1, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

C. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

D. Control system requirements: Conform to the requirements of Section 40 99 90, Package Control Systems, and 40 90 00 Supplement 1, Loop Specifications.

E. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or

equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

F. All equipment and materials furnished under this Contract shall be constructed with due regard to safety of operation, accessibility, durability or parts, and shall comply with all applicable OSHA, state, and local safety requirements.

G. The UV equipment specified herein will be installed in a new concrete channel.

H. The design documents are based on the first named Manufacturer. If an alternate manufacturer is used, any changes to the channel will be included in the project and will be provided at no additional cost to the Owner.

1.03 SUBMITTALS

A. Action Submittals:

1. Equipment and material layout drawings, with plan and sectional views, must show the reactor, lamp modules, electrical wiring, connections to other work and interconnections. Provide recommended spacing between reactors for proper maintenance and upstream/downstream straight channel length based on validation data. Provide dimensional drawings for the power supply and control panels. State the maximum distance the power supply units can be separated from the UV reactors.
2. Connection and interface requirements, dimensions, and locations, including critical clearance requirements.
3. Materials of construction.
4. Weights of components.
5. Sizes and quantities of accessories.
6. Hydraulic calculations for headloss through the UV lamps and other appurtenant elements of the system.
7. Detailed information on the UV sensors to be provided including the material used for wetted parts, the wavelengths of light, the sensor measures, information on the details of sensor calibration and traceability, as well as information on uncertainty, linearity, temperature sensitivity, angular response, selectivity, and long-term drift, sensor life and sensor calibration interval and expected variations amount online sensor readings, maintenance, cleaning, accuracy, calibration requirements and replacement frequency.
8. Description of possible power settings for a given reactor and percent turndown range.
9. Power requirements including requirements (electrical ratings and physical sizes) of isolation transformers, step down transformers, and wiring connections requirements to the lamp banks, instrumentation and controls.

10. Graph of power draw versus dose from 20 to 40 mJ/cm^2 and 65 percent UV transmittance for average and peak flows.
11. Graph showing the input power necessary to provide equivalent output versus hours of use.
12. Define power quality thresholds for continuous operation including power sag and cycle limits. Indicate how much electricity, if any, is used by lamps that are not in use.
13. Harmonic distortion calculations to show that total and individual current and voltage distortion under specified conditions are below the specified limits.
14. Refer to Section 40 99 90, Package Control Systems for further details regarding control system submittals. Additional related submittals:
    a. Standard controls philosophy, description of components, list of inputs/outputs, list of alarms and classifications, and process and instrumentation diagram (P&ID). Include description of how equipment incorporates flow, UVT and sensor readings into dose pacing calculations and all available modes of operation.
15. Equipment Supplier's warranties for lamps, ballast, sleeves and intensity sensor shall be based on the guaranteed lives agreed to in the executed supply agreement.
16. Descriptive information on ballast and sleeves, including type of ballast, number of power levels, minimum power setting, acceptable number of cycles per day, type of quartz in sleeve, data on absorbance by the sleeve material.
17. Detailed information on the automatic cleaning system including description of wiper driver, chemical used (if applicable), and method for filling chemical reservoirs. Include a close-up digital photo on CD of the actual wiper interface with the quartz sleeve.
18. Describe any manual cleaning requirements, including chemical cleaning, cleaning system parts that may require periodic replacement, and redundant features incorporated in the standard design. Describe the basic step-by-step procedure for cleaning lamps, sensors, and reactors. If applicable, include the volume of cleaning chemicals required to clean one reactor, estimate time requirement to clean one reactor, approximately pH of cleaning solution, and expected cleaning frequency given the water quality parameters.
19. Complete description of UVT monitor. Include operation and maintenance requirements. Include information regarding reading accuracy and reading stability.
20. Level control in the UV channel downstream of the UV lamps.
21. Electrical wiring between power distribution centers (PDC) or Junction Boxes, the UV lamps, and the control panel, including wire way, conduit and grounding layout drawings, complete system schematic (elementary) wiring diagrams, and interconnection diagrams.
22. Provide routine and preventative maintenance schedules.

23. Recommended shipping method, handling method, requirements for storage and protection, prior to and after installation. Including protocol for shutting equipment down when not in disinfection season.

B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Special shipping, storage and protection, and handling instructions.
3. Written factory test report of inspection.
4. Manufacturer's Certificate of Proper Installation.
5. Data summary from testing and startup period.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data, including routine maintenance requirements prior to plant startup.

1.04 WARRANTY

A. The manufacturer shall provide a full warranty on all parts and labor on the longer of the two following options, 12 months from acceptance by the Owner and beneficial use or 24 months from shipment, whichever is longer.

PART 2 PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

A. All metal components in contact with wastewater flow shall be Type 316L, stainless steel with any welds pickled and passivated.

B. All other stainless steel components shall be Type 304 stainless steel.

C. All wiring exposed to UV light shall be Teflon coated, or otherwise protected from UV radiation effects.

D. Any other materials used which are exposed to UV radiation (254 mm) must be Type 304L or Type 316L stainless steel, Type 214 quartz, Teflon, or other suitably UV resistant material unaffected by prolonged exposure over the component's life.

E. All manufacturing welds must be passivated.

2.02 DESIGN CRITERIA

A. Provide one new UV disinfection train, which shall disinfect the filtered, secondary effluent with the following characteristics.

1.	Average Daily Flow:	2 mgd
2.	Peak Hourly Flow:	4 mgd
3.	Wastewater Temperature:	41-86 degrees F

4. Filtered Effluent to UV:
   a. Average Monthly CBOD5 2 mg/L
   b. Average Monthly TSS <5 mg/L
   c. Maximum Day CBOD5 5 mg/L
   d. Maximum Day TSS <5 mg/L
5. Minimum UV Transmittance (253.7nm): 65 Percent
6. UV Dose:
   a. Minimum Design UV Dose 30 mJ/cm^2
      (based on IUVA/UVDGM (MS2) bioassay)
7. Effluent Disinfection Limit:
   a. E. Coli (30 day geometric mean) 126 #/100 ml
   b. E. Coli (max day) 941#/100 ml

2.03 GUARANTEED PERFORMANCE REQUIREMENTS

A. Effluent from the UV disinfection facility shall have E. Coli not exceeding the levels specified in the Guaranteed Performance Requirements Testing section of paragraph 3.03, Field Tests under the influent conditions as specified in the design criteria.

B. Lamp Operating Life and Lamp Output:

1. Lamp Life shall be defined to be the earlier of the following:
   a. The number of operating hours before the lamp electrodes fail and the lamp becomes unusable.
   b. The number of operating hours before the UV Output drops to:
      1) Ninety percent of the initial output.
      2) Initial output defined as the output of the lamps after 100-hour burn in period.
2. The lamp life shall be at least 12,000 hours independent of the average power setting over the life of the lamp).
3. If a lamp fails under normal operation before the specified operating life, the UV System Supplier shall replace the lamp on a pro-rate basis.
4. If the average intensity of the UV lamps measured for a channel is less than the minimum output at the end-of-lamp life, the UV System Supplier shall replace all the lamps in the Channel with new lamps at no cost to the Owner.

C. The power consumption per lamp (including ballast losses) and total system power consumption shall not exceed the guaranteed power consumption entered in the Proposal.

D. The design life of the ballasts shall be not less than 10 years. Provide an extended warranty for all ballasts that conforms to the following requirement: ballasts shall have a separate, 3-year warranty commencing upon successful completion of field tests. Any ballast that fails within the 3-year period shall be replaced at no additional cost to the Owner. If 5 percent of the ballasts have failed at least once during the warranty period, the UV System Supplier agrees to immediately replace all ballasts within 3 months of the end of the warranty period.

E. The maximum head loss at peak design flow through the entire reactor including flow control shall be not be more than shown in the design criteria tables. The calculated head loss shall be by a formula agreed to by the Engineer and confirmed by field measurement data at startup.

2.04 MATERIALS:

A. Ultraviolet Lamps: Lamps shall meet the following requirements.

1. Low pressure High Output Amalgam UV lamps. Each lamp shall produce UV light with at least 90 percent of the UV emission at 253.7 nanometer wave length.
2. Low pressure mercury slimline of the hot cathode instant start design in which the coiled filament cathodes are heated by the arc current.
3. The filament of the lamps shall be the clamped design, significantly rugged to withstand shock and vibration.
4. The electrical connections of the UV lamps shall be through a non-proprietary pigtail with molded 2-wire connector or PTFE 4-pin connector.
5. Lamps shall not produce any ozone.
6. The lamp supports shall be of a durable construction resistant to UV.
7. The lamp design shall prevent electrical arcing between electrical connections in moist conditions.

B. UV Lamp Sleeves: The UV lamps are to be protected from contact with the effluent by a 99.9 percent silicon dioxide quartz jacket or Type 214 clear fused quartz with a minimum of 90 percent transmission of UV radiation at the 253.7 nanometer wave length and have a nominal wall thickness of 1.0 mm or equal.

C. Vertical Lamp: Electronic Lamp Controllers. (ELC):

1. Each module will include one high performance electronic lamp controller for each pair of UV lamps. The ELC shall be designed for use with the specified UV lamps.

2. The electronic controller (ballast) shall comply with the following requirements:
    a. The ballast shall be specifically designed to power two UV germicidal low pressure high output lamps and shall be equipped with advanced lamp preheating, power factor correction, and advanced diagnostic software (ability to test modules from laptop).
    b. Separate ballast enclosures, if used, must meet UL/NEMA 4X specifications. Force ventilated enclosures which permit introduction of outside air shall not be acceptable unless equipped with an active air filtration system or an automatic signal to advise operators when replacement of filter is required.

D. Vertical UV Module:

1. Each vertical UV module shall be precision fabricated in Type 316L stainless steel to meet the NEMA 4X standards. The lid shall include six individual latches and clamp against an internal gasket. Four support legs shall connect the module enclosure to a bottom pan.
2. Each module shall be completely field serviceable while located in the channel and shall be fitted with water resistant UL rated multi-pin connectors for power and data.
3. All electrical connections shall be above maximum operating water elevations to protect against electrical hazard.
4. Ultraviolet lamps, electronic controls, and individual electronic lamp controllers/ballasts (if located in module panels) shall be arranged so that they may be easily tested in-place. When necessary, any malfunctioning device or unit shall be capable of being replaced without removal of the entire module from the channel.
5. Module panel cooling systems: Maintain proper operating temperatures inside the module with ambient air temperature from 32 degrees F to 130 degrees F. On failure, system is to shut down for equipment protection.
    a. For UV systems where ballasts are located remote from the channels provide active air conditioning units.
    b. For UV systems where ballasts are located in the module panels immediately above the lamp provide closed loop internal cooling system that utilizes the effluent flow to dissipate the heat generated by the ballasts.
        1) Internal aluminum heat sink and hose.
        2) Recirculation pump and hose.
        3) Food grade propylene glycol.
        4) External reservoir.

6. Each module will be equipped with lifting lugs to allow for the attachment of a lifting spreader so that the modules or banks of modules can be easily lifted with a standard hoist or similar lifting device specified elsewhere.
7. Each quartz sleeve will be provided with a fitting as it enters the bottom of the module enclosure that prevents water intrusion into the module enclosure during a high water event.
8. Each quartz sleeve will be provided with a plug so that water will not enter sleeve during prolonged outdoor storage or high channel water level.
9. Each module will be equipped with anti-condensation heater. Heater shall be 400 watt Hoffman enclosure heater with integrated thermostat, or equal to alleviate condensation from forming in inside the enclosure. The heater shall be installed on the underside of the module lid. Heaters will be tied into the module lid switch interlock so that the heater is on when the lid is closed.
10. Automatic interlock protection will be incorporated into each module enclosure such that with the opening of the module enclosure lid power to the lamps will be automatically shut off.
11. To minimize cleaning frequency of the UV system, each high output module must be equipped with mechanical wipers. The mechanical wipers must be electrically driven and can be operated in either manual or automatic mode. The cleaning wipers shall be automatically initiated and controlled from the operator interface. Cleaning cycle intervals shall be field adjustable within the range of once per day to once per week.
    a. Automatic mechanical wiping systems must be capable of periodic chemical cleaning out of the channel. Out of channel cleaning equipment shall include lifting device and cleaning tank as required. The UV disinfection system supplier shall supply all equipment including equipment not specifically listed to perform out of channel chemical cleaning.
    b. Electrically driven system: Each module shall be provided with an independent cleaning system which is actuated by an AC motor housed in the module, along with all required monitoring and control components so that each module’s cleaning system is independent, only requiring an initiate cycle command from the main controller.
12. Mechanical Wipers:
    a. Wipers shall be fabricated of UV resistant material and installed in a manner which accommodates any irregularities associated with the quartz sleeves and precludes any binding during operation.
    b. Spit drive nut, wiper, and plate stabilizers will be provided.

c. The wipers shall be replaceable without having to dismantle the wiper drive system, complete removal of the quartz sleeves, or disassembly of the module structure.
d. The wiper system shall travel the full length of the UV lamp sleeves.

13. Each UV lamp module may be equipped with flow dispersion baffles to create better mixing and more uniform UV intensity field within the reactor as long as the maximum headloss requirements herein are not exceeded.
14. The baffles shall be an integral part of the UV lamp module.
15. The baffle material shall be Type 316L stainless steel.

2.05 ELECTRICAL

A. Each module shall be completely field serviceable while located in the channel and shall be fitted with water resistant UL rated multipin connectors for power and data. Combined power and data shall not be acceptable.

B. Power interconnect cables and data cables provided in between the modules and the PDC shall be field terminated and interconnections be made by the Contractor.

C. Power cable interconnecting conduit shall be provided and installed by the Contractor.

D. Data cable interconnecting conduit shall be provided and installed by the Contractor.

E. The UV System Supplier shall provide a suggested Type 316 stainless steel raceway scheme for all external wiring for installation by the Contractor.

F. The UV Disinfection Equipment System shall include modules of UV lamps, ballasts, power distribution center (PDC) and raceway. Each module shall plug into the PDC via a multiconductor cable and molded connector. There shall be one PDC that will distribute power, and the UV control panel will relay monitoring data, and provide control for each of the UV channels. PDC shall be mounted on elevated supports or housekeeping pads. The PDC shall be located no more than 90 feet away from the banks of UV lamps. The PDC enclosure shall meet NEMA 4X Type 316 stainless steel requirements.

G. The UV control panel shall provide monitoring and control of all the UV lamp modules.

H. Power Distribution Center: Circuit breakers and ground fault circuit interrupters (GFCI) shall be located inside the PDC and be capable of being reset and tested locally. Visual confirmation of a tripped GFCI shall be provided. Alternatively, a 15A fuse system and relay interlock can be provided to ensure high voltage component is disabled during fault or maintenance.

I. The wiring within PDC must be properly isolated for proper ventilation to prevent damage to wiring.

J. Integral or chain-connected waterproof caps shall be provided for all multipin connectors.

K. The UV module connectors shall be watertight with a molded back shell and meet the requirements of UL 574 for direct water jet spray when mated.

L. All electrical raceways shall be Type 316 stainless steel.

M. All electrical power terminals shall be rated for 75 degrees C conductors.

N. Labeling: Where possible, all electrical materials, devices, appliances, and equipment used shall be indicated as acceptable by the established standards of the Underwriters Laboratories Inc. or other nationally recognized electrical product testing laboratories. Indication shall be by a valid label affixed to the item. Panels which consist of multiple components shall be listed and labeled as a unit in addition to any other requirements.

O. Interconnecting wiring diagrams shall include numbered terminal designations showing external interfaces. All terminations of wiring in all cabinets shall be labeled permanently to match the wiring diagrams.

P. Harmonics generated by the UV System shall not exceed the IEEE 519 guidelines. Compute individual and total current and voltage distortion for each PCC.

Q. Wiring in the PDC shall be properly spaced so that there is no deterioration of the wire insulation material or affect the wire rating.

2.06 INSTRUMENTATION AND CONTROLS:

A. Controls: In accordance with P&IDs, control requirements, and components as specified in Section 40 99 90, Package Control Systems, and requirements below.

B. Control Panels:

Panel No.	Maximum Dimensions HxWxD (inches)	NEMA 250 Rating	Material	Mount	Power
08LCP0101	90x36x30	NEMA 4X	316 SST	Free-standing	480 VAC

C. The UV control system shall be a network connected packaged control system. Refer to requirements for network connected packaged control systems in Section 40 99 90, Package Control Systems.

D. The UV control system shall provide complete and independent automatic control of the disinfection process, individual control of the disinfection equipment, and monitor process conditions, instrumentation, and equipment status. The UV control system shall provide alarms to indicate to operators that maintenance attention is required (i.e., minor alarms) and provide alarms to indicate extreme condition in which the disinfection performance may be jeopardized (i.e., major alarms). The UV control system shall provide interlocks to prevent damage of equipment and provide for continuous unattended disinfection operation during normal conditions to meet the specified UV system performance.

E. Functional Requirements:

1. The UV Disinfection System shall automatically restart upon a power failure/power return.
2. Provide an automatic flow paced UV disinfection control:
    a. Allow lamp banks/channels to be operated to maintain sufficient UV intensity to maintain the specified design dose and to meet the guaranteed microbial inactivation performance requirements.
        1) Provide flow-paced logic to turn banks ON and OFF so that the UV design dose is maintained. The flow set points whereby banks are turned ON and OFF shall be adjustable from the OIT. Adjust flow set points after performance testing as approved by the Engineer. Logic and time delay relays shall be provided to regulate UV bank ON/OFF cycles.
        2) The banks shall be cycled for equal wear and timed off to minimize bank cycling. The OIT shall allow operator to adjust variables controlling bank cycling (e.g., number of hours, days or weeks between cycles, etc.).

3) Dose Pacing:
   a) The dose pacing system shall be supplied to modulate the number of lamps in operation based on the flow signal, in conjunction with the UV transmittance meter when the banks are in the AUTO mode.
   b) The system shall be dose paced such that as the flow, lamp age, and water quality (transmittance) change the UV dose delivered is optimized while conserving power.
   c) The dose pacing system shall allow the operator to vary the dose setting. Logic and time delays shall be provided to regulate the UV channel/bank ON/OFF cycle.
4) Provide for banks to be designated as IN- or OUT-OF-SERVICE. If a bank is designated as OUT-OF-SERVICE, exclude it from the automatic sequence.
5) Upon loss of flow signal, UV system shall remain in its current state of operation (i.e., maintain the last valid operating condition) and alarm the event, or default to 100 percent output and alarm the event.

3. Program and coordinate data exchange with the PICS supplier (Section 40 90 00, Instrumentation and Controls for Process Systems) to enable the PICS supplier to configure the plant-wide control system to:
   a. Select between manual and automatic control of each device with automatic control.
   b. Adjust automatic controller process setpoints and change between available automatic control modes.
   c. Display all status, alarms and analog process values.

F. Operator Interface Unit controls and indications:

   a. Provide menu driven operator interface displays. The display shall include, as a minimum, the following:
      1) An overview graphic representing the UV lamp banks. As a minimum, display bank status (ON/OFF, HAND/OFF/AUTO), UV intensity, and plant flow.
      2) An alarm graphic showing the 20 most recent alarms, including time and date of occurrence. As a minimum, the alarms described above shall be provided. The alarms shall identify the affected equipment by location such as bank, module, lamp, etc.
      3) Displays for control and monitoring of all functions specified herein.
   b. The date and time shall be changeable directly from the operator interface.

G. Signal Interfaces:

1. Discretely wired signals: Refer to P&IDs.
2. Network Interface to plant control system:
   a. As required to meet functional requirements.
   b. Switch shall be compliant with Y5 specification in Section 40 91 00, Instrumentation and Control Components.
   c. Interface shall be fiber optic and constructed in accordance with Section 40 95 80, Fiber Optic Communication System.
   d. Include, but not limited to:
      1) From plant control system: Wastewater Flow.
      2) To plant control system:
         a) UV Transmittance.
         b) UV Dose.
         c) Status of each bank (ON/OFF, HAND/OFF/AUTO).
         d) UV Intensity.
         e) A single bit representing the presence of 1 or more major alarms.
         f) A single bit representing the presence of 1 or more minor alarms or warnings.
         g) Information on each device that indicates when it is forced OFF or OUT OF SERVICE by operator selection.

H. Uninterruptible Power Supply: Control components and IO circuit shall be powered via an uninterruptible power supply with a minimum of 10 minutes of backup power storage.

2.07 UV INTENSITY SENSORS

A. Each ultraviolet lamp bank shall have a minimum of one ultraviolet intensity sensor.

B. The UV intensity sensor shall be submersible.

C. The UV intensity sensor shall not degrade after prolonged exposure to UV light.

D. The UV intensity sensor shall continuously measure only the germicidal portion of the light generated (253.7 nm plus or minus 20 nm). The sensor must have a minimum sensitivity of 90 percent of the germicidal light.

E. The UV intensity measured by each active sensor shall be continuously displayed at the control panel.

F. The UV intensity sensor shall be factory calibrated.

2.08 SPARE PARTS AND SAFETY EQUIPMENT

A. The UV supplier shall furnish as part of the system the following spare parts and safety equipment:

1. 20 percent of UV lamps.
2. 20 percent of quartz sleeves and holder seals.
3. 20 percent of cleaning wiper seals/rings.
4. Five electronic ballasts with connectors.
5. Five pairs of personnel goggles for protection against UV energy between 200 - 400 nanometers wave length.
6. Two UV area warning signs.

PART 3 EXECUTION

3.01 FABRICATION

A. The UV disinfection system specified herein shall be factory assembled, to the largest extent possible, complete with all components specified.

3.02 INSTALLATION OF EQUIPMENT

A. Installation of equipment is to be done by the Contractor as required by the manufacturer.

3.03 SHOP/FACTORY FINISHING:

A. Shop prime and field finish coat ferrous metal in accordance with and as specified in Section 09 90 00, Painting and Coating (System No. 2), for all submerged surfaces.

B. Exposed metal surfaces shall be factory prepared and primed and field finish coated in accordance with Section 09 90 00, Painting and Coating (System No. 4).

C. Surfaces inaccessible subsequent to erection shall be prepared, primed, and finished with the applicable coating prior to erection.

3.04 SUPPLIER’S FIELD SERVICES

A. Qualified representative for the equipment selected shall be present at the jobsite for the minimum person-days listed for the services herein under, travel time excluded:

1. 2 person-days for installation assistance, inspection, certificate of shipment unloading, and certification of the installation. Provide certificates.

2. 15 person-days for functional and guaranteed performance requirements testing certification.
3. 4 person-days for classroom and/or jobsite training.
4. 5 person-days for providing installation supervision for the ultraviolet disinfection system.
5. Services may not be sequential and should be considered as separate trips.

B. Training of Owner's personnel shall be at such times and at such locations as requested by the Owner. The training services shall include pre-startup and post-startup classroom instruction and on-site hands-on instruction. The Owner reserves the right to video tape for training of new operators. The videos will remain the property of the Owner and will not be distributed to any third party. Provide both operation and maintenance training.

C. All training services shall be presented twice (two identical sessions) at times coordinated with the Client to allow all operators to attend.

3.05 FIELD TESTS

A. Functional Testing: Prior to startup, the Supplier’s representative shall inspect the installed UV disinfection system for proper alignment, correct operation, proper connection, and satisfactory function of all components. The Supplier’s representative shall approve the installation and provide certification that the system components have been installed correctly and are ready for operation.

1. Proposed functional testing procedure shall be developed by the UV System Supplier submitted to and reviewed by the Engineer via the Contractor, before scheduling and performing the functional test.
2. Functional testing will be witnessed by the Engineer and shall demonstrate that the system and related control system operate in accordance with the Specifications, including all operating, monitoring, and shutdown functions.
3. If, in the opinion of the Engineer, the system meets the requirements specified herein, the system will advance to performance testing. If, in the opinion of the Engineer, the functional test results do not meet the requirements specified herein, the system will be classed as nonconforming.
4. In the case of a nonconforming system, advancement to performance testing will not commence until the UV System Supplier and Contractor have made, at no additional cost to the Owner, such adjustments, changes, and/or additions as are necessary to correct the system and demonstrated this by a satisfactory functional test as specified above.

B. Guaranteed Performance Requirements Testing:

1. The Guaranteed Performance Requirements testing shall be conducted at the following times:
   a. Head Losses: During startup.
   b. Power Consumption: Prior to startup.
   c. Microbial Inactivation: Two weeks of actual system operation treating filtered secondary effluent.
   d. Lamp Output: After 7,000 hours of system operation.
2. The UV System Supplier via the Contractor shall submit the proposed Guaranteed Performance Requirements testing procedure, before scheduling and performing the Guaranteed Performance Requirements test. Submit a test plan for harmonic distortion test. An approved test plan is a prerequisite to conduction test.
3. During the Guaranteed Performance Requirements testing, the UV disinfection system shall run continuously for 30 days to demonstrate the Guaranteed Performance Requirements. The UV Equipment Supplier shall start up and operate the UV disinfection system for 3 days of testing and train the Contractor to sample and log data for the remainder of the testing. The Guaranteed Performance Requirements testing shall be done to determine the actual system operating conditions and verify that the system meets the Guaranteed Performance Requirements of this Specification.
4. Head Losses Tests: Head losses through the modules in each channel shall be measured and plotted on a curve showing flow rate on the horizontal axis and head loss in inches of water on the vertical axis. The level 3 feet upstream of all the modules and 3 feet downstream of all the modules shall be used to determine the Guaranteed Performance Requirements head losses.
5. Power Consumption: Guaranteed Performance Requirements power consumption shall be measured at the 3-phase feeder entering each PDC. The power consumption per lamp including ballast losses is calculated to be the total power draw divided by the number of lamps powered by the PDC. Measurement shall be taken when all lamps in all modules in the channel are "ON." Kilowatt-hours and power factor shall be measured and recorded. Measurements shall be made using a kilowatt-hour meter temporarily mounted at the location stated. Meter shall have been calibrated by the meter manufacturer within the 6 months immediately preceding this test.
6. Test for harmonic content at the primary side of the isolation transformer. Confirm that the individual and total current and voltage harmonic distortion at the primary of each isolation transformer are under the conditions specified on the Simplified One-Line Diagram and does not exceed IEEE 519 limits. Submit documentation of test results.

7. Microbial Inactivation:
   a. The purpose of the microbial inactivation test is to confirm that the effluent quality meets the design requirements under actual operating conditions.
   b. The test medium shall be unchlorinated filtered secondary effluent within the following range:

      Flow: 2 to 4 mgd
      UV Transmittance: 60 to 70 percent
      TSS: 1-5 mg/L

   c. Operate the UV disinfection system for a period of 30 days during which time the Supplier shall collect and analyze samples to demonstrate compliance with the requirements of this section. Sampling shall occur every day. Sample frequency shall be twice per day, with one sample taken between 7:00 a.m. and 9:00 a.m., and the second sample taken 2:00 p.m. and 4:00 p.m. each day. During this performance test period, the Supplier shall provide all labor, sampling containers, and analytical services required, and the Owner shall furnish secondary effluent and power to operate the UV disinfection system.
   d. The Supplier shall perform the following schedule of tests:

Test	Sample Location	Frequency	Procedure
E. Coli	System Inlet/Outlet	2 times/day	Standard Methods (Method 9221)
Transmittance	System Inlet	2 times/day	Standard Methods (Method 5910)
Total Suspended Solids	System Inlet	2 times/day	Standard Methods (Method 2540D)

   e. The microbial inactivation test is considered to be successful if:
      1) Effluent E. Coli level is less than 941 counts/100 mL for all samples.
      2) 126 counts/100 mL average of all samples over a 30-day period.
   f. The above test program shall be extended on a week-by-week basis if compliance is not demonstrated during the initial 30-day test period. Testing during the extended period may include collimated beam, particle count, water quality analyses, and other tests as necessary by Supplier to determine reasons for noncompliance.

8. Lamp Output:
    a. The Supplier shall measure lamp/sleeve output for a minimum of 5 percent of all lamps with 100 or more hours of service, as recorded by the plant control system.
    b. The Supplier shall measure lamp/sleeve output for the same lamps tested after 100 hours for low pressure lamps with 7,000 or more hours of service as recorded by the plant control system.
    c. The measured output from lamps/sleeves tested in (b) shall be extrapolated linearly to 12,000 hours and shall conform to the specifications herein.
    d. The lamp/sleeve combinations shall be recorded so that lamp output testing as specified herein can be conducted on the same pairs.
    e. The measurements shall be conducted at the manufacturer's facility. Supplier will enable Owner and/or Owner's representative to witness the tests at the Owner's expense.
    f. A factory calibrated radiometer (calibrated within 30 days of conducting the test) shall measure lamp output in units of milliwatts per squared centimeter.
    g. Tests results for lamps/sleeves shall be defined as meeting the performance requirements with regard to lamp output if the intensity after 12,000 hours divided by the intensity after 100 hours is greater than 0.9 for each of the lamp/sleeve measurements.
    h. Lamp output measurements shall be conducted in accordance with the USEPA Design Manual for Municipal Wastewater Disinfection (most recent version).
    i. If a lamp/sleeve pair does not meet the performance requirements, the Supplier shall replace the respective lamp at no cost to the Owner. If greater than 25 percent of the lamp/sleeve pairs do not meet the performance requirements, the Supplier shall replace all of the lamps in the UV Disinfection System at no cost to the Owner.
9. A qualified representative of the UV system Supplier shall supervise the Guaranteed Performance Requirements testing, analyze data, and certify the system's performance during the test. Tests shall be documented during continuous operation of the system, and the UV System Supplier via the Contractor shall submit to the Engineer three copies of a complete report containing all original test data, calculation, and a description of the Guaranteed Performance Requirements testing procedures and results. Test reports for lamp output testing shall be submitted directly to the Owner from the UV system Supplier via the Contractor. All test reports shall identify the UV equipment serial number and the dates the test were performed.

10. If, in the opinion of the Engineer, the system meets the Guaranteed Performance Requirements specified herein, the Engineer will recommend to the Owner, by letter, the official acceptance of the UV Disinfection System. If, in the opinion of the Engineer, the Guaranteed Performance Requirements test results do not meet the requirements specified herein, the Engineer will notify the Contractor and the Owner in writing of the unacceptable performance.
11. In the case of unacceptable performance, the Contractor, in conjunction with the UV System Supplier, shall then have 60 days in which to perform at the sole expense, any supplemental testing, equipment adjustments, changes or additions and request an additional retest of the unacceptable system.
12. Should the UV disinfection system fail to meet the required operating conditions after the necessary corrective measures are implemented, the Owner may make a claim on the Contractor's Performance Bond. Should the system not meet the required operating conditions after at least three attempts, the Contractor shall remove the system and replace it with one that will meet the Guaranteed Performance Requirements.

C. All laboratory tests necessary to confirm the Guaranteed Performance Requirements testing for the UV Disinfection System shall be performed in conformance with the applicable portions of the most recent edition of Standard Methods.

END OF SECTION

SECTION 44 44 44
PROCESS BIOREACTORS SYSTEM

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Contractor shall furnish and install a complete operational Process Bioreactor System. The system shall consist of two trains, Bioreactor 1 and 2.

B. Unit Responsibility: The Contractor is responsible to the Owner for providing a complete system as specified herein.

C. General Requirements: See Division 1, General Requirements, which contains information and requirements that apply to the work specified herein and are mandatory to this Project, including, but not limited to, Codes and Regulations.

D. The Contractor shall procure the Process Bioreactor System from a single Bioreactor System Manufacturer. The Bioreactor System Manufacturer shall be responsibility under Contact to the Contractor to provide a fully operational system that meets the requirements of these documents including the performance guaranty specified herein. It is understood that the Bioreactor System Manufacturer may purchase other equipment from equipment manufacturers but the responsibility for proper operation rests with the Bioreactor System Manufacturer and ultimately with the Contractor.

E. The equipment included as part of the bioreactor system will be furnished both by the Contractor and the Bioreactor System Manufacturer. The Contractor shall have the responsibility of satisfactorily operation of the system with the full cooperation of the Bioreactor System Manufacturer.

1.02 GENERAL

A. The Contract Drawings show the general arrangement of equipment, devices, and supports, based on preliminary drawings provided by the Bioreactor System Manufacturer, OVIVO. The Contractor shall verify that the Bioreactor System Manufacturer's shop and installation drawings are coordinated with the Contract Drawings and it shall be responsible of the Bioreactor System Manufacturer for fully coordinating, in all respects, with the Contract Documents. Any modifications to the Contract Drawings required based on the Bioreactor System Manufacturer's requirements for changes shall have engineering cost paid and be the responsibility of the Contractor and Bioreactor System Manufacturer for all associated costs. There will be no additional cost paid to the Contractor for any changes required by the Bioreactor System Manufacturer.

B. The Bioreactor System Manufacturer shall be responsible for the design of all equipment specified herein based on actual site conditions. The intent of these specifications is to have a fully operating system. Contractor shall provide all required components whether or not specified herein for a complete and functional system.

C. This section includes the following:

1. Items provided by the Bioreactor System Manufacturer under contract to the Contractor. If additional equipment is required to meet the guaranteed performance, the Contractor shall provide additional equipment, modifications, tests, and documentation as recommended by the Bioreactor System Manufacturer. The quantities of equipment listed below are based on information provided by the Bioreactor System Manufacturer. If the quantities are incorrect or if the Bioreactor System Manufacturer updates the requirements, the additional equipment will be included within the Bioreactor System Manufacturer scope of supply at no addition cost.
    a. Low Speed Mechanical Aerators:
        1) Total of four units, two in each train.
        2) Per the requirements of Section 44 15 00, Low Speed Surface Mechanical Aerators.
    b. Submersible Mechanical Mixers:
        1) Total of fourteen, seven mixers per train.
        2) Provide all lifting devices to remove mixers from bottom of basin to the top of the basin including the Davit crane with cable, lifting arm and pulley system.
        3) Per the requirements of Section 43 22 56.01, Submersible Mechanical Mixers.
    c. Flow Control Gate:
        1) Two Gates, one gate per train.
        2) Used to control NRCY recycle to the anoxic zone.
        3) Each gate shall consist of a drive motor, gear reducer, floor stand, shaft and gate assembly.
        4) Per the requirements of Section 44 16 00, Flow Control Gates.
    d. Fabricated Effluent Weir Slide Gates:
        1) Two Weir Gates, one gate per train.
        2) Used to control water levels for varying flows and treatment in each bioreactor.
        3) Each gate shall consist of a drive motor, gear reducers, multiple shafts and gate assembly for precision level control of weir gate.
        4) Per the requirements of Section 35 20 16.25, Fabricated Slide Gates.

e. Motor Control Center for Bioreactor:
   1) One MCC with Mixer Starters, VFDs, control system for monitoring the DO and ORP for each bioreactor, and control logic for each Bioreactor process.
   2) MCC shall be per the requirements of Section 26 24 29, Low Voltage Motor Control.
   3) VFDs shall be per the requirements of Section 26 29 23, Low Voltage Adjustable Frequency Drives.
   4) Low Voltage Transformers shall be per the requirements of Section 26 22 00, Low-Voltage Transformers.
f. Control panels as specified herein.
g. Instruments for Process Indication, Control and Optimization
   1) Four Dissolved Oxygen Probes.
   2) Two ORP Probes.
   3) Two Level Sensors for indication and transmission.
   4) Six Analyzers for indication and transmission.
   5) Probes, sensors and analyzers shall be per the requirements of Section 40 91 00, Instrumentation and Control Components.

2. Additional equipment to be provided by Contractor as shown in the Contract Drawings and specified in the Contract Documents:
   a. Fine Bubble Air Diffuser System in the Reaeration Zone, including the drop leg.
   b. Positive Displacement Blower System.
   c. Contractor shall furnish all other equipment, including but not limited to: piping and supports, insulation, wiring, gates and valves, and all other accessories not provided by the Manufacturer for a complete operational system, as shown in the Contract Drawings.
   d. Contractor is responsible for all structural requirements, including but not limited to supports, grating, concrete tanks and all other accessories not provided by the Bioreactor System Manufacturer for a complete operational system, as shown in the Contract Drawings.
   e. Contractor shall provide all electrical requirements including but not limited to, conduit and conductors, terminal boxes, and all other accessories not provided by the Bioreactor System Manufacturer for a complete operational system, as shown in the Contract Drawings.

D. Related work specified in other sections:

1. Division 1, General Requirements.
2. Sections 05 50 00, Metal Fabrications.
3. Section 09 90 00, Painting and Coatings.

4. Division 26, Electrical.
5. Section 26 20 00, Low Voltage AC Induction Motors.
6. Section 26 29 23, Low Voltage Adjustable Frequency Drives.
7. Section 40 27 00, Process Piping-General.
8. Section 40 27 00, Process Piping Specialties.
9. Section 40 27 02, Valves and Operators.
10. Section 40 05 15, Pipe Support System.
11. Section 40 91 00, Instrumentation and Control Components.
12. Section 40 99 90, Package Control Systems.
13. Section 40 42 13, Process Piping Insulation.
14. Section 44 44 13.01, Chemical Metering Pumps Skids.

1.03 PAYMENT

A. Payment for the work specified in this section shall be in accordance with Section 01 29 00, Payment Procedures.

1.04 PRODUCT HANDLING

A. Equipment, including spares shall be shipped by the Bioreactor System Manufacturer when the equipment is ready and available for shipment. The Contractor shall be responsible for receiving, unloading and properly storing the equipment in accordance with Bioreactor System Manufacturer instructions. Promptly upon the arrival of any equipment components at the job site or first shipping destination, the Contractor shall prepare a Supplier's receiving report and submit a copy thereof to the Bioreactor System Manufacturer and Owner. The receiving report is to note equipment receipt and all evidence of damage in transit, if any. Confirmation of inspection will be no later than 10 days after receipt of delivery.

B. Finished iron or steel surfaces not required to be painted, such as flange faces, shall be properly protected to prevent rust, corrosion and damage.

C. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.05 SYSTEM DESCRIPTION

A. The process bioreactors included in this section utilize a 5-stage Bardenpho® biological treatment system, along with backup chemical systems, in order to remove nitrogen and phosphorus. Two trains will be included, each capable of treating 2-mgd AADF, to provide redundancy and for easier operation during low flow periods. Each train will have 2.67 mg of volume, a 14-foot side water depth, and will include the following zones:

1. Anaerobic.
2. Pre-Anoxic.

3. Aeration.
4. Post-Anoxic.
5. Reaeration.

B. Process Performance Requirements:

1. The Contractor is responsible for the proper installation, calibration, testing, and the treatment performance of the system when operated according to the approved Operation and Maintenance Manual.
2. Operating Conditions:
   a. Site Reference: White House WWTP.
   b. Type of application: Tertiary.
   c. Type of Installation: Outdoor.
   d. Number of trains two.
   e. Design flow per train (continuous operation): 2.0 mgd maximum month average daily flow (MMADF).
   f. Maximum Daily Flow per train (hydraulic capacity): 3.0 mgd.
   g. Peak Hourly Flow per Train: 4.0 mgd.
   h. Temperature Range: 14 - 25 degrees C.
3. Influent Water Characteristics: Screened Raw Wastewater.

Parameter	**TSS**	**$CBOD_5$**	**NH_3**	**TKN**	**TP**
Units	lbs/day (mg/L)	lbs/day (mg/L)	lbs/day (mg/L as N)	lbs/day (mg/L)	lbs/day (mg/L)
Maximum Month Average Day	5,307 (318)	5,007 (300)	718 (43)	956 (57)	100 (6.00)

4. Contractor's Process Performance Guarantee shall be subject to the influent meeting the raw water characteristics as defined in the Influent Water Characteristics. Performance testing shall be conducted during periods when raw water quality is within the parameters identified in Influent Water Characteristics.
5. Effluent limits based on TDEC permit when the effluent is discharged to Frey Branch are:

Parameter	**TSS**	**$CBOD_5$**	**TN**	**TP**	**NH3-N summer**	**NH3-N Winter**	**E. Coli**	**pH**
Units	mg/L	mg/L	lb/day	lb/day	mg/L	mg/L	# of colonies	pH units
Monthly Average	30	10	90*	6.0*	0.77	1.55	126/100 mL	NA
Weekly Average	40	15	NA	NA	1.2	2.4	NA	NA
Daily Max	45	20	NA	NA	1.5	3.1	941/100 mL	≤ pH ≤ 9

* = rolling annual average mass limit

6. Process Performance Test:
    a. The Process Performance Test is a demonstration of the product and process's ability to meet pre-agreed standards. Following completion of functional testing and when the Owner's facilities are ready for operation and at the sole discretion of the Engineer, the Contractor and Bioreactor System Manufacturer shall conduct two 15-day Process Performance Tests. Each test day shall be defined as 24 hours of continuous operation. Successful completion of the Process Performance Test is a requirement for issuance of Notice of Substantial Completion.
    b. Each test shall be performed at periods identified by the Owner and will occur within a 12-month period. The Owner will provide at least 1 month notice of the testing period. Owner may elect to perform both tests contiguously for 1 month of to have two separate 15 day test periods based on influent conditions.
    c. The performance testing will be based on the standards required when the effluent is being discharged to Frey Branch. Alum supplement are available in enough quantity and quality if required. Excessive use of chemicals will not be permitted. Bioreactor System Manufacturer shall indicate maximum amount of chemicals anticipated. Owner will review chemical requirements with the Contractor and the Bioreactor System Manufacturer and come to agreement on dosage requirements based on operating experience and data for the plant. The starting point for testing will be with no use of chemicals.
    d. Samples to be taken will include a daily composite sample upstream and downstream of the filters. Grab samples will be taken daily at the same location at a time mutually agreeable to the Owner and Contractor. Samples will be split between the Owner and the Contractor.
    e. The Owner will provide all personnel, raw wastewater, chemicals, laboratory testing equipment and services, and incidentals necessary to operate the System during the Process Performance Test and shall operate the System in strict accordance with the Operation and Maintenance as directed by the Contractor and Bioreactor System Manufacturer. If the Owner determines that the Project is substantially complete, with the sole exception of completion of the Process Performance Test, and the Owner cannot supply personnel, wastewater, chemicals, or equipment, issuance of Notice of Substantial Completion will not be delayed. However, Contractor shall return and participate in Process Performance Testing anytime in a period of 12 months following Notice of Substantial Completion and shall abide by the conditions for remedies of mal-performance as established by this agreement.

f. The Owner will record System effluent water quality based on continuous reading instrumentation. Calibration shall be performed as specified by the manufacturer of the instruments. Measurements will be made in accordance with Appropriate EPA Methods, or other commonly approved field test methods, mutually agreeable to the Owner and Contractor.

g. Contractor and/or the Bioreactor System Manufacturer shall provide personnel to observe and direct the Process Performance Test.

h. At the end of each test day, the Owner will provide Contractor and Bioreactor System Manufacturer with a copy of the test data. Contractor shall then consolidate the test data and provide the Owner with the results. Following each day of operation, the Engineer will review the results of performance testing, and at his sole discretion will determine if the performance requirements were met for that day, based on actual performance results achieved for the system.

i. If any test days fail to meet the performance guarantee during the 15-day Process Performance Test, the entire 15-day test shall be repeated.

j. If any test period is interrupted due to equipment failure that is the responsibility of the Contractor, the entire 15-day test shall be repeated.

k. If, during the Process Performance Test, it appears that the Process Guarantee is not being met, the Contractor and Bioreactor System Manufacturer shall have the right to have the Plant operated at such conditions as it may deem necessary or advisable for purposes of determining the nature or cause of the failure of the plant to meet such guarantee, provided such operating conditions are in accordance with good engineering practice and the Contractor's and Owner's safety rules enforced at the plant site, and thereafter will have the right to make or have made such adjustments as it deems necessary or advisable in order to meet such guarantee and the right to make or have made, at Contractor's own expense, such alterations or modifications to the equipment as it deems necessary or advisable. It is understood and agreed that any mechanical corrective work necessary to the system to cause the Plant to meet the Process Guarantee will be performed by the Contractor at his own expense at times mutually agreed upon by the Contractor and the Owner.

l. Upon successful completion of the Process Performance Test, as demonstrated by the results provided to the Owner, the Process Performance Guarantee shall be deemed to have been met, and Contractor shall have no further obligation or liability hereunder. The Owner will countersign Contractor's standard letter of notification of compliance as provided by the Customer Service Representative.

m. The Contractor shall be deemed to have passed performance test if the average of each week passes the monthly average concentrations and the grab samples passes the grab sample requirements.

1.06 SUBMITTALS

A. Biological Process Model: Equipment manufacturer shall provide a Biological Process Model and Report for this facility. The model shall be constructed in a commercial simulator (SUMO, Biowin, GPS-X, or similar.) The model shall be prepared by a user that has received relevant training and have sufficient experience at preparing such models for oxidation ditches. Proprietary manufacturer, spreadsheet, or simplified calculations are not acceptable to meet this requirement. Any deviations in the default parameters for the modeling software shall be identified and explained.

B. Shop Drawings from the Contractor:

1. Complete list of all system components to be provided.
2. Make, model, weight, and horsepower of each equipment assembly.
3. Complete catalog information, descriptive literature, specifications, and identification of materials of construction for all equipment.
4. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
5. Data table which lists registers of all data to be exported to and exported from the plant control. As a minimum, data table shall provide the following in formation for each variable: Tag name, description, memory location, scaling, and alarm set point. Data tables shall include (but not limited to):
   a. All physical inputs and outputs.
   b. All calculated variables.
   c. All set points (which will be changed by operator entry at the plant control system).
   d. Data used to control the process.
6. Drawings:
   a. Detail Process and Instrumentation Drawings (P&IDs) based on actual site conditions.
   b. Detailed Installation drawings showing the equipment/instrument dimensions, size, locations of connections, and anchor bolt locations.
   c. Performance data curves, capacity, horsepower demand over the entire operating range.

d. Complete system interconnection diagrams between controller, drive motors, and related components or controls external to system, including wire numbers and terminal board point identification.

7. Calculation supporting sizing of equipment, including mixers and aerators, signed and sealed by a Registered Professional Engineer.
8. Submittals as required by Section 40 99 90, Package Control Systems.
9. Procedures for Instrumentation and Control elements of Functional Test (Field) shall be submitted for approval prior to the Functional Test. Functional Test shall not be executed prior to approval of Functional Test procedures submittal.
10. Overview of training topics.
11. Factory finish system.

C. Quality Control Submittals:

1. Factory Functional Test Reports.
2. Shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.
5. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

D. Operation and Maintenance Manuals:

1. In accordance with Section 01 78 23, Operation and Maintenance Data.
2. Provide comprehensive Operation and Maintenance Manual covering all equipment used for the process. Incorporate operation and maintenance data from other manufacturers into one Operation and Maintenance Manual.
3. Maintenance Summary Forms.

E. Contract Closeout Submittals: Manufacturer's warranty.

1.07 PATENTS

A. The Contractor shall assume all costs of patent fees or licenses for equipment or processes, and shall safeguard and save harmless the Owner and its agents from damages, judgments, claims, and expenses arising from license fees or claimed infringements or any letters of patent or patent right, or because of royalty or fee for the use of any equipment or process, structural feature, or arrangement of any of the component parts of the installation; and the price stipulated for all such patent fees, licenses, or other costs pertaining thereto.

1.08 MANUFACTURER'S WARRANTY

A. The Contractor shall provide a 60-month design, materials, and workmanship warranty from the date of beneficial use. In the event the equipment fails to perform as specified, the Contractor shall promptly repair or replace the defective equipment without any cost to the Owner (including handling and shipment costs). Normal wear and tear shall be excluded.

PART 2 PRODUCTS

2.01 BIOREACTOR SYSTEM MANUFACTURER

A. Material, equipment, and accessories specified in this section shall be products of:

1. Ovivo.
2. Westech.
3. Or approved equal.

B. The Bioreactor System as shown in the Drawings and described in the Specifications was designed around the first listed manufacturer. Contractor shall be responsible for any changes to the design because of selecting an alternate manufacturer. The design shall be updated to reflect the same level of design as the original Drawings.

2.02 GENERAL

A. The Equipment to be provided by the Manufacturer is specified in paragraph 1.02 General.

B. The equipment covered by these Specifications shall call attention to certain features but do not purport to cover all details of the construction of the unit. Ancillary and accessory devices, within the confines of the Contractor or Bioreactor System Manufacturer's scope, necessary for Bioreactor system performance shall be included by the Contractor whether specified or not.

C. The equipment covered by these Specifications is intended to be standard process equipment of proven ability as manufactured by reputable concerns having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed.

D. All parts shall be so designed and proportioned as to have liberal strength and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustment.

E. The nameplate ratings for the motors shall not be exceeded, nor shall the design service factor be reduced when its piece of equipment is operating at any point on its characteristic curve.

F. The location, size, and type of all piping shall be as shown on the Drawings, or as required by the equipment, if size not shown.

2.03 INSTRUMENTATION AND CONTROLS

A. Controls: In accordance with P&IDs, control requirements, and components as specified in Section 40 99 90, Package Control Systems, and requirements below.

B. Control Panels:

Panel No.	Maximum Dimensions HxWxD (inches)	NEMA 250 Rating	Material	Mount	Power
ACP-5-1	84x48x18	NEMA 12	Painted Steel	Free-standing	120V ac and 120V ac UPS
ACP-5-2	48x36x12	NEMA 4X	316 SST	Rack Provide solar shields on top, sides and back, coordinate with rack dimensions	120V ac

C. The Bioreactor control system shall be a network connected packaged control system. Refer to requirements for network connected packaged control systems in Section 40 99 90, Package Control Systems.

1. ACP-5-1 shall include the PLC process and be connected to the plantwide control system via Ethernet/IP using fiber optic media.
2. ACP-5-2 shall function as a remote IO enclosure connected to ACP-5-1 via Ethernet/IP using fiber optic media.

D. The Bioreactor control system shall provide complete and independent automatic control of the bioreactor process, individual control of the equipment, and monitor process conditions, instrumentation, and equipment status. The system shall provide alarms to indicate to operators that maintenance attention is required (i.e., minor alarms) and provide alarms to indicate extreme condition in which the bioreactor performance may be

jeopardized (i.e., major alarms). The bioreactor control system shall provide interlocks to prevent damage of equipment and provide for continuous unattended operation during normal conditions to meet the specified system performance.

E. Functional Requirements:

1. Provide automatic control of dissolved oxygen and ORP in each bioreactor.
2. Provide manual control mode for each device having automatic control.
3. Program and coordinate data exchange with the PICS supplier (Section 40 90 00, Instrumentation and Control for Process Systems) to enable the PICS supplier to configure the plant-wide control system to:
   a. Select between manual and automatic control of each device with automatic control.
   b. Adjust automatic controller process setpoints and change between available automatic control modes.
   c. Display all status, alarms and analog process values.

F. Operator Interface Unit controls and indications:

1. Provide menu driven operator interface displays. The display shall include, as a minimum, the following:
   a. An overview graphic representing the Bioreactor Status
   b. An alarm graphic showing the 20 most recent alarms, including time and date of occurrence.
   c. Displays for control and monitoring of all functions specified herein.
2. The date and time shall be changeable directly from the operator interface.

G. Signal Interfaces:

1. Discretely wired signals: Refer to P&IDs.
2. Network Interface to plant control system:
   a. As required to meet functional requirements.
   b. As required to support provision of a complete plant control system (VTScada) interface to the following controls:
      1) Automatic and manual modes of control for:
         a) Mixers.
         b) Surface Aerators.
         c) All gates, including diverter gates.
         d) Dissolved Oxygen.
         e) Oxidation Reduction Potential (ORP).

2) Status monitoring of all equipment including:
   a) Equipment.
   b) Mixers.
   c) Surface Aerators.
   d) All gates, including diverter gates.
   e) Statuses:
      (1) On/Off.
      (2) Speed or position (as applicable).
      (3) Fault.
      (4) Auto/Manual mode.
3) A single bit representing the presence of 1 or more major alarms.
4) A single bit representing the presence of 1 or more minor alarms or warnings.

c. Include a signal for each device that indicates when it is forced OFF by operator input.

2.04 ELECTRICAL

A. Electrical Special Requirements: All interconnecting cable/conduit required between equipment and panels and all associated motors, motor starters, AFD, SCR, and other instrumentation shall meet the requirements of Division 26 Electrical.

B. All interconnecting cable/conduit required between equipment, panels, all associated motors, motor starters, AFDs, SCRs, and other instrumentation shall be provided whether shown or not on the drawings for a complete and operational system.

C. All electrical equipment, components, materials, and workmanship shall comply with the requirements of Division 26, Electrical.

2.05 ACCESSORIES

A. The following are accessories to be provided by the Manufacturer:

1. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighting over 100 pounds.
2. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.
3. Equipment Identification Plates: Provide 3/16 inch, Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

2.06 SHOP/FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coatings, System No. 2 for immersed and System No. 4 for non-immersed or as approved by Engineer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in strict accordance with manufacturer's installation instructions and recommendations.

B. Furnish oil and grease required for initial operation. Furnish grades of oil and grease in accordance with manufacturer's recommendations.

C. Install all equipment, components, piping and appurtenances true to alignment and rigidly supported.

D. Install all instrumentation and controls in accordance with the appropriate Standard Details provided on Drawings.

3.02 FIELD FINISHING

A. Coat all equipment not factory coated or damaged during installation.

B. Equipment manufacturer shall supply paint for field touchup of surfaces as required.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each piece of equipment assisted by manufacturer's representative, as follows:

1. Alignment: Prior to facility startup, test complete assemblies for correct rotation, proper alignment and connection, quiet operation, excessive vibration, and satisfactory specified performance.
2. Vibration Test:
   a. Test with units installed and in normal operation, and with the actual building structures and foundations provided. Units shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes exceeding the limits specified in excess of 1.5 mils.

b. The maximum vibration velocity for mixing equipment shall not exceed 0.3 inches per second at any filtered discrete frequency as measured on any rigid section of the gear reducer housing, in three orthogonal directions axial and perpendicular to the axis of gear rotation in accordance with ANSI/AGMA 6000-B96, specification for "Measurement of Linear Vibration on Gear Units."
c. If units exhibit vibration in excess of the limits specified, adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.

3. Control System Testing: Demonstrate automatic and manual control of each piece of equipment. Demonstrate all operator interface functions.
4. See Section 01 91 14, Equipment Testing and Facility Startup.

B. PICS to Equipment Vendor Interface Testing: Required. Refer to Section 40 90 00, Instrumentation and Control for Process Systems, Article Performance Test During and After Facility Startup, for additional requirements.

C. Performance Test:

1. Conduct on each piece of equipment assisted by manufacturer's representative.
2. Perform under actual or approved simulated operating conditions.
3. Perform with the Engineer present.
4. Meet the performance requirements specified earlier in this section.
5. Adjust, align, or modify units and retest if necessary. In addition, identical units shall be tested under the same provisions, whether specified or not.
6. See Section 01 91 14, Equipment Testing and Facility Startup.

3.04 MANUFACTURERS' SERVICES

A. Manufacturer's Representative:

1. The Manufacturer Representative may be the actual equipment manufacturer.
2. Provided by Contractor:
   a. Manufacturers:
      1) Mechanical Aerators.
      2) Submersible Mixers.
      3) Flow Control Gates.

b. Present at site or classroom designated by Owner, for minimum person-days listed below for each manufacturer, travel time excluded:
   1) 1 person-day for installation inspection, supervision of functional and performance test, completion of Manufacturer's Certificate of Proper Installation, and classroom or site training of Owner's personnel.
c. Contractor shall coordinate schedule of services with Owner, Engineer, and Manufacturer and inform Manufacturer, Owner, and Engineer a minimum of 3 weeks before manufacturer's representative is requested to be onsite.

B. Process Bioreactor System Manufacturer's Representative:

1. Provided by Contractor.
2. Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 5 person-days for installation assistance and inspection.
   b. 30 person-days for supervision of functional and performance testing.
   c. 5 person-days for facility startup.
   d. 5 person-days for classroom or site training of Owner's personnel.
      1) Prior to training, submit training outline for review by Owner.
3. Contractor shall coordinate schedule of services with Manufacturer and Owner and inform Manufacturer a minimum of 3 weeks before Manufacturer's representative is requested to be on Site.

C. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 44 45 16.02
FINE BUBBLE AIR DIFFUSER SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 2, Measurement of Oxygen Transfer in Clean Water.
2. American Society of Mechanical Engineers (ASME): B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.
3. ASTM International (ASTM):
   a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
   c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   d. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

1.02 DEFINITIONS

A. Adequate Mixing: Variation in mixed liquor suspended solids (total residue) of less than 15 percent between the mean value of Samples taken at any two depths along any vertical line extending between water surface and elevation of the top of diffusers.

B. Basin: Structure within which aeration occurs.

C. Bay: Portion of grid on each side of dropleg and manifold assembly.

D. Cell: Portion of aeration basin physically separated from other portions of basin. A cell may contain an aeration zone or a portion of an aeration zone.

E. Diffuser Assembly: Flexible membrane diffuser with an element holder and retaining device.

F. Distribution Header: Piping between manifold and diffuser assembly.

G. Dropleg: Connection from air source to manifold.

H. Dynamic Wet Pressure (DWP): Pressure to operate at specified conditions minus submergence and flow control losses.

I. Grid: Configuration of diffuser system in a zone.

J. Manifold: Single run of piping that connects dropleg with distribution header(s).

K. Specific Permeability Rating: Number of cubic feet of air per minute at 70 degrees F (plus or minus 5 percent) and 10 percent to 50 percent relative humidity that will pass through 1 square foot of diffuser element materials, 1-inch thick with a differential pressure equivalent of 2-inch water column (ceramic only).

L. Standard Cubic Feet per Minute (scfm): Air at 68 degrees F, 14.7 psia, and 36 percent relative humidity.

M. Standard Oxygen Transfer Rate (SOTR): Rate of oxygen transfer to tap water at standard conditions of 20 degrees C, 0.0 mg/L residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air).

N. Zone: Area within an aeration basin used to provide a particular type or level of treatment. One or more cells may be included in a zone.

1.03 PERFORMANCE REQUIREMENTS

A. Airflow Rate Output: Not differ by more than 10 percent, at minimum and maximum airflows, for any two system diffusers (based on diffuser with lower flow rate).

B. Air Distribution and Balancing: Control by use of orifices and proper header size selection only.

C. Do not use flow distribution control devices requiring automatic or manual operation.

D. Mixing: Adequate throughout reaeration zone at stated minimum airflow requirements.

E. Achieve Adequate Mixing in aeration basins at mixed liquor suspended solids concentrations between 1,000 and 5,000 mg/L.

F. Air Distribution and Balancing: Sufficient to maintain mixed liquor suspended solids in a state of suspension over entire depth of aeration basin at stated minimum airflow requirements.

G. Material being aerated is final effluent from the Bioreactor.

H. Reaeration System Requirements:

1. Diffuser Airflow (scfm):
   a. Minimum 2.38.
   b. Average 2.61.
   c. Maximum 2.87.
2. Available Airflow (scfm per Zone):
   a. Peak: 381.
   b. Average: 347.
   c. Minimum: 317.
3. SOTR (Pounds of O_2 per Day per Zone):
   a. Required: 1,760.
   b. Average: 1,935.
   c. Peak: 2,130.

1.04 DESIGN REQUIREMENTS

A. Furnish fixed header, fine bubble, diffused air aeration equipment system as a complete package including, but not necessarily limited to, dropleg; air manifold; distribution headers; diffusers; diffuser pressure monitoring system; supports; drainline, sump, and airlift purge; header joints; accessories; and miscellaneous appurtenances.

B. Furnish complete, engineered systems. Drawings indicate air manifold, header, and diffuser orientations only. Details such as air manifold sizes, air header sizes and spacing, air manifold and header supports and spacing, diffuser spacing, etc., shall be defined by and be the responsibility of Contractor and shall be consistent with requirements in this section.

C. Design aeration equipment so that upon completion of installation, diffusers are level to within plus or minus 3/8 inch of a common horizontal plane.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, and weight of each equipment assembly.
   b. Manufacturer’s catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical drawings showing equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment.

d. A detailed drawing of proposed aeration equipment layout for each basin showing air line sizes and lengths, distances between air distribution headers, and location of diffusers, supports, and expansion joints.
e. Diffuser, diffuser connector, balancing orifices, and system head loss curves covering range of airflow rates specified.
f. Calculations showing distribution and balancing of air within each basin for minimum and maximum airflow rates specified.
g. Shop and Field Painting Systems Proposed: Include manufacturer's descriptive technical catalog literature and specifications.
h. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.

B. Informational Submittals:

1. Calculations by a registered engineer to demonstrate design complies with requirements of this section.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
3. Factory test results, reports, and certifications. Include oxygen transfer performance test.
4. Manufacturer's Certificate of Compliance.
5. Special shipping, storage and protection, and handling instructions.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
   a. Include manufacturer's written/printed installation instructions with erection drawings indicating, by piece marking, how entire assembly (for each basin service) is to be shipped and field assembled.
7. Manufacturer's Certificate of Proper Installation.
8. Manufacturer's special guarantee.
9. Service records for maintenance performed during construction.

1.06 SPECIAL GUARANTEE

A. Furnish manufacturer's extended guarantee or warranty, which shall be in addition to the Contractor's 1-year correction period, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, replacement of diffuser connectors and assemblies found defective during period of 5 years after date of Substantial Completion. Manufacturer shall be responsible for material replacement of parts or materials that fail during warranty period. Down time, labor, or associated costs shall not be included in the extended warranty period beyond the Contractor's 1-year correction period.

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

Item	Quantity
Completely assembled diffusers	10
Air distribution pipe support assemblies	10
Air distribution pipe expansion joints	10
Tool sets, if required, for removal and replacement of diffuser assemblies	2

B. Delivery: As required by the manufacturer, paid by the Contractor and approved by the Owner/Engineer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. SSI Aeration, Inc.
2. Or approved equal.

2.02 SERVICE CONDITIONS

A. Reaeration System:

1. Basin Sidewater Depth: 12.72 feet.
2. Allowable Diffuser Mounting Distance Above Basin Floor (Floor to Diffuser Element):
   a. Minimum: 9 inches.
   b. Maximum: 12 inches.
3. Available Pressure at Dropleg (psig): 5.7.

2.03 GENERAL

A. Shop fabricate welded metal parts and assemblies from Type 304L stainless steel with a 2D finish conforming to ASTM A240/A240M.

B. Shop fabricate nonwelded parts and pieces from sheets and plates of Type 304 stainless steel conforming to ASTM A240/A240M, unless specified otherwise.

C. After fabrication, pickle and passivate stainless steel assemblies and parts in accordance with ASTM A380.

D. Each aeration basin shall have a minimum of seven manifolds. Each air manifold line shall extend to full width of each basin.

E. Header and Header Support System: Allow for expansion and contraction over a temperature range of 125 degrees F when installed.

2.04 DROPLEG, AIR MANIFOLD, AND DISTRIBUTION HEADERS

A. Dropleg:

1. Locate elbow from air supply main connection at top of basin. Top connection and dropleg connection to air manifold shall be loose follower flanges.
2. Support from its upper connection, with additional support at lower elbow. Connection between dropleg and air manifold shall be a slip joint.
3. Stainless steel to a minimum of 10 feet below operating water surface of aeration Basin. At that point (approximately elevation 818.00), dropleg shall change to PVC.

B. PVC Air Manifold:

1. Perpendicular to air distribution headers, same nominal pipe size as dropleg, and connected air manifold to distribution headers at common pipe centerline. Manifold shall act as drain line.
2. Fabricate with minimum 6-inch-diameter fixed joint connections to each air distribution header. Fabricate Manifolds in sections up to 24 feet in length.
3. Construct from Schedule 80 PVC. Manifolds shall be provided for long-term exposure to 130 degrees F near-wall temperature.

C. Distribution Headers:

1. Minimum 4 inch.
2. Fabricate in sections up to a maximum of 24 feet in length, with fixed joints or expansion joints as required.
3. Fabricate with diffuser element holders factory solvent welded to crown of header. Attach diffuser elements to distribution headers to resist 150 foot-pounds applied torque about polar axis of holder and 100 foot-pounds about longitudinal axis. Equivalent alternate designs will be considered by Engineer.

D. Include expansion/contraction system consisting of fixed or flanged joints and guide supports. Guide supports shall allow for longitudinal movement.

2.05 FLEXIBLE MEMBRANE DIFFUSER ASSEMBLIES

A. Fine bubble, disk type with flexible perforated air release membrane. After 1 year of continuous operation without basin dewatering or diffuser cleaning, pressure drop through diffuser at specified flow rates shall not increase more than 1 psi.

B. Backflow preventer assembly to prevent liquid from passing into aeration header. Diffusers shall require no special tools for attaching diffusers to diffuser connectors.

C. Membrane: Ethylene propylene diene monomer (EPDM) suitable for application to continuous aeration of activated sludge mixed liquor without significant increase in head loss.

1. Replaceable without use of any special tools.
2. Exterior surface shall be smooth to restrict biological film growth.
3. Inflate during aeration and deflate when airflow is discontinued, further restricting biological film growth.
4. Cleanable in-place with water from a hose. Acid or other chemical cleaning methods shall not be required to restore diffuser to like-new performance conditions.
5. Perforated over entire surface to release fine bubbles uniformly.

D. Each Basin consists of one zone with one grid in each zone. Grids shall contain seven headers. First zone of each basin shall contain a minimum of 133 equally spaced diffuser assemblies. Spacing between diffuser assemblies shall provide for uniform mixing of contents.

2.06 DIFFUSER PRESSURE MONITORING SYSTEM

A. Furnish each aeration grid with one pressure monitoring connecting box, bubbler tube, support brackets, polyethylene tubing and carrier pipe.

1. Connecting Box: Handrail mounted fiberglass box capable of containing three 1/2-inch PVC ball valves, and quick coupling connectors, all of which are accessible through a front access door.
2. Mounting Hardware: Type 316 stainless steel.
3. Three ball valves connect to grid air distribution header and diffuser element holder plenum with 3/8-inch diameter tubing and a 1/2-inch bubbler tube (for submergence pressure at top of diffuser).

B. Furnish one portable monitoring panel with at least one differential pressure gauge, quick coupling connectors, PVC ball valves, one set of calibration curves, and tubing and fittings as necessary to measure pressure differential between header and holder plenum and holder plenum and diffuser submergence.

2.07 HEADER JOINTS

A. Special Flanged Joints or Slip Joints Between Sections of Air Distribution Header:

1. Individual header sections shall rotate independently of adjacent header sections for alignment.
2. Flanged Joints for Stainless Steel Piping: Face ring-follower flange type with through-bolts, capable of transmitting longitudinal forces caused by expansion and contraction in air distribution header.
3. Slip joints shall allow for expansion and contraction of air distribution header.

B. Fixed Joints for PVC Piping: Spigot section solvent welded to one end of Distribution Header, threaded socket section welded to mating distribution header, and O-ring gasket and threaded screw-on retainer ring.

2.08 APPURTENANCES

A. Couplings: Van Stone type flanges ASTM A182/A182M stainless steel drilled 150-pound ASME B16.5 Standard.

B. Face Rings: Stainless steel, ASTM A240/A240M, Type 304L, inside diameter (ID) drilled 1/16-inch larger than pipe outside diameter (OD).

C. Gaskets: Neoprene, 45 durometer to 55 durometer; locate at expansion joints and couplings to form an airtight connection at 20 psig minimum.

D. Miscellaneous: Nuts, bolts, washers, and other nonwelded parts: Type 304 stainless steel, ASTM A240/A240M. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

E. Lifting Lugs: Suitably attached for equipment assemblies and components weighing over 100 pounds.

F. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.09 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Oxygen Transfer Performance Testing Procedure: As described in most recent ASCE 2. Use a Theta value of 1.024. Engineer must approve specific details of test procedure and any deviation from requirements stated below.
   a. Nonsteady-state reaeration test shall consist of three reaeration test runs. SOTR shall be average of SOTRs obtained for each reaeration test run. Sodium sulfite catalyzed with cobalt chloride shall be used to strip residual dissolved oxygen between reaeration test runs.
   b. Test Facilities: Provided by manufacturer and subject to approval of Engineer. Test facility shall be capable of providing sidewater depths and diffuser submergences specified under Article Service Conditions. Test aeration tank shall be a minimum of 200 square feet.
   c. Diffuser density for each test shall be equal to or less than diffuser density proposed by manufacturer for aeration system being tested. Diffuser density is defined as number of diffusers per square foot of tank area.
   d. For each system being tested, test airflow rate per diffuser (scfm per diffuser) shall not be greater than airflow rate per diffuser proposed for manufacturer's system.
2. Obtain approval of test reports from Engineer prior to shipment of any equipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Accurately place anchor bolts using templates furnished by manufacturer and in accordance with Section 05 50 00, Metal Fabrications.

3.02 CORROSION PROTECTION

A. Atmospheric exposed plastic surfaces shall be field prepared and painted in accordance with Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each aeration system.

B. Performance Test:

1. Conduct on each aeration system.
2. Perform under actual or approved simulated operating conditions. Airflow shall be as measured by plant instrumentation. Calibrate airflow instrumentation as part of testing procedure.
3. Test for a continuous four period without malfunction.
4. Adjust, realign, or modify units and retest if necessary.
5. Test as follows:
   a. Pressure Test: Measure air pressure immediately upstream of elbow located at top of each dropleg, and at maximum airflows and submergences stated under Article Performance Requirements.
   b. Mixing Test:
      1) Perform at minimum airflows stated in Article Performance Requirements.
      2) Select three vertical lines and two depths in each basin.
      3) Take three Samples at each of two depths along each vertical line using Van Doren sampler.
      4) Independent testing laboratory approved by Engineer will perform residue test on each Sample. Mean value of total residue for three Samples at each depth will be used to determine conformance with requirements.
      5) All testing and sampling shall conform to procedures established in latest edition of Standard Methods for Examination of Water and Wastewater.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance and inspection.
2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for pre-startup classroom or Site training.
4. 1 person-day for facility startup.

END OF SECTION

DRAWINGS
(BOUND SEPARATELY)