U.S. DEPARTMENT OF ENERGY
OAK RIDGE ENVIRONMENTAL MANAGEMENT

Y-12 National Security Complex
Oak Ridge, Tennessee

TECHNICAL REQUIREMENTS

for the construction of the
OUTFALL 200 MERCURY TREATMENT FACILITY

Contract No. _______

Volume 3 of 3 (Divisions 32 through 49)

****

Specifications

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UCOR
URS | CH2M
Oak Ridge LLC

June 2017

Project No. 662886

Copy No.________________________
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UCOR Project Engineer

Teresa J. Pierce, P.E.

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email=teresa.pierce@ettp.doe.gov, c=US
Date: 2017.06.29 19:23:26 -04'00'

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<td>Ferric Chloride Metering Pump A, B, C Data Sheet</td>
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<td>Sodium Bisulfite Feed Pump A, B, C, D Data Sheet</td>
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<td>Sodium Hydroxide Pump A, B Data Sheet</td>
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<td>Organosulfide Polymer Metering Pump A, B, C, D Data Sheet</td>
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<td>Clarifier/Thickener System</td>
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<td>Induction Motor Data Sheet</td>
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<td>44 44 63.01</td>
<td>Polymer Feed System, Liquid ....................................................... 1- 8</td>
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<td>Filter Aid Polymer Metering Pump A, B, C Data Sheet</td>
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<td>Thickening Aid Polymer Pump A, B Data Sheet</td>
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DIVISIONS 45 THROUGH 49 (NOT USED)

**END OF SECTION**
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Aggregate Base Courses

<table>
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Document Review & Approval:

**Originator:**
Robert L Townsend/Lead Civil Engineer

**Design Verification Complete:**
Dan L Peterson/Sr Civil Reviewer

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager
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):
   b. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   f. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.
   g. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.
   i. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.
   j. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. ASTM International (ASTM):
   a. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   b. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   d. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
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. Standard Specifications: When referenced in this section, shall mean Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction, January 2015.

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.

2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 Base Course

A. As specified for Type B, Grading C or D in Section 903.05 of the Standard Specifications.

B. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.

2.02 Gravel Surfacing

A. As specified for Type B, Grading C in Section 903.05 of the Standard Specifications.

B. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring either free or as coating on stone.

2.03 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 312313, 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 in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

A. In accordance with Section 303.06 of the Standard Specifications.

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 CONSTRUCTION OF COURSES

A. Construction of Courses: In accordance with Section 303.10 of the Standard Specifications, except as modified hereinafter.
B. Untreated Aggregate Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Add keystone to achieve compaction and as required when aggregate
does not compact readily due to lack of fines or natural cementing
properties, as follows:
   a. Use leveling course or surfacing material as keystone.
   b. Spread evenly on top of base course, using spreader boxes or chip
      spreaders.
   c. Roll surface until keystone is worked into interstices of base
      course without excessive displacement.
   d. Continue operation until course has become thoroughly keyed,
      compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

C. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. In accordance with Section 303.10 of the Standard Specifications, except as
modified hereinafter.

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 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.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-
section at all times, and to keep surface smooth and thoroughly compacted.
B. Finished Surface of Untreated Aggregate Base Course: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.07 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Provide Engineer 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>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Frequency</th>
<th>Sampling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation</td>
<td>AASHTO T11 and AASHTO T27</td>
<td>One sample every 500 tons but at least every 4 hours of production</td>
<td>Roadbed after processing</td>
</tr>
<tr>
<td>Moisture Density (Maximum Density)</td>
<td>AASHTO T99, Method D</td>
<td>One test for every aggregate grading produced</td>
<td>Production output or stockpile</td>
</tr>
<tr>
<td>In-Place Density and Moisture Content</td>
<td>AASHTO T310, and AASHTO T265 for moisture content</td>
<td>One for each 500 ton but at least every 10,000 sq ft of area</td>
<td>In-place completed, compacted area</td>
</tr>
</tbody>
</table>

3.08 CLEANING

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

END OF SECTION
**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Asphalt Paving

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**Document Review & Approval:**

**Originator:**

Robert L Townsend/Lead Civil Engineer

**Design Verification Complete:**

Dan Peterson/Sr Civil Reviewer

**Approved:**

W. Laird Ellis, Jr. PE/Design Manager
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):
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
   g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
   k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
   l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
   m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).

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):
   c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.02 DEFINITIONS

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

B. RAP: Reclaimed asphalt pavement.


1.03 DESIGN REQUIREMENTS

A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of this Specification.

B. Design Criteria:

1. Mix 411D per Section 411.03 of the Standard Specifications. Furnished Mix Tolerances: Conform to asphalt concrete mix formula within the following, plus or minus:
   a. Aggregate Passing 4.76 millimeter (No. 4) and Larger Sieves: 5 percent.
   b. Aggregate Passing the 2.38 millimeter (No. 8) to 150 μm (100) Sieves: 4 percent.
   c. Aggregate Passing the 75 μm (No. 200) Sieve: 2 percent.
   d. Bitumen Content: 0.3 percent of volume or batch weight of aggregate.
   e. Temperature Leaving Mixer: 11 degrees C (20 degrees F).
1.04  SUBMITTALS

A.  Informational Submittals:

1.  Asphalt Concrete Mix Formula:
   a.  Submit minimum of 45 days prior to start of production.
   b.  Submittal to include the following information:
       1)  Gradation and portion for each aggregate constituent used in
           mixture to produce a single gradation of aggregate within
           specified limits.
       2)  Bulk specific gravity for each aggregate constituent.
       3)  Measured maximum specific gravity of mix at optimum
           asphalt content determined in accordance with
           ASTM D2041.
       4)  Properties as stated in this Section for at least four different
           asphalt contents other than optimum, two below optimum,
           and two above optimum.
       5)  Percent of asphalt lost due to absorption by aggregate.
       6)  Index of Retained Strength (TSR) at optimum asphalt
           content as determined by AASHTO T283.
       7)  Percentage of asphalt cement, to nearest 0.1 percent, to be
           added to mixture.
       8)  Optimum mixing temperature.
       9)  Optimum compaction temperature.
      10)  Temperature-viscosity curve of asphalt cement to be used.
      11)  Brand name of any additive to be used and percentage
           added to mixture.

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 for the following materials:
   a.  Aggregate: Gradation, source test results.
   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.
   e.  Quality control.
1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Independent Testing Laboratory: In accordance with ASTM E329.
   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 10 degrees C (50 degrees F) or air temperature is lower than 4 degrees C (40 degrees F). 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: Emulsified Asphalt, Grade AEP or CAE-P conforming to Section 904.03 of the Standard Specifications.

B. Tack Coat: Emulsified asphalt, conform to Section 904.03 of the Standard Specifications.

C. Sand (Blotter Material): Clean, dry, with 100 percent passing 4.75-millimeter (No. 4) sieve, and a maximum of 10 percent passing 75 μm (No. 200) sieve.

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. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

C. Aggregate:

D. Mineral Filler: In accordance with Section 407.02 of the Standard Specifications.

E. Asphalt Cement: Paving Grade PG70-22 as specified in Section 904.01 of the Standard Specifications.

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 Section 407 of the Standard Specifications.

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 25 millimeters (1 inch).
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 Section 411.05 of the Standard Specifications.

B. Tack Coat:

1. Prepare material, as specified in Section 403.04 of the Standard Specifications, prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping applications.
3. Do not apply more tack coat than necessary for the day’s paving operation.
4. Touch up missed or lightly coated surfaces and remove excess material.
5. Application Rate: Minimum 0.25 liter to maximum 0.70 liter of asphalt (residual if diluted emulsified asphalt) per square meter (0.05 to 0.15 gallon per square yard) of surface area.

C. 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 two equal lifts.
3. Compacted Lift Thickness:
   a. Minimum: Twice maximum aggregate size, but in no case less than 25 millimeters (1 inch).
   b. Maximum: 100 millimeters (4 inches).
4. Total Compacted Thickness: As shown.
5. Apply such 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 150 millimeters (6 inches) 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 150 millimeters (6 inches) on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.

D. Compaction: In accordance with Section 407.15 and Table 407.15-1 of the Standard Specifications.

1. Joint Compaction:
   a. Place top or wearing layer as continuously as possible.
   b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.
   c. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
   d. Cut away waste material and lay new mix against fresh cut.

E. 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: 3 millimeters (1/8 inch) from lower edge of a 3.6-meter (12-foot) 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: 6 millimeters (1/4 inch) in 3.6 meters (12 feet) from rate of slope shown.

4. Finished Grade:
   a. Perform field differential level survey on maximum 15-meter (50-foot) meter grid and along grade breaks.
   b. Maximum Deviation: 6 millimeters (0.02 foot) from grade shown.

F. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by Engineer.
2. Preparation:
   a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
   b. Seal in dry weather and when temperature is above 2 degrees C (35 degrees F).
3. Application:
   a. Fill cracks over 1.5 millimeters (1/16 inch) in width with asphalt-sand slurry or approved crack sealer prior to sealing.
   b. When sealing patched surfaces and joints with existing pavements, extend minimum 150 millimeters (6 inches) beyond edges of patches.

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 12 millimeters (1/2 inch) 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 50 millimeters (2 inches).
   5. Actual compacted thickness of intermittent areas of 100 square meters (120 square yards) or less may exceed 50 millimeters (2 inches), but not 100 millimeters (4 inches).
   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: 75 millimeters (3 inches) 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 350 to 525 Newtons per linear centimeter (200 to 300 pounds per linear inch). Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 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 6 millimeters (1/4 inch) or minus 0 millimeter 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 T230 and 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 400 mg (500 tons) of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice’s) Specific Gravity: Once every 900 mg (1,000 tons) or once every 8 hours, whichever is greater.

2. Density Tests: Once every 450 mg (500 tons) of mix or once every 4 hours, whichever is greater.

END OF SECTION
**UCOR-FM-001, REV. 0 - SPECIFICATION COVER SHEET**

**Specification Document Control No.:** 32 31 13  
**Revision No.:** 0  
**Project:** Outfall 200 Mercury Treatment Facility  
**Engineering Discipline:** Civil  
**Specification Division:** 32 – Exterior Improvements  
**Date:** 6/23/2017

**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)  
Chain Link Fences and Gates

### Revision History:

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### Document Review & Approval:

**Originator:**  
Robert L Townsend/Lead Civil Engineer  
NAME/POSITION  
[Signature]  
DATE: 6/26/17

**Design Verification Complete:**  
Dan Peterson/Sr Civil Reviewer  
NAME/POSITION  
[Signature]  
DATE: 6/26/17

**Approved:**  
W. Laird Ellis, Jr. PE/Design Manager  
NAME/POSITION  
[Signature]  
DATE: 6/26/17

Digitally signed by W. Laird Ellis, Jr.  
Date: 2017.06.23 11:15:20 -06'00'
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):
   f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. F552, Standard Terminology Relating to Chain Link Fencing.
   n. F567, Standard Practice for Installation of Chain-Link Fence.
   p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
1.02 DEFINITIONS

A. Terms as defined in ASTM F552.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
      1) Fence, gate posts, rails, and fittings.
      2) Chain link fabric.
      3) Gates and hardware.
      4) Gate operators, motors, and mounting arrangements, switches, and controls; include operating instructions.
      5) Gate access system, including access control features, power and control wiring diagrams, and operating instructions.
      6) Accessories: Barbed wire.

2. Test Reports: Field test result for compliance of installation of chain link fence, gates, and gate operators.

B. Informational Submittals:

1. Manufacturer’s recommended installation instructions.
2. Evidence of Supplier and installer qualifications.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
1.04 QUALITY ASSURANCE

A. Qualifications:

1. Automatic Gate Operator System Supplier: 5 years’ experience in gate operator systems.
2. Automatic Gate Operator System Installer: Experienced installer who has completed chain link fences and gates similar in material, design, and extent to those indicated for Project and whose work has resulted with a record of successful in-service performance with a minimum 3 years’ experience.

B. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

C. Preinstallation Conference: Conduct conference at project Site with gate installer to verify layout and operations of automatic gate operating system.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.06 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence and gates.

B. Interruption of Existing Utility Service: Notify owner of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

1.07 SPECIAL GUARANTEE

A. Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1. Faulty operations of gate operators and controls.
2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
PART 2 PRODUCTS

2.01 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.02 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392, Type II, Class 2, 2.0 ounces per square foot; galvanized after weaving.

B. Height: 84 inches, unless otherwise shown.

C. Core Wire Gauge: No. 9.

D. Pattern: 2-inch diamond-mesh.

E. Diamond Count: Manufacturer’s standard and consistent for fabric furnished of same height.

F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.

G. Wires of Twisted Selvages:
   1. Twisted in a closed helix three full turns.
   2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.

2.03 POSTS

A. General:
   1. Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence, except as modified in this section.
   3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.
   4. Lengths: Manufacturer’s standard with allowance for minimum embedment below finished grade of 34 inches.
   5. Protective Coatings:
      a. Zinc Coating: ASTM F1043, Type A external and internal coating.
B. Line Posts:
   1. Round Steel Pipe:
      a. Outside Diameter: 2.375 inches.
      b. Weight: 3.65 pounds per foot.

C. End, Corner, Angle, and Pull Posts:
   1. Round Steel Pipe:
      a. Outside Diameter: 2.875 inches.
      b. Weight: 5.79 pounds per foot.

D. Posts for Removable Fence Panels: As specified for end, corner, angle, and pull posts.

E. Posts for Swing Gates 8 Feet High and Under:
   1. ASTM F900.
   2. Round Steel Pipe:
      a. Outside Diameter: 4.0 inches.
      b. Weight: 6.56 pounds per foot.

F. Posts for Swing Gates Over 8 Feet High: As recommended by fence manufacturer.

G. Posts for Horizontal Sliding Gates:
   1. ASTM F1184, Type II, Class 1.
   2. Round Steel Pipe:
      a. Outside Diameter: 4.00 inches.
      b. Weight: 6.56 pounds per foot.

2.04 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:
   1. ASTM F1083.
   2. Outside Diameter: 1.66 inches.
   3. Weight: 2.27 pounds per foot.

B. Protective Coatings: As specified for posts.

C. Strength and Stiffness Requirements: ASTM F1043, top rail, heavy industrial fence.
2.05 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:
   1. One-piece.
   2. Length not less than 2 inches shorter than full height of chain link fabric.
   3. Provide one bar for each gate and end post, and two for each corner and pull post.

E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

F. Tie Wires, Clips, and Fasteners: According to ASTM F626.

G. Barbed Wire Supporting Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire integral with post cap for each post, with single 45-degree arms for supporting three strands of barbed wire. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.

2.06 TENSION WIRE

A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.07 BARBED WIRE

A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade:
   1. Line Wire: Two strands of No. 12-1/2 gauge.
   2. Barbs:
      a. Number of Points: Two.
      b. Length: 3/8 inch minimum.
c. Shape: Round.
d. Diameter: No. 14 gauge.
e. Spacing: 5 inches.

2.08 GATES

A. General:

1. Gate Operation: Opened and closed easily by one person.
3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
4. Gate leaves more than 8-feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.
5. Gate Fabric Height: Same as for adjacent fence height.
7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
8. Gate Posts and Frame Members: Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
9. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Swing Gates: Comply with ASTM F900 for single and double swing gate types.

1. Leaf Width: As shown.
2. Hinges: Offset type, malleable iron.
   a. Furnished with large bearing surfaces for clamping in position.
   b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
3. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
4. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
5. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both leaves of double gate.
6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.
C. Cantilever Horizontal Sliding Gates:

1. Comply with ASTM F1184 for single slide gate types I, Class 1 with external roller assemblies.
3. Roller Guards: As required per ASTM F1184 for Type II, Class 1 gate.
4. Hangers, roller assemblies, and stops fabricated from galvanized malleable iron.

D. Rolling Gate:

1. Track Rollers: Malleable iron or heavy pressed steel with provision for grease lubrication.
2. Ground Rollers: Malleable iron or heavy pressed steel with provision for grease lubrication.
4. Gates more than 8 feet in height shall have three tracks.
5. Frames: ASTM F1184, Type I.

2.09 GATE OPERATOR SYSTEM

A. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, safety devices, and weatherproof enclosures; coordinate electrical requirements with Division 26, Electrical.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide operator with UL approved components.
4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor.

C. Gate Operator:

1. UL325 listed, heavy-duty, high frequency, electrical models designed to open and close gates provided.
2. For each gate, supply manufacturer of gate operator with complete
details of gate, hardware, track rollers, adjacent fence posts, and fence
construction for development and detailing of gate operator.
3. Furnish with following features:
   a. Metal enclosure, including attachments shall be constructed with
      finish and design suitable for exterior installation in all-weather
      environment.
   b. Minimum 1-hp motor, 208V ac, three-phase, 60-Hz electric
      power, reversible.
   c. Electric motor driven hydraulic power pack with hard rubber
      wheels in contact with operating type secured to gate.
      Transmission of opening or closing forces to gate shall be by
      rotation of wheels against operating type.
   d. Positive limit switch, to sense position of gate and provide control
      to prevent damage to gate operator.
   e. NEMA 250, Type 12 enclosure for motor control components.
   g. 24V ac control circuit to power remote control gate activation
      devices.
   h. Manual operation feature or disconnect, without use of tools, for
      easy operation during power failure, malfunction, or emergency.
   i. Aluminum drive rail designed for attachment to sliding gate in
      manner that reinforces gate assembly.
   j. Gate Travel Speed:
      1) Minimum 1 foot per second.
      2) Speed adjusting feature that provides range of appropriate
         speeds for slide gate operation is acceptable but not
         required.
      3) Maximum Gate Weight: 3,000 pounds.
      4) Frequency of Use: 10 cycles per hour.
      5) Operating Type: Enclosed wheel and drive or roller chain
         with manual release.
   k. Compatible with gate operator control devices provided.
4. Manufacturers:
   a. Hy-Security Gate Operator, Seattle, WA.
   b. Automated Equipment Co., Seattle, WA.
   c. Stanley.
   d. Richards Wilcox, Aurora, IL.
D. Access System:
   1. Combination unit card reader and digital keypad in weatherproof
      enclosure mounted on steel tube post anchored to concrete foundation
      outside gate. Face lighted unit fully visible at night.
a. Combination Card Reader and Digital Keypad:
   1) Provided and installed by Access Control Intrusion Detection Surveillance system vendor per Section 28 13 70, Access Control Intrusion Detection and Surveillance System. Fully compatible as integrally connected part of ACIDS system.
   2) Integral Form-C dry contacts on back of unit to provide gate operation permissive to gate operator upon valid card credentials or keypad entry. Contacts momentarily change state to initiate gate open operation for a valid entry.

2. For safety, provide loop detectors minimum of 4 feet away from each side of gate.

3. Gate Operation:
   a. Entry: Gate opens when activated by valid proximity card or keypad code in reader. Gate closes after adjustable time period up to 90 seconds.
   b. Exit: Gate opens when activated by detector loop in pavement or pushbutton inside gate. Gate closes as for entry.
   c. Override or 7-day timer to allow gate to remain open for up to 12 hours with equipment at rest.

4. Manufacturers:
   a. Power Door Engineering, Seattle, WA.
   b. Quentin Control Systems, NW, Inc., Seattle, WA.
   c. Continental Instruments Corp., Westbury, NY.
   d. Richards Wilcox, Aurora, IL.

2.10 CONCRETE

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

2.11 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
   1. Material above Finished Grade: Copper.
   2. Material on or below Finished Grade: Copper.

B. Connectors and Grounding Rods: Comply with UL 467.
   1. Connectors for Below-Grade Use: Exothermic welded type.
   2. Grounding Rods: Copper-clad steel.
PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer’s recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

D. Drainage Crossings: Where the chain-link fence must cross drainage ditches or swales, the main fence shall be carried across a ditch or swale with additional fence added below.

   1. Frames and Bracing: The fence added below shall be fabricated with galvanized round steel pipe conforming to the requirements for top and brace rails.
   2. The construction of the frame shall be welded or assembled with corner fittings. The frame shall be rigid and to the extent necessary to maintain a 2-inch clearance between bottom of the frame and finish grade. If necessary to maintain rigidity, attach to the frame a series of 3/8-inch diameter galvanized steel pipe stakes that are embedded a minimum of 2 feet to the sides and bottom of the ditch.
   3. Attach chain link fabric securely to frame at intervals not exceeding 12 inches.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 311000, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Embedment Coating: Coat portion of galvanized or aluminum-coated steel posts that will be embedded in concrete as specified in Section 099000, Painting and Coating. Extend coating 1 inch above top of concrete.
3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:

1. Minimum 3 feet below finished grade.
2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal
posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 BARBED WIRE SUPPORTING ARMS

A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.07 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.08 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 days.

B. Install fabric with twisted and barbed selvage at top.

C. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

D. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.

E. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.

F. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.

G. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.
3.09 BARBED WIRE

A. Install barbed wire uniformly in configurations of three strands of barbed wire on supporting arms. Pull wire taut and install securely to supporting arms and secure to end terminal post or terminal arms.

3.10 GATES

A. Install gates according to manufacturer’s written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.11 GATE OPERATOR SYSTEMS

A. Install gate operator systems in accordance with manufacturer’s recommendations, aligned and true to fence line and grade.

B. Furnish with equipment and accessories necessary for complete installation.

C. Hand excavate holes for pads in firm undisturbed soil to dimensions, depths, and locations as required by gate operator component manufacturer’s written instructions and as shown on the drawings.

D. Vehicle Loop Detector System: Cut grooves in pavement and bury and seal wire loop according to manufacturer’s written instructions. Connect to equipment operated by detector.

3.12 ELECTRICAL GROUNDING

A. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
3.13 FIELD QUALITY CONTROL


B. Gate Tests:
   1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
   2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
   3. Confirm that latches and locks engage accurately and securely without forcing and binding.

C. Automatic Gate Operator:
   1. Energize circuits to electrical equipment and devices.
   2. Adjust operators, controls, safety devices, and limit switches.
   3. Start units to confirm proper motor rotation and unit operation free of binding. Test and adjust all gate controls for proper operation.
   4. Replace damaged and malfunctioning controls and equipment.
   5. Lubricate hardware, gate operator and other moving parts.

3.14 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, to train Owner’s personnel to adjust, operate, and maintain gates.

3.15 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION
# UCOR-FM-001, REV. 0 - SPECIFICATION COVER SHEET

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**Specification Title & Description:**
(List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Precast Modular Block Retaining Wall

## Revision History:

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## Document Review & Approval:

**Originator:**
Robert L Townsend/Lead Civil Engineer

**Design Verification Complete:**
Jen A. Schaeffer/Lead Geotech Engineer

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager

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PART 1   GENERAL

1.01 WORK OF THIS SECTION

A. This section includes precast modular block retaining wall systems retaining compacted soil backfill.

B. The modular block units will be Redi-Rock International or approved equivalent. Design recommendations provided herein are based upon the manufacturer’s information about the block wall.

C. Work shall consist of furnishing all materials, labor, equipment, field supervision, and installing a modular block wall system in accordance with given specifications.

D. All installations should conform to the Drawings, profiles, and Specifications for this Project. Construction of the modular block wall may involve removal and demolition of existing slope and landscaping as shown on Drawings. Work shall be conducted to minimize overexcavation into the existing slope.

1.02 REFERENCES

A. Definitions:

2. Geosynthetics: Geotextiles, geogrids, or geomembranes.
4. Geogrid: A geosynthetic material comprised of a regular network of tensile elements manufactured in a mesh-like configuration of consistent aperture openings.
5. Drainage Aggregate: Clean, crushed stone placed within and immediately behind the precast modular block units to facilitate drainage and reduce compaction requirements immediately adjacent to and behind the precast modular block units.
6. Unit Core Fill: Clean, crushed stone placed within the hollow vertical core of a precast modular block unit. Typically, the same material used for drainage aggregate as defined above.
7. Foundation Zone: Soil zone immediately beneath the leveling pad and the reinforced zone.
8. Retained Zone: Soil zone immediately behind the drainage aggregate and wall infill for wall sections designed as modular gravity structures.
Alternatively, in the case of wall sections designed with geosynthetic soil reinforcement, the retained zone is the soil zone immediately behind the reinforced zone.

9. Reinforced Zone: Structural fill zone within which successive horizontal layers of geogrid soil reinforcement have been placed to provide stability for the retaining wall face. The reinforced zone exists only for retaining wall sections that utilize geosynthetic soil reinforcement for stability.

10. Reinforced Fill: Granular fill placed within the reinforced zone.

11. Leveling Pad: Hard, flat surface upon which the bottom course of precast modular blocks are placed. The leveling pad may be constructed with crushed stone or cast-in-place concrete.

12. Wall Infill: The fill material placed and compacted between the drainage aggregate and the excavated soil face in retaining wall sections designed as modular gravity structures.

B. Reference Standards:

1. Design:
   b. FHWA-NHI-10-024 Volume I and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
   d. National Concrete Masonry Association (NCMA): TEK 2-4A, Specification for Segmental Retaining Wall Units.

2. Precast Modular Block Units:
   a. ASTM C150, Standard Specification for Concrete Blocks.

3. Soils:
   a. ASTM C33, Standard Specification for Concrete Aggregates.
   c. ASTM D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. (56,000 ft-lbf/ft (2,700 kN-m/m)).
   d. ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.03 SYSTEM DESCRIPTION

A. Design Requirements: Design the retaining wall system in accordance with the design guidelines presented by the manufacturer of the gravity block wall system. The designer of the gravity block wall system shall be certified and
authorized by the manufacturer of the gravity block wall system and shall be a licensed Professional Engineer in the State of Tennessee.

B. Performance Requirements: The contractors, material suppliers, and wall system suppliers shall have sufficient past project experience and shall be approved by the Engineer as part of submittal.

C. Wall Design Criteria and Parameters: Design of the gravity block wall system shall be based on the criteria and geotechnical parameters specified below:

1. Design calculations shall be based on the recommended procedure by the manufacturer of the gravity block wall system. This procedure shall be based on the requirements specified in the 2012 International Building Code (IBC), including current interims and the National Concrete Masonry Association (NCMA) Design Manual for Segmental Retaining Walls. In the event of conflict, the most stringent of the design requirements shall be used.

2. Factors of safety shall be as follows:
   a. Sliding: Greater than or equal to 1.5 for static, 1.1 for seismic.
   b. Overturning: Greater than or equal to 1.5 for static, 1.1 for seismic.
   c. Bearing Capacity: Greater than or equal to 2.0.
   d. Global Stability: Greater than or equal to 1.5 for static, 1.1 for seismic.
   e. Geotechnical parameters for design shall be as shown on the Drawings.
   f. Allowable bearing pressure for the foundation shall be 3,000 psf.

1.04 SUBMITTALS

A. Submittals shall be made 15 days prior to the start of construction. In addition, the Contractor shall provide a list of successfully completed projects along with related Project references.

B. Product Data: Manufacturer’s materials specifications, installation instructions, and general recommendations.

C. Installer Qualification Data: Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall.

D. Retaining Wall Plans: Engineering drawings, cross-sections, elevations, and large scale details of elevation, typical sections, details, and connections. Plans shall be stamped and signed by a qualified Professional Engineer licensed in the State of Tennessee.

E. Retaining Wall Design Calculations and Construction Shop Drawings: Contractor shall furnish sets of construction shop drawings and copies of the
supporting structural calculations that are signed and stamped by a qualified Professional Engineer licensed in the State of Tennessee.

1.05 QUALITY ASSURANCE

A. Preconstruction Meeting: A meeting between the Geotechnical Engineer, wall designer, Contractor, material supplier, subcontractors, and the Owner shall be held at the Site in order to review the gravity block retaining wall design and construction requirements. A notification shall be sent to all the parties at least 3 days in advance of the time of the meeting.

1.06 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall inspect the materials upon delivery to confirm that the proper type, grade and color of materials have been delivered. All product specifications shall be reviewed to assure that all specified materials have been delivered.

B. The Contractor shall store and handle all materials in accordance with the manufacturer’s recommendations and in a manner that prevents deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, UV exposure or other causes. Damaged materials shall not be incorporated into the wall construction.

PART 2 PRODUCTS

2.01 PRECAST MODULAR BLOCK RETAINING WALL UNITS

A. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor.

B. Modular blocks shall be large blocks (Redi-Rock or equivalent).

C. Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete with a minimum 28-day compressive strength of 4,000 psi

D. Each concrete block shall be cast in a single continuous pour without cold joints.

E. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions and tolerances provided by the block manufacturer.
F. All precast modular block (PMB) units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall.

2.02 GEOGRID REINFORCEMENT

A. Materials for geogrid reinforcement shall be as recommended by the wall manufacturer and installed as required by design.

B. The minimum length of geogrid reinforcement (if used) shall be the greater of the following:

1. 0.7 times the wall design height, H.
2. The length required by design to meet internal and external stability requirements, soil bearing pressure requirements and constructability requirements.

2.03 DRAINAGE AGGREGATE AND WALL INFILL

A. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall consist of free-draining, all-weather, coarse-grained materials that is placed behind the segmental block units as specified on the Drawings. The drainage fill gradation shall be as follows as determined by ASTM D422:

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<tr>
<td>No. 200 (0.075 mm)</td>
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2.04 REINFORCED FILL

A. Material used as reinforced backfill material in the reinforced zone (if applicable) shall be a granular fill meeting requirements in Section 31 23 23, Fill and Backfill. Material strength properties shall meet minimum values provided on the Drawings.

2.05 LEVELING PAD

A. Base leveling pad material shall consist of compacted crushed surfacing base course minimum of 12 inches thick. Base course rock shall be in accordance with Section 31 23 23, Fill and Backfill.
2.06 DRAINAGE

A. Drainage Pipe: Drainage collection pipe shall be a 4-inch diameter, perforated HDPE pipe. The drainage collection (underdrain) pipe shall be placed as shown or directed on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer’s requirements.

B. The Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The Contractor shall coordinate the work of subcontractors affected by this requirement.

C. The Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project.

3.02 PREPARATION

A. Excavation:

1. The Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the Drawings. The Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Contractor.

2. Over-excavated soil shall be replaced in accordance with Section 312316, Excavation.

3. Start excavation at lowest wall level. If wall steps up in one block height, the base block should be installed at the lowest level in order to establish grade and face location of the second level.

4. Overexcavated or filled areas shall be well compacted and inspected and approved by a qualified Geotechnical Engineer.

B. Foundation Preparation:

1. The Contractor shall ensure that the excavation limits are consistent with the Shop Drawings and that all soil fill material is properly compacted according to project specifications.

2. A qualified Geotechnical Engineer shall inspect and approve the reinforced zone and leveling pad foundation soil subgrade in order to confirm adequate bearing capacity. The Geotechnical Engineer may recommend additional testing of the foundation, depending on the nature of the material exposed at the subgrade during excavation.
Subgrade soil areas not meeting required bearing strength shall be marked in the field and the Contractor shall remove and replace these areas with approved fill materials.

3. Foundation subgrade soils and any backfill materials shall be compacted to a minimum of 95 percent modified proctor maximum dry density and at moisture content within 2 percent of optimum, in accordance with ASTM D1557.

C. Leveling Pad:

1. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units.
2. Crushed Stone Leveling Pad: Crushed stone shall be placed in uniform maximum lifts of 6 inches. The crushed stone shall be compacted a minimum of 95 percent modified proctor maximum dry density and at moisture content within 2 percent of optimum, in accordance with ASTM D1557.

3.03 PRECAST MODULAR BLOCK WALL SYSTEM INSTALLATION

A. The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer’s recommendations and these specifications, these Specifications shall prevail.

B. Drainage Components: Pipe, geotextile and drainage aggregate shall be installed as shown on the Shop Drawings.

C. Precast Modular Block Installation:

1. The first course of block units shall be placed with the front face edges tightly abutted together on adjacent blocks, on the prepared leveling pad at the locations and elevations shown on the Drawings. The Contractor shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the Drawings.
2. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the V-shaped joints between adjacent blocks to prevent migration of drainage aggregate and backfill through the vertical joint at the face of the wall. Drainage aggregate shall be placed in the V-shaped joints between adjacent blocks, and extend to a minimum distance of 12 inches behind the block unit.
3. Drainage aggregate shall be placed in 8-inch maximum lifts and compacted by a minimum of three passes of a vibratory plate compactor.
4. The drainage collection pipe (minimum 4-inch diameter) shall be placed immediately behind the wall at the bottom of the wall with a minimum of 1.5 percent gradient to maintain a positive gravity flow as shown or directed on the Drawings.

5. Unit core fill shall be placed in the precast modular block unit vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.

6. Base course blocks for gravity wall designs (without geosynthetic soil reinforcement) may be furnished without vertical core slots. If so, disregard Item 4 above, for the base course blocks in this application.

7. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90-degree corner units, the upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.

8. The elevation of retained soil fill shall not be less than one block course (18 inches) below the elevation of the retained backfill throughout the construction of the retaining wall.

D. Geogrid Reinforcement Installation (if required):

1. Geogrid reinforcement shall be installed at the locations and elevations shown on Drawings on level fill compacted to the requirements of this Specification.

2. Geogrid reinforcement shall be placed between rows of blocks as specified by the wall designer and extended to the embedment length shown on the Plans. The strips shall be staked or anchored as necessary to maintain a taut condition.

3. The geogrid strip shall be continuous throughout its entire length and may not be spliced. The geogrid shall be furnished in nominal, prefabricated roll widths. No field modification of the geogrid roll width shall be permitted.

4. Neither rubber tire nor track vehicles may operate directly on the geogrid. Construction vehicle traffic in the reinforced zone shall be limited to speeds of less than 5 mph once a minimum of 8 inches of compacted fill has been placed over the geogrid reinforcement. Sudden braking and turning of construction vehicles in the reinforced zone shall be avoided.
E. Construction tolerance should follow manufacturer’s recommendations, but wall batter tolerance should not exceed 1/8-inch per foot maximum.

3.04 WALL INFILL AND REINFORCED BACKFILL PLACEMENT

A. Backfill material placed immediately behind the drainage aggregate shall be compacted to 90 percent of maximum dry density at plus or minus 2 percent optimum moisture content per ASTM D1557 modified proctor. Compactive effort within 5 feet of the back of the precast modular blocks should be accomplished with walk-behind compactors.

B. Outside of the 5 feet zone behind the wall, the retained backfill material shall be compacted to a minimum of 95 percent modified proctor dry density in accordance with ASTM D1557.

C. Backfill material shall be installed in lifts that do not exceed a compacted thickness of 8 inches.

D. The Contractor shall protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill or wall infill.

E. The toe of the wall should be filled and compacted as the wall is being constructed.

F. The fill areas shall be graded or protected to drain surface water run-off away from the wall face.

3.05 OBSTRUCTIONS IN THE INFILL AND REINFORCED FILL ZONE

A. The Contractor shall make all required allowances for obstructions behind and through the wall face in accordance with the approved Shop Drawings.

B. Should unplanned obstructions become apparent for which the approved Shop Drawings do not account, the affected portion of the wall shall not be constructed until the Retaining Wall Design Engineer can appropriately address the required procedures for construction of the wall section in question.

END OF SECTION
High-Density Polyethylene (HDPE) Pressure Pipe and Fittings

## Revision History:

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<th>Description</th>
<th>Date</th>
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<td>Issue for Construction</td>
<td>June 21, 2017</td>
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## Document Review & Approval:

### Originate:

Steven R. Polson, P.E./Lead Process Mechanical

**NAME/POSITION**: Steve Polson

**SIGNATURE**: Digitally signed by Steve Polson

**DATE**: 6/20/17

### Design Verification Complete:

Qingshan Wang, P.E./Process Mechanical QC Reviewer

**NAME/POSITION**: Qingshan Wang

**SIGNATURE**: Digitally signed by Qingshan Wang

**DATE**: 6/20/17

### Approved:

W. Laird Ellis, Jr. PE/Design Manager

**NAME/POSITION**: W. Laird Ellis, Jr.

**SIGNATURE**: Digitally signed by W. Laird Ellis, Jr.

**DATE**: 2017.06.21 12:35:19 -06'00'
PART 1  GENERAL

1.01  REFERENCES

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

1. American Society of Mechanical Engineer’s (ASME):
   b. B18.2.2, Square and Hex Nuts (Inch Series).

2. American Water Works Association (AWWA):
   a. C906, Polyethylene (PE) Pressure Piping and Fittings, 4 in. through 63 in., for Water Distribution and Transmission.

3. American Society of Mechanical Engineers (ASME):

4. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   k. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

5. Plastics Pipe Institute (PPI):
   a. Handbook of Polyethylene Pipe.
   b. Technical Note 38, Bolt Torque for Polyethylene Flanged Joints.
c. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Catalog information confirming pipe, fittings, and other materials conform to requirements of this section.
   b. Drawings of specific connection details.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Infrared temperature gun product data.
3. Certificates of qualification for persons to be fusing HDPE pipe.
4. Testing Plan: Submit at least 15 days prior to testing and include the following as a minimum:
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
   e. Calculation of maximum allowable leakage for piping section(s) to be tested.
   f. Method of water and flush debris disposal.
5. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
6. Test report documentation.
7. Electrofusion Attached Thrust and Flex Restraint Devices: Provide detailed procedures and engineering calculations to demonstrate shear strength equal to or greater than the tensile strength of adjacent pipe.
8. Certify that the electrofusion process does not result in derating of the pipe to which thrust restraint device is attached.
10. Fusion parameters including recommended limits of criteria recorded by data logger.
11. Fusion report for each joint, including information listed under Article Field Quality Control.
1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Pipe Manufacturer: Listed with Plastic Pipe Institute as meeting recipe and mixing requirements of resin manufacturer for resin used to manufacture pipe for this Project.
   2. Persons fusing HDPE pipe shall be certified under ASTM F2620 or ASME B31.3.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Do not cut, kink, or otherwise damage pipe during transportation.

B. Storage:
   1. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.
   2. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
   3. Keep pipe shaded from direct sunlight prior to installation in trench.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pipe and fittings specified in this section shall be products of:
   1. JM Eagle.
   2. Performance Pipe.
   3. ISCO Industries.

2.02 MATERIALS

A. Pipe and Fittings:
   1. Conform to requirements of AWWA C906 and/or ASTM F714.
   2. Resin:
      a. Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 4710 material with cell classification of 445474C, or better. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F.
   4. Outside Diameter Basis: IPS for sizes up to 3 inches, and DIPS for sizes greater than 3 inches..
5. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.

6. Fittings:
   a. Sizes 6 Inches and Smaller: Molded and fabricated from polyethylene pipe.
   b. Sizes 8 Inches and Larger: Use thermal butt-fusion.
   c. Polyethylene fittings shall have same or higher pressure rating as pipe.

B. Backup Rings:
   1. Convoluted for Flanged Connections:
      a. ASTM A240/A240M, Type 316 stainless steel.
      b. Complete with one-piece, molded polyethylene flange adapters.
      c. Flanged Connections: Same or greater pressure rating as pipe.

C. Gaskets: Material, size, and thickness shall be as recommended by pipe or flange manufacturer, and in accordance with PPI Technical Note 38.

D. Joints: Thermal butt-fusion or electrofusion, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly.

E. Bolts, Nuts, Washers:
   1. Type 316 stainless steel, ASTM A193/A193M, Grade B8 hex head bolts; and ASTM A194/A194M, Grade 8 hex head nuts.
   2. Bolts: Fabricated in accordance with ASME B18.2.2 and provided with washers of same material as bolts.

F. Wall Anchor:
   1. Material: Same as HDPE pipe.
   2. Internal Diameter: Equal to adjacent pipe.
   3. Shear Strength: Equal to or greater than tensile strength of adjacent pipe.
   4. Fabrication: Butt fusion. Extrusion bead welding is not allowed.

G. Electrofusion Flex Restraint:
   1. Material: HDPE.
   3. Designed for restraining movement of HDPE pipe.
   4. Manufacturers:
      a. Central Plastics Company.
      b. ISCO Industries.
H. Products that restrain HDPE pipe with wedges, machined serrations, or clamps are not acceptable.

I. Electrofusion Transition Saddles:

1. Saddles: Designed and manufactured in accordance with ASTM F1055 for use with pipe conforming to ASTM 02513, D3035, and F714. Installed by electrofusion strictly in accordance with the manufacturer's written instructions and procedures with no negative impact to the integrity or pressure rating of the adjoining pipe.
2. Tested in accordance with AWWA C906.
3. Produced from PE3408 grade polyethylene meeting the requirements of ASTM 3350.
4. Outlet Material: Type 316 stainless steel.
5. Compression Ring Material: Type 304 stainless steel.
6. Pressure Rating: 160 psi at 73 degrees F.
7. Manufacturer: Central Plastics, or equal.

2.03 SERVICE CONDITIONS

A. Degritted Stormwater:

1. Temperature Range: 12 to 30 degrees C.


PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, ASME B31.3, and pipe manufacturer’s recommendations.
2. Joining: Butt-fuse pipes and fittings in accordance with pipe manufacturer’s recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavation.
3. Remove and extract internal fusion bead from pipe.
   a. Verify complete internal fusion bead removal was performed. Accomplish by examination of extracted internal fusion bead or by means of closed circuit television (CCTV) examination.
   b. Extracted Internal Fusion Bead:
      1) Appearance shall have same double roll back semblance as does the external fusion bead.
2) Possess smooth root cut, or pipe smoothness and shall be verified by means of closed circuit television (CCTV) examination.

c. Removal of internal bead may include pipe wall mass. However, wall mass that is removed shall not exceed 1/10th of pipe wall thickness.

4. If HDPE pipe surface temperature is above 90 degrees F as measured with infrared temperature gun, allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.

5. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:
   a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange “stub ends” are not allowed.
   b. Convoluted backing flange, as specified.
   c. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer’s standard.
   d. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torqueing.

6. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

7. Minimum Long-Term Field Bending Radius: Restricted to limits recommended by AWWA M55, Table 8-2.

3.02 FIELD QUALITY CONTROL

A. Joint Fusion:

1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine, and shall be capable of being retrieved electronically. Data to be logged shall include the following:
   a. Pipe size and dimensions.
   c. Operator identification.
   d. Job identification number.
   e. Weld number.
   f. Fusion, heating, and drag pressure settings.
   g. Heater plate temperature.
   h. Time stamp showing when weld was performed.
   i. Heating and curing time of weld.
   j. Curing temperature readings and time stamps of readings.
   k. Error messages and warnings for out of range temperature or pressure settings.
2. In addition to logged items above, the following shall be logged or annotated on report:
   a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.
   b. Ambient temperature and humidity.
   c. If internal bead was removed.

B. Joint Weld Testing:

2. Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with Work.
3. Test Frequency:
   a. First 1,000 Linear Feet: Two joints selected at random by Engineer.
   b. Each Additional 1500 Linear Feet: One joint selected at random by Engineer.
   c. Each Test Failure: Two additional joints selected at random by Engineer.

C. Pipeline Hydrostatic Test:

1. General:
   a. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.
   b. Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements of initial service leak and allowable make-up water volume under specified conditions.
   c. Test newly installed pipelines.
   d. Isolate new pipelines that are connected to existing pipelines.
   e. Using water as test medium, pipes shall successfully pass a hydrostatic test prior to acceptance.
   f. Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Engineer, be done prior to placement of asphaltic concrete or roadway structural section.
   g. Contractor may, if field conditions permit and as determined by Engineer, partially backfill trench and leave joints open for inspection and conduct initial service leak test. Final field hydrostatic test shall not be conducted until backfilling has been completed as specified above.
   h. Supply of temporary water shall be as stated in Section 01 50 00, Temporary Facilities and Controls.
   i. Dispose of water used in testing in accordance with federal, state, and local requirements.
2. Preparation:
   a. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
   b. Wait 5 days minimum after concrete thrust blocking or designed thrust collars are installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
   c. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
   d. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Engineer.

3. Procedure:
   a. Test pressure shall be 150 percent of system operating pressure based on pressure as measured at lowest point in pipeline.
   b. Test 5.
   c. Maximum filling velocity shall not exceed 0.25 feet per second, calculated based on full area of the pipe.
   d. Expel air from pipe system during filling.
   e. Test procedure shall be in accordance with ASTM F2164.
      1) Initial Expansion Phase: Add water as required to maintain test pressure for 4 hours.
      2) Test Phase: Reduce pressure by 10 psi and start pressure test.
      3) Test is successful if pressure stays within 5 percent of initial value for 1 hour.
   f. If test is not completed because of leakage, equipment failure, or other reasons, depressurize test section and allow it to relax for at least 8 hours before retesting.
   g. If there is leakage, repair defective pipe section and repeat hydrostatic test.

3.03 MANUFACTURER’S SERVICES

A. Provide pipe manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, for assistance during pipe joining operations and pipe installation.

END OF SECTION
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

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.

2. 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. 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. Method of disposal for highly chlorinated disinfecting water.
7. Independent Testing Agency: Certification that testing agency is qualified to perform chlorine concentration testing and bacteriological testing in accordance with AWWA standards, agency requirements, and this Specification.
8. Certified Bacteriological Test Results:
   a. Facility tested is free from coliform bacteria contamination.
   b. Forward results directly to Owner.
1.03 QUALITY ASSURANCE

A. Independent Testing Agency: Certified in the State of Tennessee, with 10 years’ experience in field of water sampling and testing. Agency shall use calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

1.04 SEQUENCING

A. Commence disinfection after completion of following:

1. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, and equipment.
2. Disinfection of:
   a. All plumbing piping and equipment in contact with potable water (termed “Sanitary Water” by the Owner).
   b. All fire water piping connected to potable water upstream of backflow preventer.

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.

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.

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 an independent testing laboratory.

C. Chlorine Concentration Sampling and Analysis:
   2. Collect Samples in accordance with applicable AWWA Standard.
   3. Analyze Samples for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.

D. Turbidity Sampling and Analysis:
   1. After pipelines have been cleaned, disinfected, and refilled with potable water, Contractor’s independent laboratory shall 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.

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

END OF SECTION
Welded Stainless Steel Tanks
EQUIPMENT AND COMPONENT NUMBERS

941002-CHEM-T-531  93% Sulfuric Acid Tank

PART 1  GENERAL

1.01 REFERENCES

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

2. American Society of Mechanical Engineers (ASME):
   d. BPVC SEC VIII, Division 1, Rules for Construction of Pressure Vessels.
   e. BPVC SEC IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
5. American Society of Safety Engineers (ASSE): Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components.
6. ASTM International (ASTM):
   b. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials 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 of High-Temperature Service, or Both.
   e. A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.
7. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   e. D18.2, Guide to Weld Discoloration Levels.
   f. QC 1, Standard for AWS Certification of Welding Inspectors.


9. National Association of Corrosion Engineers (NACE):
   a. NACE Standard RP0391, Materials for the Handling and Storage of Commercial Concentrated (90 to 100%) Sulfuric Acid at Ambient Temperatures.
   b. NACE SP0294, Design, Fabrication, and Inspection of Storage Tank Systems for Concentrated Fresh and Process Sulfuric Acid and Oleum at Ambient Temperatures.


1.02 WORK OF THIS SECTION

A. The Work of this section includes providing one welded stainless steel sulfuric acid storage tank and all appurtenant work.

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.

1.03 SUBMITTALS

A. All submittal information shall be provided in English.

B. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of the Statement of Work.

C. Shop Drawings and Samples: Provide shop drawings in conformance with the requirements of the Statement of Work.

D. In addition to the requirements of the Statement of Work, submit the following additional detailed shop drawing information:

1. Calculations of steel tank sealed by a professional engineer, registered in the State of Tennessee.
2. Shop drawings in accordance with Section 05 05 23, Welding.
3. Complete specifications, dimensional drawings, and descriptive literature on the tanks and their accessories to be furnished, including:
   b. Shell height and plate thickness.
   c. Type and thickness of roof.
   d. Type and thickness of the bottom plates.
   e. Location of all circumferential and longitudinal welded joints.
   f. Dimension, location, and details of all nozzles, and accessories such as manways. Identify all tank nozzles with the identification mark shown on the Tank Data Sheets.
   g. Tank data indicating equipment number, pressure rating, and details of nozzle designs.
4. Manufacturer’s literature and catalog data of components.
5. Tank designer’s detailed requirements for tank anchorage.

E. Quality Control Submittals: Conform to the requirements of the Statement of Work and Section 05 05 23, Welding.

F. Operation and Maintenance Manual and Maintenance Summary: Provide an Operation and Maintenance Manual and Maintenance Summary in conformance with the requirements of Section 01 78 23, Operation and Maintenance Data.

1.04 GUARANTEE

A. The Supplier shall guarantee the materials and workmanship of the tank and its appurtenances for a period of 24 months from date of installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Where a manufacturer’s standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features, and materials of construction as specified herein.

B. Materials, equipment, components and accessories specified in this section shall be products of:

1. Fisher Tank.
2. Landmark Structures.
3. Associated Tank Constructors, Inc.
4. Approved equal.
2.02 DESIGN CONDITIONS

A. Liquid: 93 percent sulfuric acid.

B. Specific Gravity: 1.84 at 60 degrees F.

C. Design Pressure: 0.50 psig positive pressure and 0.15 psig vacuum.

D. Design Temperature: Refer to Section 01 61 00, Common Product Requirements.

E. Location: Outdoors under roof structure.

F. Design for wind and seismic loads in accordance with the latest edition of the International Building Code (IBC) by the International Code Council. Refer to Section 01 61 00, Common Product Requirements. Also see Section 01 88 15, Anchorage and Bracing.

2.03 GENERAL REQUIREMENTS

A. See Section 01 61 00, Common Product Requirements, for specific requirements related to the equipment specified herein.

B. Materials:

1. Tank Plates: ASTM A240, Type 316L stainless steel. Shaped and bent in the shop to exact radius required.

2. Bolts, Anchor Bolts, and Hex Nuts: Type 316 stainless steel.

3. Minimum Thickness of Plate for Floor, Shell, and Roof: 3/16 inch.

4. Metal Design and Fabrication: In accordance with applicable AISC codes of standard practice. Plates and shapes shall be sheared, sawn, or machined true to dimensions shown. Joining of parts shall be by welding. Grind exposed and rough edges to a smooth, uniform radius.

C. Design:

1. Tanks: Designed, fabricated, and inspected in accordance with current API 650 standard requirements, except as modified by NACE SP0294, and these Specifications.

2. Constructed with continuous complete joint penetration groove welds, inside and out. The vessel shall be completely shop welded with no field welding permitted. The tank shall be fabricated from a minimum number of pieces. All longitudinal shell seams shall be staggered. Shell seams shall be located to clear all nozzle openings.

3. Dimensions, capacities, nozzle locations, and design information for the tank to be provided are described on the attached Tank Data Sheets.
4. The Contractor shall be responsible for the design of the welded steel tanks, based on these Specifications, the associated Tank Data Sheets, and Section 01 61 00, Common Product Requirements.

5. Welded joints shall be inspected using radiographic testing wherever possible. Joints which cannot be radiographically tested shall be 100 percent ultrasonically examined.

6. Welds shall be cleaned and passivated in accordance with ASTM A380 after all other work in the area of installation is complete. A second cleaning and passivating treatment may be required by the Buyer’s Technical Representative (BTR) if contamination occurs during installation.

D. Nozzles:

1. Unless specified otherwise, shell side nozzle centerlines shall intersect and be perpendicular to the tank axial centerline. Centerlines of nozzles in ends of tanks shall be parallel to the tank axial centerline.

2. Nozzle flanges shall be ASME B16.5 Class 150, raised-face, weld neck style unless noted otherwise. Where specified, ring flanges with a full fillet weld at the junction of the flange face and the edge of the nipple may be used. Grind smooth to a 1/8-inch minimum radius.

3. Unless specified otherwise, flanged nozzle projection shall be 6 inches (nozzle face to nearest outside tank surface). Flange bolt holes shall symmetrically straddle the tank centerlines.

4. Gasket surfaces shall be flat and parallel within 1/16 inch from the tank centerline over the flange width.

2.04 ACCESSORIES

A. Side Manways: As shown on the attached Tank Data Sheets. Minimum clear opening of 30 inches unless otherwise noted. Furnish flanged and bolted type cover with confined gasket. Hinge cover to tank shell. Grind welds and sheared edges smooth. Type 316 stainless steel bolts and nuts.

B. Conservation Vent (CHEM-CARV-531):

1. Size: 8 inches.
2. Pressure Setting: 3.5 ounces per square inch.
3. Vacuum Setting: 2.0 ounces per square inch.
5. Material: PVC base and cover with FEP film covered Type 316 pallets. All elastomers shall be Viton.
6. Manufacturer and Product: Protectoseal; Model PVC8546B.

C. Gaskets: Two sets (one spare) of 1/8-inch thick full-face gaskets for all flanged nozzles and manways. Gasket material shall be Viton.
D. Equipment Identification Plates: 16-gauge Type 316 stainless steel identification plates shall be securely mounted on each tank in a readily visible location with stainless steel screws or drive pins. Nameplates shall contain the manufacturer’s name, model, serial number, size, and characteristics. Tank nameplates shall include the information required by API 650, including, but not limited to:

1. Equipment tag number.
2. Name of tank manufacturer.
3. Tank capacity.
5. Date of manufacturer.

E. Lifting Lugs: Provide for all tanks. Quantity and location as recommended by tank manufacturer.

2.05 TESTING

A. After fabrication, hydrostatic pressure test the tank with water containing 1 ppm of free chlorine (to prevent microbial induced corrosion).

B. Fill tank with water and pressurize to 0.2 psig. Pressure shall be held for 1 hour without loss of pressure or sign of leaks.

2.06 SOURCE QUALITY CONTROL

A. CWI shall be present whenever welding is performed. CWI shall perform inspection at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI duties include:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fit-up and in-process inspection.
5. Providing 100 percent visual inspection of welds.
6. Supervising nondestructive testing personnel and evaluating test results.
7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

B. Welding inspection is part of the Contractor’s Quality Control and is a separate function from Fabrication. The CWI cannot also be a production welder on the project.

C. Weld NDT:

1. 100 percent VT by CWI of all welds for acceptance in accordance with AWS D1.6, Section 6.28 for Statically Loaded Nontubular Connections,
unless more stringent NDT is required in this specification section. Heat
tint shall not exceed Level 3 per AWS D18.2.

2. Shell:
   a. Butt Joint Groove Welds: Random 10 percent RT examine, unless
      more frequent RT examination is required by API 650 for tank
      service class.
         1) Comply with AWS D1.6, Section 6, Part B and AWS D1.6,
            Section 6.28.
   b. Openings:
      1) Groove Welds: 100 percent UT per AWS D1.6, Part C and
         AWS D1.6, Section 6.28.
      2) Fillet Welds: 100 percent PT per AWS D1.6, Sections 6.7.6
         and 6.28 for Statically Loaded Nontubular Connections.

3. Floor Opening Welds: 100 percent examine using NDT methods
   specified for shell opening welds.

4. Anchor Bolt Attachment Welds:
   a. 100 percent NDT of all welds that support first three consecutive
      anchor bolts at tank base as follows:
      1) Fillet Welds: PT per AWS D1.6, Sections 6.7.6 and 6.28 for
         Statically Loaded Nontubular Connections.
      2) Groove Welds: UT per AWS D1.6, Part C and AWS D1.6,
         Section 6.28.
   b. If rejection rate exceeds 5 percent, 100 percent examine next three
      anchor bolt supports using same testing procedures and
      acceptance criteria.
   c. If rejection rate is less than 5 percent, testing rate may be reduced
      to 20 percent of welded connections.
   d. Engineer will determine welds to be tested.

5. Accessories and Attachments: PT at 10 percent rate per AWS D1.6 for
   Statically Loaded Nontubular Connections.

D. Visual Inspection: Perform visual inspection. Acceptance standards in
   accordance with ANSI/AWS D1.6, Paragraph 6.2 and additional
   nondestructive testing requirements as specified herein and Section 05 05 23,
   Welding.

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 MANUFACTURER’S FIELD SERVICES

A. Provide manufacturer’s representative at site for 1 person-day in accordance with Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan, for installation assistance, inspection, testing, and certification of proper installation.

3.03 SUPPLEMENTS

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

1. Tank Data Sheet 941002-CHEM-T-531.

END OF SECTION
**GENERAL INFORMATION**

- **Service:** 93% SULFURIC ACID (SPECIFIC GRAVITY = 1.84)
- **Capacity:** 5,580 GALLONS
- **Design code:** API 650/ASME SP-354
- **Thickness:**
  - **Roof:** FLAT
  - **Shell:** VERTICAL CYLINDRICAL
  - **Bottom:** FLAT
- **Material:** STAINLESS STEEL
- **Temperature:** -20° TO 120°F

**NOZZLE SCHEDULE**

<table>
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<tr>
<th>MK</th>
<th>Size</th>
<th>Type</th>
<th>Service</th>
<th>Projection</th>
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<tr>
<td>N1</td>
<td>2&quot;</td>
<td>FLG</td>
<td>DISCHARGE</td>
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<td>N2</td>
<td>3&quot;</td>
<td>FLG</td>
<td>DRAIN/PUMP OUT</td>
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<td>N3</td>
<td>4&quot; / 2&quot;</td>
<td>FLG</td>
<td>INLET/FILL WITH 2&quot; DIP TUBE</td>
<td>6&quot;</td>
<td>2'-5&quot;</td>
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<tr>
<td>N4</td>
<td>8&quot;</td>
<td>FLG</td>
<td>VENT (FLAT FACED FLANGE)</td>
<td>6&quot;</td>
<td>2'-5&quot;</td>
</tr>
<tr>
<td>N5</td>
<td>4&quot;</td>
<td>FLG</td>
<td>SPARE</td>
<td>6&quot;</td>
<td></td>
</tr>
<tr>
<td>N6</td>
<td>4&quot;</td>
<td>FLG</td>
<td>LEVEL TRANSMITTER</td>
<td>6&quot;</td>
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<tr>
<td>N7</td>
<td>4&quot;</td>
<td>FLG</td>
<td>OVERFLOW</td>
<td>6&quot;</td>
<td></td>
</tr>
<tr>
<td>N8</td>
<td>8&quot;</td>
<td>FLG</td>
<td>VENT (FLAT FACED FLANGE)</td>
<td>6&quot;</td>
<td>2'-5&quot;</td>
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<tr>
<td>N9</td>
<td>30&quot;</td>
<td>FLG</td>
<td>MANWAY</td>
<td>6&quot;</td>
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**ACCESSORIES**

- **X** HANDRAILS WITH SELF-CLOSING GATE AND TOE BOARDS
- **X** WALKABLE TOP
- **X** ANCHOR LUGS
- **X** DIP TUBE
- **X** WEAR PLATE
- **X** BLIND FLANGES: PROVIDE BLIND FLANGES WITH BOLTING FOR ALL SPARE NOZZLES

**NOTES:**

1. HANDRAIL OPENING WIDTH TO MATCH WALKWAY OPENING WIDTH.
2. PROVIDE 2" DIP TUBE ASSEMBLY CONSISTING OF 4" TANK FLANGE AND 2" PIPE FLANGE. PROVIDE 1/2" ANTI-SYPHON HOLE AT TOP OF DIP TUBE ABOVE OVERFLOW CONNECTION.
3. PROVIDE 12" x 12" x 1/2" ALLOY 20 WEAR PLATE SEAL WELDED TO BOTTOM OF TANK CENTERED UNDER DIP TUBE.
Welded Steel Tank

**Revision History:**

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<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
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<td>June 16, 2017</td>
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**Document Review & Approval:**

**Originator:**

Steven R. Polson, P.E./Lead Process Mechanical

**Design Verification Complete:**

Qingshan Wang, P.E./Process Mechanical QC Reviewer

**Approved:**

W. Laird Ellis, Jr. PE/Design Manager
PART 1            GENERAL

1.01 REFERENCES

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

      3. American Society of Mechanical Engineers (ASME):
         c. BPVC SEC VIII, Division 1, Rules for Construction of Pressure Vessels.
         d. BPVC SEC IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
      6. American Society of Safety Engineers (ASSE): Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components.
      7. ASTM International (ASTM):
         f. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
         g. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure of High-Temperature Service, or Both.

i. A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.


8. American Water Works Association (AWWA):
   a. C207, Steel Pipe Flanges for Waterworks Service—Sizes 4 Inch through 144 Inch (100 mm through 3,600 mm).
   b. C228, Stainless-Steel Pipe Flanges for Water Service—Sizes 2 In. through 72 In. (50 mm through 1,800 mm).
   c. D100, Welded Steel Tanks for Water Storage.

   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   d. QC 1, Standard for AWS Certification of Welding Inspectors.


11. National Association of Corrosion Engineers (NACE): SP0178, Fabrication Details, Surface Finish Requirements, and Proper Design Consideration for Tanks and Vessels to be Lined for Immersion Service.


13. 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. BCL: Bottom capacity level is elevation above which the required capacity is provided.

B. CJP: Complete Joint Penetration.

C. CWI: Certified Welding Inspector.

D. Freeboard: Vertical distance from bottom of roof purlin at wall and TCL.

E. MT: Magnetic Particle Testing.
F. NDT: Nondestructive Testing.
G. PJP: Partial Joint Penetration.
H. PQR: Procedure Qualification Record.
I. PT: Liquid Penetrant Testing.
J. RT: Radiographic Testing.
K. TCL: Top capacity level is elevation of the lip of the overflow.
L. UT: Ultrasonic Testing.
N. WPQ: Welder Performance Qualification.

1.03 SYSTEM DESCRIPTION

A. Steel Tank System:

1. Welded steel tanks and accessories as specified herein for the following tanks.
   b. Equalization Tank (941002-CHTR-T-400).
2. Piping: As specified in Section 40 27 00.03, Carbon Steel Pipe and Fittings, General Service.
3. Cathodic protection per Section 26 42 03, Cathodic Protection System—Water Storage Tanks.
4. Internal lining and external coating system per Section 09 97 13, Steel Tank Coatings.

1.04 DESIGN REQUIREMENTS

A. Design, as specified herein, welded steel tanks and associated accessories.

B. Design of anchor chairs shall consider clearances needed for hydraulic bolt tensioner.

C. Tank Dimensions:

1. Storm Water Storage Tank (941001-HDWK-T-250):
   a. Storage Capacity: 2,000,000 U.S. gallons.
   b. Elevation(s): As shown on Drawings.
2. Equalization Tank (941002-CHTR-T-400):
   a. Storage Capacity: 500,000 U.S. gallons.
   b. Dimensions and Elevation(s): As shown on Drawings.

D. Design Loads:

1. In accordance with Section 01 61 00, Common Product Requirements.
2. Horizontal Wind Velocity and Loads: For overall stability and anchorage of tanks, calculate wind pressures in accordance with ASCE 7, AWWA D100, and state specialty codes that govern.
3. Wind Girders and Intermediate Stiffeners: In accordance with AWWA D100, Section 3.5.
4. Seismic Design Loads and Factors:
   a. Risk Category III.
   b. Seismic Design Category C.
   c. Site Class D.
   d. Seismic Importance Factor $I_E = 1.25$.
   e. $S = 0.375$, $S_I = 0.121$.
   f. $S_{DS} = 0.375$ g, $S_{D1} = 0.187$ g.
   g. Use General Design Procedure AWWA D100, Section 13.2.9.2.
   h. $R_I = 3.0$, $R_c = 1.5$.
   i. Freeboard = 2.0 feet.
   j. Use AWWA D100 Chapter 14 for design steel stresses.
5. Hydrodynamic Seismic Hoop Stress of Each Shell Course:
   a. Compute using AWWA D100, Section 13.5.4.2.3.
   b. Hydrodynamic Seismic Hoop Tensile Stress: Add to hydrostatic hoop tensile stress in determining total stress.
   c. Allowable Stress: Not to exceed maximum tensile stress set forth in AWWA D100 multiplied by 1.33 factor.
6. Vertical Buckling Stress:
   a. Compute maximum longitudinal shell compression stresses using AWWA D100, Section 13.5.4.2.1.
   b. Calculate tank shell section modulus and determine compressive bending stress for each shell course using computed overturning moments. Add tank dead load shell stress to compressive bending stress for each shell course.
   c. Allowable Stress: Not to exceed maximum local buckling stress set forth in AWWA D100, Table 10 or Table 11 multiplied by 1.33 factor.
7. Effective Stress:
   a. Calculate effective stress by combining total hydrodynamic plus static hoop tension stress with vertical compression stress using Von Mises Theory for two-dimensional stress. Assume tension stress is algebraically positive and compression stress is negative.
   b. Allowable Stress: Not to exceed maximum tensile stress set forth in AWWA D100 multiplied by 1.33 factor.
8. Other Loads: Painters’ trolley ring, 400-pound concentrated load at any point.

E. Welds Joining Tank Shells: CJP butt-joint welds. PJP groove welds not permitted.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop and erection drawings for steel tank system and accessories signed and sealed by Contractor’s tank designer.

2. Tank system, vent and tank accessory calculations signed and sealed by Contractor’s tank designer. All details shall satisfy the minimum requirements, sizes, factors herein specified or shown.

3. Details of anchor bolt assembly including size, material, and placement method. Include brand of hydraulic bolt tensioner and verify adequate clearance to tank shell.

4. Welding Data (Shop and Field):
   a. Show on a weld map, complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tail of welding symbol.
   b. Clearly distinguish between shop and field welds.
   c. Welding and NDE Symbols: In accordance with AWS A2.4.
   d. Welding Terms and Definitions: In accordance with AWS A3.0.
   e. Submit welding data together with Shop Drawings as a complete package.

5. Notch Tough WPSs:
   a. Notch-tough welding shall be required for welding of tank shells and annular rings per AWWA D100, Chapter 14.
   b. Qualify WPSs for Supplementary Essential Variables in addition to essential variables as indicated in ASME Section IX, QW-251.2. Provide heat-input table on WPSs for welder guidance.
   c. PQRs for notch-tough welding shall document heat-input control by monitoring volts, amps, and travel speed or time-rate of change of weld metal volume as calculated by measuring change in electrode length over a period of time.
   d. Charpy V-notch tests shall be conducted on weld metal and heat affected zone. Test coupons shall be oriented transverse to final direction of rolling. Full size Charpy specimen test acceptance shall be same as base metal specified herein.
B. Informational Submittals:

1. Manufacturer’s instructions for coating systems.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
3. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.
4. Manufacturer’s Test Reports:
   a. Mill certifications for steel tank plates.
   b. Mill certifications for structural steel.
5. Credentials and Statements of Qualification of Contractor’s Personnel and Subcontractors:
   a. Tank designer.
   b. Tank manufacturer.
   c. Tank installer.
   d. Welder/welder operator.
   e. Weld testing agency.
   f. Welding inspector.
   g. NDT personnel.
   h. Nonshrink grout manufacturer’s representative.
   i. Painting Subcontractor.
6. Welding Documentation:
   a. Shop and field WPSs and supporting PQRs.
   b. NDT procedure specifications.
   c. Shop and field CWI reports.
   d. Shop and field NDT reports.
7. Field Test Results:
   a. Vacuum test for flat bottom floor plate welds.
   b. Hydrostatic test report.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Tank Designer: Registered professional engineer licensed to perform specified Work in the state of the Tennessee.
2. Tank Installer: Certified by Tank Manufacturer as qualified to perform specified Work.
3. Experience requirements for Tank Manufacturer, Tank Designer and Tank Installer shall include five or more steel tanks presently in water service, of similar size and character to specified Work, all in satisfactory operation for minimum of 5 years.
4. Welder/Welding Operator: Qualified by Tank Manufacturer or Contractor in accordance with referenced welding codes.
5. CWI: Certified in accordance with AWS QC 1, and having prior inspection experience with specified welding codes.
6. Nondestructive Testing Personnel: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

7. Nonshrink Grout Manufacturer’s Representative: Authorized and trained representative of grout manufacturer with minimum 3 years’ experience in successful installation on steel tank projects. See additional requirements of Section 03 62 00, Nonshrink Grouting.

8. Painting Subcontractor: Minimum of 5 years’ experience in lining and coating of welded steel tanks for water storage.

B. Welding Documentation:

1. WPSs: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) for shop welding and AWS D1.1 (Annex M Forms) for field welding.

2. WPQs: Qualified by tank fabricator in accordance with ASME BPVC SEC IX (Form QW-484) for shop welding and AWS D1.1 (Annex M Forms) for field welding.

3. CWI certificate(s).

4. NDT personnel certifications.

C. Regulatory Requirements:

1. Tank Accessories: In accordance with applicable safety and building codes, including Code of Federal Regulations, 29 CFR 1910.27 Fixed Ladders, OSHA and IBC.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel:

1. Shell and Floor: ASTM A516, Grade 70.

2. Roof: API STD 650 or AWWA D100.

3. Steel Plate: 1/4-inch minimum thickness.
   a. Floor plate shall include a 1/8-inch corrosion allowance.


2.02 ACCESSORIES

A. Shell Manways:

1. Design in accordance with API STD 650 or ASME BPVC SEC VIII, Division 1.

2. Flanged and bolted type, AWWA C207, Class D, ring type with red rubber, ring type gaskets as indicated in AWWA C207, Table 1.


4. Cover: Blind flange per AWWA C207, Class D. Hinge to tank shell.
5. Bolts and Nuts: In accordance with AWWA C207, galvanized.
6. Nozzles: Minimum 1/2-inch-thick per ASTM A106/A106M, Grade B pipe or fabricated from rolled plate per ASTM A516/A516M, Grade 70.
7. Mixers:
   a. Provide reinforced nozzle and two welded rod clips at each mixer location as shown on Drawings.
   b. Coordinate with mixer manufacturer for locations and alignment requirements.

B. Roof Hatch:

1. Roof hatch shall be sized as shown on the Drawings with hinges, handle, hold-open device, hasp, lock, and weathertight seal.
2. Hatch shall be fabricated of steel, minimum 1/4-inch thick.
3. Hatch Cover: Lap curb minimum 2 inches when closed with weathertight seal.
5. Provide hasp for locking the hatch.
6. Door Hardware:
   a. Hinges: Heavy-duty brass or stainless steel with stainless steel pins through-bolted to cover plate with tamper-proof stainless steel bolts flush with top of cover and to outside leg of channel frame with stainless steel bolts and locknuts.
   b. Lifting Mechanism: Stainless steel compression lift springs enclosed in telescoping vertical housing or stainless steel torsion lift springs.
   c. Hold-Open Arm:
      1) Locks automatically in open position.
      2) Disengages with slight pull on vinyl grip with one hand.
      3) Door can be easily closed with one hand by pulling forward and down on vinyl grip.
   d. Snap Lock: Stainless steel snap lock mounted on bottom of door leaf with removable topside and inside fixed lever handles.
   e. Provide stainless steel safety chain and attachments.
7. Curb: Provide with 6-inch curb, welded to the tank top.
8. Hatch assembly interior and exterior shall be coated same as tank.

C. Pipe Connections:

1. Inlet-outlet and drain connections as shown on Drawings.
2. Standard weight ASTM A53/A53M, Grade B, Type E or Type S, ASTM A106/A106M, Grade B, or as shown on Drawings.
3. Fabricate in accordance with ASME B31.3, Normal Fluid Service category.

D. Reinforcing Plates at Shell Openings: In accordance with API 650, Section 5.7.
E. Overflow:
   1. Pipe: Standard weight, ASTM A53/A53M, Grade B, Type E or S, or ASTM A106/A106M, Grade B, and as shown.
   2. Overflow Weir: Plate: Minimum 1/4-inch thick.
   3. Flanges: AWWA C207, Class D, ring type.

F. Roof Hatch:
   1. 3-foot square with hinges, handle, hold-open device, hasp, lock, and weathertight seal.
   2. Curb: Extend minimum 6 inches above roof plate.
   3. Hatch Cover: Lap curb minimum 2 inches when closed with weathertight seal.

G. Handrails:
   1. 1-1/2-inch diameter, Schedule 40 steel pipe.
   2. Roll roof handrails to radius concentric with reservoir rim.
   3. Cap and weld pipe ends to seal out moisture where platform handrail posts bear on platform grating.

H. Exterior Stairs:
   1. In accordance with ALI A14.3 and 29 CFR 1910.27.
   2. Hot-dip galvanize after fabrication.

I. Rest Platforms and Landings:
   1. Steel Grating: Metal bar type, rectangular, open construction.
   3. Band edges with bars similar to main bearing bars.

J. Roof Vent:
   1. Provide a roof vent, meeting AWWA D100 Standards.
   2. Locate near the center of the tank roof.
   3. Vent shall have sufficient capacity to pass air so that excessive pressure/vacuum will not develop at the maximum design flowrate of water entering or exiting the tank, as identified below.
      a. Storm Water Storage Tank (HDWK-T-250):
         1) Maximum Flow Rate Entering Tank: 40,000 gpm.
         2) Maximum Flow Rate Leaving Tank: 13,000 gpm.
b. Equalization Tank (CHTR-T-400):
   1) Maximum Flow Rate Entering Tank: 5,000 gpm.
   2) Maximum Flow Rate Leaving Tank: 4,000 gpm.
4. Tank vent shall have sufficient capacity to pass air so that excessive pressure/vacuum will not develop in the case of a pipe failure.
5. Tank overflow shall not be considered a tank vent.
6. Vent shall be constructed to prevent the entrance of birds, animals and insects.
7. Vent shall include a pressure-vacuum-screened vent or a separate pressure-vacuum relief mechanism that will operate in the event that the screens frost over or become clogged. The screens or relief mechanism shall not be damaged by the occurrence and shall return automatically to operating position after the blockage is cleared.
8. Tank shall have locking mechanism to prevent unauthorized access to the tank.
9. Vent shall be constructed of corrosion resistant materials.

K. Painters’ Trolley Ring: Minimum 1/4-inch by 4-inch curved plate supported a minimum of 4 inches clear of the tank wall at 4-foot intervals by 1/4-inch thick plate welded to tank shell.

L. Ringwall Grout: In accordance with Section 03 62 00, Nonshrink Grouting.

M. Caulking Manufacturer and Product: Sika; Flex 1A sealant.

N. Anchor Bolts and Nuts: ASTM A193/A193M, Grade B7 with ASTM A194/A194M, Grade 2H heavy hex nuts.

O. Threaded Couplings: Black, forged steel, Class 3000, ASME B16.11.

P. Steel Pipe and Fittings:
   1. ASTM A106/A106M, Grade B, or ASTM A53/A53M, Type E or Type S, Grade B, unless shown or noted otherwise.
      b. Standard weight.
   2. AWWA C207, Class D, ring type, unless otherwise shown.
   3. Gaskets: 1/16-inch or 1/8-inch thick, to match flanges per AWWA C207, Table 1.
   4. Flange Bolt-Ups:
      a. Nonburied: Steel bolts, ASTM A193, Grade B7 with ASTM A194/A194M, Grade 2H nuts, galvanized.
      b. Buried: Stainless steel bolts, ASTM A193/A193M, Grade B8M Type 316 with matching nuts.
   5. As otherwise specified in Section 40 27 00.03, Carbon Steel Pipe and Fittings, General Service.
Q. Cathodic Protection:

1. Provide cathodic protection for interior tank surfaces per Section 26 42 03, Cathodic Protection System—Water Storage Tanks.
2. Penetrations for cathodic protection appurtenances shall be coordinated with cathodic protection contractor.

2.03 CONTROLS

A. In accordance with general control requirements and component qualities specified in Section 40 99 90, Package Control Systems.

B. Lightning protection in accordance with Section 26 41 00, Facility Lightning Protection.

2.04 FABRICATION

A. General:

1. AWWA D100, Section 9 and Section 10.
2. Shell Plate: Shop bent to radius shown.
3. Coatings and Linings: As specified in Section 09 97 13, Steel Tank Coatings.

B. Welding:

2. Roof Columns: Cap welded at both ends.
3. Overflow Pipe: Weld support straps to pipe prior to coating interior of pipe.
4. Ladder Guard: Weld hinges and hasp staple to ladder rails.

C. Finish:

1. Shop prime as specified in Section 09 97 13, Steel Tank Coatings, unless otherwise noted. Field cutting or welding of galvanized parts will not be permitted.
2. For items embedded in concrete, coat as specified in Section 09 90 00, Painting and Coating.
3. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.
4. Prepare galvanized surfaces to be painted in the field approximately 48 hours to 72 hours before painting as specified in Section 09 90 00, Painting and Coating.
2.05 SOURCE QUALITY CONTROL

A. CWI shall be present whenever shop welding is performed. CWI shall perform inspection at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI duties include:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fit-up and in-process inspection.
5. Providing 100 percent visual inspection of welds.
6. Supervising nondestructive testing personnel and evaluating test results.
7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

B. Welding inspection is part of the Contractor’s Quality Control and is a separate function from fabrication. The CWI cannot also be a production welder on the project.

2.06 MANUFACTURERS

A. Landmark Structures.
B. Fisher Tank Company.
C. Associated Tank Constructors, Inc.
D. Chicago Bridge and Iron, Inc.
E. Approved equal.

PART 3 EXECUTION

3.01 SITE GRADING

A. As specified in Section 31 23 16, Excavation.
B. Drilled Foundation Piers: As specified in Section 31 63 29, Drilled Concrete Piers.

3.02 GROUT

A. Center shims below tank shell and fill 6-inch wide by 2-inch minimum space between steel tank baseplate and base slab with non-shrink grout, as specified in Section 03 62 00, Nonshrink Grouting.

3.03 CONCRETE

A. Placement: As specified in Section 03 30 00, Cast-in-Place Concrete.
3.04 TANK ERECTION

A. General:

1. Do not field bend steel plate.
2. Use anchor bolts to anchor tank to concrete foundation.

B. Anchor Bolts:

1. Anchor Bolt Tension: Pretension to 80 percent of design load after non-shrink grout has cured.
2. Pretension bolts using hydraulic bolt tensioner only, do not use a torque wrench.
3. Wrap embedded smooth portion of bolt with bond breaker tape.

C. Welded Joints:

2. Continuously weld columns to baseplates and to roof structural support system.
3. Continuously seal weld roof, exterior, and interior joints above and below elevation of top of shell curb angle to preclude crevice corrosion and rust discoloration.
4. Close ends of steel pipe roof columns with 1/4-inch steel plate and seal weld ends.
5. Roof Vent: Continuously weld joints for watertight installation.

3.05 WELDING

A. General:

1. Perform in accordance with AWWA D100, ASME BPVC, SEC IX, Part QW for shop welding, and AWS D1.1 for field welding, except as modified herein.
2. Perform only in presence of Contractor’s CWI.

B. Roof Plates and Rafters: Continuous, double-fillet welded.

C. Shell:

2. Openings: Groove or fillet welded. Provide post weld heat treatment of CJP butt joint welds in material thicker than 1-1/2 inches.
3. Shell to Annular Ring: Double fillet welded.
D. Floor:
   1. Floor Plates: Fillet-welded.
   2. Openings: Groove or fillet welded.

E. Anchor Bolt Attachments:
   1. Groove or fillet welded.
   2. Provide post-weld heat treatment of all complete penetration groove welds in material 1-1/4 inches or thicker.
   3. Fillet welds 5/16-inch minimum single pass.

F. Accessories and Attachments:
   1. Joints: Seal welded, as minimum.
   2. Steel Piping: Complete joint penetration butt welds.

3.06 WELD DEFECT REPAIR
   A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with weld acceptance indicated herein.

3.07 SAFETY CLIMB DEVICE
   A. Install mandrel in accordance with manufacturer’s instructions to enable the worker to be attached to device at all times during climb without having to remove hands from railing to operate system effectively and able to easily pivot onto and off of rest platforms or landings while safely attached to device.
   B. When installed to any height, fall prevention system shall be extremely rigid and combine to become an integral part of structure.

3.08 FIELD FINISHING
   A. As specified in Section 09 97 13, Steel Tank Coatings.
   B. Corrosion protection for miscellaneous tank appurtenances per Section 09 90 00, Painting and Coating.
   C. Cathodic protection per Section 26 42 03, Cathodic Protection System—Water Storage Tanks.

3.09 FIELD QUALITY CONTROL
   A. CWI shall be present whenever field welding is performed. CWI shall perform inspection at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI duties include:
1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fitup and in-process inspection.
5. Providing 100 percent visual inspection of welds.
6. Supervising nondestructive testing personnel and evaluating test results.
7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

B. Welding inspection is part of the Contractor’s Quality Control and is a separate function from fabrication. The CWI cannot also be a production welder on the project.

C. Weld NDT:

1. 100 percent VT by CWI of all welds for acceptance in accordance with AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections, unless more stringent NDT is required in this specification section.
2. Roof: MT or PT at 10 percent rate per AWS D1.1/D1.1M, Table 6.1 for statically loaded nontubular connections.
3. Shell: Spot RT examine per AWWA D100, Sections 11.5, 11.6, or Chapter 14 as appropriate.
   a. Openings:
      1) Groove Welds: 100 percent UT per BPVC SEC VIII, D1, Paragraph UW-53, and Appendix 12.
      2) Fillet Welds: 100 MT or PT per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.
   b. Connection to Floor: 100 percent MT or PT per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.
4. Floor Opening Welds: 100 percent examine using NDT methods specified for shell opening welds.
5. Anchor Bolt Attachment Welds:
   a. 100 percent NDT of all welds that support first three consecutive anchor bolts at tank base as follows:
      1) Fillet Welds: MT per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.
      2) Groove Welds: UT per ASME BPVC, SEC VIII, D1, UW-53, and Appendix 12.
   b. If rejection rate exceeds 5 percent, 100 percent examine next three anchor bolt supports using same testing procedures and acceptance criteria.
   c. If rejection rate is less than 5 percent, testing rate may be reduced to 20 percent of welded connections.
   d. Engineer will determine welds to be tested.
6. Accessories and Attachments: MT at 10 percent rate per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.

D. Field Tests: In accordance with AWWA D100, Section 11:

1. Vacuum test flat bottom floor plate welds.
2. Hydrostatic test tank after painting is complete.

END OF SECTION
Storm Drain, Sanitary Sewer, and Drainage 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. ASTM International (ASTM):
   e. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
   g. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
   n. F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

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.”

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTEANCES

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.

3.02 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.
3.03 SUPPLEMENTS

A. Data Sheets.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>-.03</td>
<td>Polyvinyl Chloride (PVC)</td>
</tr>
<tr>
<td>-.05</td>
<td>Reinforced Concrete</td>
</tr>
</tbody>
</table>

END OF SECTION
## SECTION 33 41 01.03
POLYVINYL CHLORIDE (PVC)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe: 15-inch diameter and under</td>
<td>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.</td>
</tr>
<tr>
<td>Pipe: 18- through 24-inch diameter</td>
<td>ASTM F679: Standard dimension ratio less than 35, except that the cell classification shall be 12454-C as defined in ASTM D1784.</td>
</tr>
<tr>
<td>Ribbed Profile Pipe: 18- through 36-inch diameter</td>
<td>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.</td>
</tr>
<tr>
<td>Joints</td>
<td>ASTM D3212 rubber gasketed.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>ASTM F477. Lubricants: As approved by manufacturer.</td>
</tr>
<tr>
<td>Fittings</td>
<td>PVC, gasketed. Provide plug when service piping is not required.</td>
</tr>
<tr>
<td>Plugs</td>
<td>Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.</td>
</tr>
<tr>
<td>Source Quality Control Testing</td>
<td>In accordance with specified ASTM.</td>
</tr>
</tbody>
</table>

END OF SECTION
### SECTION 33 41 01.05
**REINFORCED CONCRETE**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>ASTM C76, Wall B, class as shown. Mark each joint with pipe class. Rotating packer or platform not allowed.</td>
</tr>
</tbody>
</table>
| 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/Fe₂O₃: 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.                                                                 |
<p>| 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.                                                                                                                                                                                                  |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Quality Control Testing</td>
<td>Load Bearing 0.01-inch Crack, Compressive Strength and Absorption: ASTM C76.</td>
</tr>
<tr>
<td></td>
<td>Load Bearing Ultimate: ASTM C76.</td>
</tr>
<tr>
<td></td>
<td>Permeability: ASTM C497.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
Fabricated Slide Gates
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:

2. 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.
4. 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. 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 of each equipment assembly.
b. Manufacturer’s catalog information, descriptive literature, specifications, and identification of materials of construction.

c. Certification by the manufacturer that the gate fully complies with AWWA C561.

d. Documentation of leakage testing following a minimum of 25,000 open/close cycles as specified herein.

e. 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.

f. Gate operator and stem calculations for each gate and service condition.

g. Gate opening and closing thrust forces that will be transmitted to the support structure with operator at extreme positions and load.

h. External utility requirements such as air, water, power, drain, etc., for each component.

i. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.

j. Power and control wiring diagrams, including terminals and numbers.

k. Performance Test Procedures.

l. 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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stem collars for all gate stems</td>
<td>One of each different size</td>
</tr>
<tr>
<td>Bronze lift nuts</td>
<td>One of each different size</td>
</tr>
<tr>
<td>Indicator lights</td>
<td>One dozen</td>
</tr>
<tr>
<td>Special tools required to maintain or dismantle</td>
<td>One complete set</td>
</tr>
</tbody>
</table>

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

PART 2 PRODUCTS

2.01 AWWA STANDARD COMPLIANCE


2.02 SUPPLEMENTS

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

2.03 MATERIALS

A. Stainless Steel:

1. Plate, Sheet, and Strip: ASTM A240/A240M, Type 3045L.
2. Bars and Shapes: ASTM A276, Type 304L.

2.04 PERFORMANCE REQUIREMENTS

A. Leakage shall not exceed 0.04 gallon per minute per foot of gate periphery under either seating or unseating head conditions in accordance with AWWA C561. Gate design shall have been tested to meet this standard after a minimum of 25,000 cycles.

2.05 SLIDE GATES

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

1. Style A: Upward acting type for wall surface mounting 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 P-type invert seal for wall surface mounting on the concrete structures.
4. Style D: Downward acting weir gate type with invert “P” seal for embedded side frame mounting in concrete structures.

B. Guide Frames:
   1. Stainless steel.
   2. Vertical Guides: Design for maximum rigidity, and extend in one continuous piece from the gate invert to form posts for support of gate operators of self-contained gates. When guides extended above the operating floor, they shall be sufficiently strong so that no further reinforcements are required.
      a. Weight: Not less than 9 pounds per linear foot.
      b. Incorporate a replaceable UHMW polyethylene bearing and sealing strips in a retainer slot on the upstream and downstream sides of the gate.
   3. Frame Invert: For flush bottom gate, furnish an EPDM or Viton insert to function as a seating surface for the gate disc.
      a. Weight: Not less than 9 pounds per linear foot.
   4. Join vertical guide frames and invert with factory welded corners.
   5. Size guided slot to provide a minimum disc engagement of 1 inch on each side.

C. Disc:
   1. Disc Plate (Sliding Member): One-piece stainless steel. Reinforce as required so that the disc will not deflect more than 1/720 of the gate span, when the upstream liquid depth (seating head side) is as shown on the schedule and the downstream liquid depth is less than 1/2 inch.
   2. Reinforce gate disc with one-piece stainless steel angles or channels welded to the disc plate. Bolted reinforcements will not be permitted.

D. Operator Support Yoke:
   1. For self-contained gate operators, attached to the vertical extensions of the guide frames.
   2. Constructed from at least two stainless steel angles, or two other suitable shapes, and bolt in place to provide a rigid assembly.
   3. Maximum Deflection: Not to exceed 1/4 inch under full operator applied loading.
E. Stems:

1. 1-inch minimum diameter, ASTM A276, Type 316 stainless steel.
2. Threads: Acme type with RMS surface roughness of 63 micro inches or less on the flanks for manually operated gates and 32 micro inches or less on the flanks for electrically operated gates. Extend threaded portion of stem 2 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 cast iron, bushed stem guides, mounted on cast iron brackets; adjustable in two directions and spaced so that the L/r ratio does not exceed 200.
7. Adjustable stop collar for the CLOSED position.
8. Connect the stems to the disc plate with a yoke, bolted to the stem and welded to the disc.
9. 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.

F. Stem Covers:

1. Transparent UV resistant 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. For downward acting weir gate (HDWK-G-200), tape shall be applied in a manner that indicates “0 inches” on the stem when the gate is at the minimum setting, elevation 930.25. For throttling gate (HDWK-G-100), tape shall be applied in a manner that indicates “0 inches” on the stem when the gate is fully closed.

G. Manufacturers:

1. Fontaine-Aquanox, Ltd.
2. Waterman Industries.
3. Whipps, Inc.
4. Hydro Gate Corp., Henry Pratt Industries.
2.06  GATE OPERATORS

A.  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.

B.  Dual-Stem Gate Operators:

1.  Enclosed, geared floor 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.

C.  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. Size actuators for continuous modulating duty.
   b. 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. Motor shall have built-in overload protection.
   c. Controller capable of 1,200 starts per hour.
   d. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
   e. Furnish motor enclosure with drainage and breathing holes.
   f. 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. Controls: Furnish the following in accordance with operator control styles listed below and specified in Slide Gate Schedule:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Local OPEN/STOP/CLOSE pushbutton station</td>
</tr>
<tr>
<td>B</td>
<td>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.</td>
</tr>
<tr>
<td>C</td>
<td>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.</td>
</tr>
</tbody>
</table>
**Feature Description**

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.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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.

8. **Manufacturers and Products:**

a. Rotork Controls.
b. Flowserve Limitorque.
c. AUMA.

**D. Identification Tagging Requirements:**

1. For each gate operator, 1-1/2-inch minimum diameter heavy brass 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.

2.07 **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: Graduated in 1/4 inches and marked every inch and foot. Total length of demarcation shall be 8 feet 0 inches. Provide at both gate locations.

1. Manufacturer and Product: Stevens Water Monitoring Equipment; Porcelain Enameled Style C.
2.08 SHOP/FACTORY FINISHING

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

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. Brace thimbles internally during concrete placement.
E. Accurately place anchor bolts using templates furnished by the manufacturer and as specified in Section 05 50 00, Metal Fabrications.
F. Lubricate stems before operating.
G. Staff Gauges: For downward acting weir gate (HDWK-G-200), mount staff gauge with 0 inches on the gauge set at the minimum gate setting, elevation 930.25. For throttling gate (HDWK-G-100), remove bottom inch of staff gauge and mount so that 1 foot 0 inches on the gauge is at elevation 931.75.

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. Gate shall be modulated by a variable control signal from the plant instrumentation system, or otherwise developed, to demonstrate modulating capability.
   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. 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. 1/2 person-day for facility startup.
4. 1/2 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 Engineer.

B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

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

<table>
<thead>
<tr>
<th>Gate Identification No. and Location</th>
<th>Assembly Style</th>
<th>Wall Opening (width/height inches)</th>
<th>Gate Height (inches)</th>
<th>Max. Gate Travel (inches)</th>
<th>Flow Stream</th>
<th>Design Operating Head (feet) Seating/Unseating Condition</th>
<th>Operator Type/Control Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDWK-G-100</td>
<td>Style B</td>
<td>30/108</td>
<td>72</td>
<td>30(^1)</td>
<td>INF</td>
<td>2.0/2.0(^2)</td>
<td>Type 4/Style 4</td>
</tr>
<tr>
<td>HDWK-G-200</td>
<td>Style C</td>
<td>144/120</td>
<td>90</td>
<td>81(^3)</td>
<td>SW</td>
<td>2.8/2.8(^4)</td>
<td>Type 4/Style 4</td>
</tr>
</tbody>
</table>

Notes:

1. Gate travel from fully lowered (closed) position.
2. Head relative to gate centerline when fully lowered.
3. Top of gate elevation when fully raised = 937.00 ft
4. Head relative to gate centerline when fully raised.
**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Piping Support Systems

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### Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

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### Document Review & Approval:

**Originator:**

Steven R. Polson, P.E./Lead Process Mechanical

**Design Verification Complete:**

Qingshan Wang, P.E./Process Mechanical QC Reviewer

**Approved:**

W. Laird Ellis, Jr. PE/Design Manager
PART 1  GENERAL

1.01 REFERENCES

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

3. ASTM International (ASTM):
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
4. International Code Council (ICC):
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 2 inches and larger. 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. Results of piping stress analysis as specified herein.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Maintenance information on piping support system.

1.04 QUALIFICATIONS
A. Contractor shall provide designed piping support systems and submit Shop Drawings and calculations prepared and sealed by a Registered Professional Engineer in the state of Tennessee, as identified in Article Design Requirements.

1.05 DESIGN REQUIREMENTS
A. General:
1. For Piping Smaller than 30 Inches Contractor shall design, size, and locate piping support systems throughout facility, whether shown or not.
   a. Supports are identified only where specific types and locations are required; additional pipe supports may be required.
   b. Support design shall meet requirements of MSS SP 58 and ASME B31.3, or as modified by this section.
2. For Piping 30 Inches and Larger: Engineer will design, size, and locate piping support systems throughout facility.
3. For piping 6 inches and larger nominal size, provide piping system stress analysis in accordance with B31.3.

B. Pipe Support Systems:
1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes (including insulation and weight of fluid in pipes), internal pressures, and temperature differentials.
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. Snow and ice loads in accordance with governing codes and as shown on Structural General Drawings.
5. Thermal displacement.
6. 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.
7. Electrical Conduit Support: Include in design of framing support system, where applicable.

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.

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.

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.
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.

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.

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.

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.

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

D. Channel Type:
   1. Unistrut.
   2. Anvil; Power-Strut.
   3. B-Line; Strut System.
   4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to 120-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.; Fig. 2000.
B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP 58, Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63P base.
   b. B-Line; Figure B3092, sizes 1 inch through 36 inches with B3088T base.
   c. Submerged supports shall be hot dipped galvanized.
3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 63T base.
   b. B-Line; Figure B3093, sizes 3/4 inch through 36 inches with Figure B3088T base.

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).

2.06 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.

2.07 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.
C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.08 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.
   1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

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.

2.09 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.

2.10 PIPE ANCHORS

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

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

2.11 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.
2.12 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. 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.

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.

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.

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.
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.

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 shutdown, 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. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
   a. Single point attachment to ceiling 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.
      1) These lines include positive displacement pumps and other lines, if any, as identified below:
         a) INF Piping.
         b) SLR Piping.
c) SLW Piping.
d) TSL Piping.

2. 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.
      1) These lines include positive displacement pumps and other lines, if any, as identified below:
         a) INF Piping.
         b) SLR Piping.
         c) SLW Piping.
         d) TSL Piping.

3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. 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 to 120-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 of hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating. Color shall be light gray, as specified.

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>
<thead>
<tr>
<th>Exposure Conditions</th>
<th>Support Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Areas</td>
<td>Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping</td>
</tr>
<tr>
<td>Shops and Warehouse Areas</td>
<td>Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping</td>
</tr>
<tr>
<td>Pipe Galleries</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Headworks</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Process Areas: High Humidity in Filter Press room.</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Process Areas: Wetted or Submerged</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Pipes conveying chemicals listed in Table 2</td>
<td>Provide with corresponding support per Table 2.</td>
</tr>
</tbody>
</table>

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.
<table>
<thead>
<tr>
<th>Chemical Areas</th>
<th>Support for Direct Exposure</th>
<th>Support for Remote Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulants</td>
<td>FRP</td>
<td>Precoated steel or galvanized steel</td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td>FRP</td>
<td>Precoated steel</td>
</tr>
<tr>
<td>All other chemicals</td>
<td>FRP</td>
<td>Precoated steel or galvanized steel</td>
</tr>
<tr>
<td>Polymers</td>
<td>Precoated steel</td>
<td>Precoated steel</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>Stainless steel</td>
<td>Precoated steel</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>Stainless steel</td>
<td>Precoated steel</td>
</tr>
</tbody>
</table>

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.
Pipe Heat Tracing

Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

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Document Review & Approval:

**Originator:**
Steven R. Polson, P.E./Lead Process Mechanical

**Design Verification Complete:**
Qingshan Wang, P.E./Process Mechanical QC Reviewer

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager
PART 1    GENERAL

1.01 REFERENCES

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

1. Factory Mutual.
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 75 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. Suitable for use on 277V ac supply systems. 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) for metallic piping and 104 degrees F (40 degrees C) for non-metallic piping.

D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C) for metallic piping and 122 degrees F (50 degrees C) for non-metallic piping.

E. Service Voltage: 277V ac.

F. Manufacturers and Products:
   1. Raychem; BTV-CR.
   2. Thermon; BSX.
   3. Nelson; CL1-J1 or L1-J1.

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.
   2. Splice Kit:
      a. Raychem; S-150.
      b. Thermon; PCS-1-SR.
      c. Nelson; PLT-BS.
   3. Tee Kit:
      a. Raychem; T-100.
      b. Thermon; DS-S.
      c. Nelson; PLT-BY.
   4. End Seal Kit:
      a. Raychem; E-150.
      b. Thermon; DE-S.
      c. Nelson; LT-ME.
   5. Lighted End Seal Kit:
      a. Raychem; E-100-L.
      b. Thermon; DLS.
      c. Nelson; LT-L.
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.

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.

2.05 PIPE MOUNTED THERMOSTAT

A. Type: Fixed, nonadjustable, set at 40 degrees F, except for sodium bisulfite piping which shall be set at 60 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, 277V 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.

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, 277V 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.

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:

<table>
<thead>
<tr>
<th>Service</th>
<th>Piping Material</th>
<th>Location</th>
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<tbody>
<tr>
<td>BWW</td>
<td>316 SS, SCH 10S</td>
<td>MTF Exterior</td>
</tr>
<tr>
<td>D</td>
<td>PVC, SCH 80</td>
<td>MTF Exterior</td>
</tr>
<tr>
<td>D</td>
<td>316 SS, SCH 10S</td>
<td>MTF Exterior</td>
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<tr>
<td>DCT</td>
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<td>FCL</td>
<td>CPVC, SCH 80</td>
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<tr>
<td>FLPS</td>
<td>CPVC, SCH 80</td>
<td>MTF Exterior</td>
</tr>
<tr>
<td>GR</td>
<td>GLDI</td>
<td>MTF Exterior</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Heating Tape Length (min. feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolted flanges (per pair)</td>
<td>Two times pipe diameter</td>
</tr>
<tr>
<td>Valves</td>
<td>Four times valve length</td>
</tr>
<tr>
<td>Pipe hanger or support penetrating insulation</td>
<td>Three times pipe diameter</td>
</tr>
</tbody>
</table>

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
**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Process Piping—General

### Revision History:

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### Document Review & Approval:

**Originator:**

Steven R. Polson, P.E./Lead Process Mechanical

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**Design Verification Complete:**

Qingshan Wang, P.E./Process Mechanical QC Reviewer

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**Approved:**

W. Laird Ellis, Jr. PE/Design Manager

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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:

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.
   c. B1.20.1, Pipe Threads, General Purpose (Inch).
   e. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   g. B16.9, Factory-Made Wrought Buttwelding Fittings.
   h. B16.11, Forged Fittings, Socket-Welding and Threaded.
   i. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
   j. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   k. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   l. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
   m. B16.25, Buttwelding Ends.
   p. B31.9, Building Services Piping.
   q. B36.10M, Welded and Seamless Wrought Steel Pipe.
6. American Water Works Association (AWWA):
   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):
   b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   d. QC1, Standard for AWS Certification of Welding Inspectors.

8. ASTM International (ASTM):
   g. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   h. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   j. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
k. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
r. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
x. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
gg. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.


uu. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.


9. FM Global (FM).
11. NSF International (NSF):
   b. ANSI 372: Drinking Water System Components - Lead Content.
12. National Electrical Manufacturers Association (NEMA):
   a. LI 1, Industrial Laminating Thermosetting Products.
   b. NEMA Z535.1, Safety Color Code.
1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
   a. Top face of channel walls and cover slabs.
   b. Liquid surface or within 2 feet above top of liquid surface.
   c. Top of tank wall or under tank cover.

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:

2. Building Service Piping: ASME B31.9, as applicable.
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.


4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.

5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.


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:
   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.


10. 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 M Forms).

3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex M 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 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.
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) and Piping Schedule located at the end of this section as Supplement and on Piping Schedule located on the Drawings.

B. Diameters Shown:

2. Fabricated Steel Piping: Outside diameter, ASME B36.10M.

2.03  JOINTS

A. Grooved End System:

1. Rigid type.
2. Use of flexible grooved joints allowed where shown on Drawings or with prior approval by Engineer.
3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. 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.

C. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.
D. 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.

E. Flexible Mechanical Compression Joint Coupling:
   1. Stainless steel, ASTM A276, Type 305 bands.
   2. Manufacturers:
      a. Pipeline Products Corp.
      b. Fernco Joint Sealer Co.

F. 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 DOUBLE WALL CONTAINMENT PIPING SYSTEM
A. System components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.
2.06 PIPE CORROSION PROTECTION

A. Ductile Iron: See Data Sheet.

B. Heat Shrink Wrap:
   1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
   2. Manufacturer and Product: Raychem; WPC or TPS.

C. 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.

D. Insulating Flanges, Couplings, and Unions:
   1. Materials:
      a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have working pressure ratings equal to or higher than that of joint and pipeline in accordance with the following:
         1) Process Piping: B31.3.
         2) Building Service Piping: ASME B31.9, as applicable
      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: Reference Section 26 42 01, Pipe Bonding and Test Stations, for flange insulating kit details.

5. Manufacturers and Products:
   a. Dielectric Flanges and Unions:
      1) PSI, Houston, TX.
      2) Advance Products and Systems, Lafayette, LA.

2.07 THRUST BLOCKS
A. Thrust blocks are not allowed.

2.08 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.

2.09 VENT AND DRAIN VALVES
A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.10 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.

2.11 FINISHES
A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.
2.12 IDENTIFICATION LABELS

A. Fabricate labels with background and letter colors per NEMA Z535.1.

B. Color Field and Letter Height: In accordance with ASME A13.1.

C. Pipe Labels for Piping 6 Inches and Larger:

1. Labels:
   a. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
   b. Provided with ties or straps.
   c. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.

2. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.

3. Message: Piping system name as indicated on Piping Schedule.

4. Manufacturers and Products:
   b. Seton Identification Products; Ultra-mark Pipe Markers.

D. Pipe Labels for Piping Smaller than 6 Inches:

1. Labels: Self-adhesive tape, with separate directional flow arrow banding tape. Labels shall be suitable for maximum temperature of 300 degrees F for ALP piping.


3. Message: Piping system name as indicated on Piping Schedule.

4. Manufacturers and Products:
   a. Brady Signmark; B-946 Self-Sticking Vinyl Pipe Markers and Directional Flow Arrow Tape.

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, except for damaged glass-lined pipe or PVDF-lined pipe that is to be promptly removed from Site.

3.03 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3, Normal Fluid Service Category, and as specified on Piping Data Sheets.

B. Use GTAW with inert purging gas for welding stainless steel pipe.

C. Weld Identification: Keep paper record of which welder welded each joint.

D. Pipe End Preparation:
   2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.

E. 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.

F. 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.
G. Climatic Conditions: 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.

H. 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.

I. Surface Defects: Chip or grind out those affecting soundness of weld.

J. Weld Quality: Meet requirements of ASME B31.3, Normal Fluid Service Category.

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. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. 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.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
10. Manufacturer: Same as pipe manufacturer or grooved joint flange adapter manufacturer.
D. Threaded and Coupled Joints:
   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. Grooved-End Joints:
   1. Piping shall be grooved in accordance with manufacturer’s latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer’s standards and to AWWA C606.
   2. Install grooved joint couplings and gaskets in accordance with manufacturer’s latest published installation instructions.

F. 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.

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 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. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
  10. 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.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. 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 Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer’s recommendation.
4. Pipe Cover: Minimum 2 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 INSTALLATION—DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. Install according to manufacturer’s instructions.

B. Valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.

C. Centering Devices for Double Wall Containment Piping:
1. Center and support carrier pipe within the containment pipe with centering devices. Locate not less than every 9 feet, or within 24 inches of the termination of containment pipe on fabricated pieces.

2. Install centering devices such that leak detection cable (if specified) will be unrestricted and such that system maintains free drainage.

D. Following Installation and Testing:

1. Flush clean carrier and containment piping system.
2. Purge annular space of moisture with clean, dry air.

3.09 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.


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. Carbon Steel Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.

2. Buried:
   a. Pipe: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating.
   b. Joints: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating, or heat shrink wrap as specified herein.

3. Submerged or Embedded: Shop 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.

4. Piping that is supplied as part of a steel tank shall be coated in accordance with the tank specification.

C. Copper Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.

2. Buried: 
   a. Pipe.
   b. Joints.

D. PVC and CPVC Pipe, Exterior, Exposed: As specified in Section 09 90 00, Painting and Coating.
E. 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.
   d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
   e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.

F. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer’s instructions.

G. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

H. Heat Shrink Wrap: Apply in accordance with manufacturer’s instructions to surfaces that are cleaned, prepared, and primed.

I. 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.
   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.

J. Pipe Bonding for Buried Piping: As specified in Section 26 42 01, Pipe Bonding and Test Stations.

K. Cathodic Protection for Buried Piping: As specified in Section 26 42 00, Cathodic Protection, and as shown.

3.10 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 lugs fabricated in accordance with details shown on Drawings.
   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.

3.11 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.12 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.

3.13 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 at all low and high point locations.

3.14 INSULATION
   A. See Section 40 42 13, Process Piping Insulation.

3.15 HEAT TRACING
   A. See Section 40 05 33, Pipe Heat Tracing.

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 10 14 00, Signage, 31 23 23.15, Trench Backfill and 09 90 00, Painting and Coating.

3.18 FIELD QUALITY CONTROL
   A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.
   B. Minimum Duties of Welding Inspector:
      1. Job material verification and storage.
      2. Review welder performance qualifications and require retests of welders whose qualifications have expired or if there is a reason to question a welder’s skill level.
      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:

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 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, to assist with unloading of the double wall containment piping system, system tests, containment pipe joint closure, installation and testing of leak detection system, and training of Owner’s personnel in operation and maintenance of leak detection system. Manufacturer’s representative shall complete a Manufacturer’s Certificate of Proper Installation. Inspection and examination practices shall be according to ASME B31.3 for Normal Fluid Service.

3.20 CLEANING

A. Following assembly and testing, and prior to disinfection 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, and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. 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.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.
3.21 SUPPLEMENTS

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

1. Piping Schedule (see Drawings).
2. Data Sheets.

<table>
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<th>Title</th>
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<td>Cement Mortar, Glass and Ceramic-Lined Ductile Iron Pipe and Fittings</td>
</tr>
<tr>
<td>40 27 00.03</td>
<td>Carbon Steel Pipe and Fittings—General Service</td>
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<td>40 27 00.08</td>
<td>Stainless Steel Pipe and Fittings—General Service</td>
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<td>40 27 00.09</td>
<td>Stainless Steel Pipe and Fittings—Special Service</td>
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<td>40 27 00.10</td>
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<td>PVC Double Wall Containment Piping</td>
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<td>CPVC Double Wall Containment Piping</td>
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<td>40 27 00.15C</td>
<td>Stainless Steel Double Wall Containment Piping</td>
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<tr>
<td>40 27 00.18</td>
<td>Polyvinylidene Fluoride (PVDF) Pipe and Fittings</td>
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END OF SECTION
### SECTION 40 27 00.01
CEMENT MORTAR, GLASS AND CERAMIC-LINED DUCTILE IRON PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>General</strong></td>
<td>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 the specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA 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).</td>
</tr>
<tr>
<td><strong>Pipe</strong></td>
<td>Buried Liquid Service Using Mechanical 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.</td>
</tr>
</tbody>
</table>
| **External Coating**      | Exposed pipe, interior or exterior: primed in accordance with System No. 5, Section 09 90 00, Painting and Coating. Buried: Zinc coating with standard asphaltic topcoating in accordance with the following:  
  - Materials: The coating materials shall be metallic zinc wire with a zinc content of at least 99.99 percent by mass, and bituminous paint topcoat compatible with zinc.  
  - Zinc Coating Mass: The mean mass of the metallic zinc coating shall be a minimum of 200 grams per square meter when measured in accordance with the section titled “Test Method for Determining Zinc Mass” of this Specification.  
  - The mass of the zinc coating shall be verified at the beginning of each shift, at changes to application equipment settings, and at sufficiently frequent intervals to verify conformance to the mass requirements. Results shall be documented and kept on file for a period of 1 year.  
  - Pipe Surface: The pipe surface shall be dry and free from dirt, oil, grease, asphalt, loose rust, or any non-adhering particles or foreign contaminants. |
SECTION 40 27 00.01
CEMENT MORTAR, GLASS AND CERAMIC-LINED
DUCTILE IRON PIPE AND FITTINGS

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<tr>
<td></td>
<td>material. The metallic zinc shall be applied to the as-cast annealed external pipe surface, or to a blast cleaned or wire brushed surface, at the manufacturer’s discretion.</td>
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<tr>
<td></td>
<td>• Method of Application: The metallic zinc coating shall be applied by an arc spray thermal spray process in which the metallic zinc is heated to a molten state and projected in small droplets by clean and dry compressed air onto the external pipe surface.</td>
</tr>
<tr>
<td></td>
<td>• Coating Characteristics: The metallic zinc coating shall cover the outside exterior pipe surface and shall be free from bare patches or areas with lack of adhesion which reveals bare iron pipe surface. A spiraled appearance is permissible provided the zinc coating masses comply with the requirements described under the “Zinc Coating Mass” section of this specification.</td>
</tr>
<tr>
<td></td>
<td>• Damaged areas of the zinc coating caused by handling are acceptable, provided the area of damage is less than 5 cm² per square meter and that the minor dimension of the damaged area does not exceed 5mm. Greater areas of damage shall be repaired in accordance with the materials and procedures discussed in the “Repairs to the Zinc Coating” section of this Specification.</td>
</tr>
<tr>
<td></td>
<td>• Repairs to the Zinc Coating: Any damaged areas exceeding the criteria described under the “Coating Characteristics” section of this Specification shall be repaired utilizing either 1) metallic zinc spray complying with this Specification, or 2) application of a zinc-rich paint containing more than 85 percent zinc by mass in the dried film. One recommended zinc rich paint repair material which meets this requirement is Tnemec-Zinc 90-98 manufactured by the Tnemec Company in Kansas City, Missouri.</td>
</tr>
<tr>
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<td>• Finishing Layer (Topcoat): After zinc coating, the pipe shall be given a finishing layer of bituminous paint topcoat compatible with zinc. Application of the finishing layer may be done by spray, brush, or roller at the manufacturer’s discretion. It shall uniformly cover the zinc coating and be free from significant lack of adhesion. Repairs to the finishing layer shall be in accordance with the manufacturer’s recommendations. The mean dry film thickness of the finishing layer shall not be less than 50 μm (2 mils) and to avoid blistering and permit proper performance of the zinc coating, shall not exceed 250 μm (10 mils).</td>
</tr>
</tbody>
</table>
### Item Description

- **Test Method for Determining Zinc Mass**: A rectangular metallic test coupon approximately 3 cm by 40 cm is weighed to the nearest 0.01 grams. Immediately prior to application of the zinc, the test coupon is attached along the longitudinal axis of the pipe surface by applying adhesive tape (duct tape) to each end of the coupon in such a manner as to result in 100 square centimeters of exposed coupon surface. The pipe surface with the attached coupon shall be coated with the same equipment and application process as the entire pipe. After zinc coating, the tape is removed and the coupon is again weighed to the nearest 0.01 gram. The weight of the zinc on the test coupon is determined by subtracting the initial weight of the bare coupon from the coated weight of the coupon. The mass of the zinc in grams, is then multiplied by 100 to give the mass of zinc in grams per square meter.

### Lining

**Cement-Mortar**: AWWA C104/A21.4.

**Glass**: Completely fused above 1,400 degrees F, 6 mils to 10 mils thick, defects which expose base metal not greater than 0.01 percent of total lined surface, hardness greater than 5 on the Mohs scale, lining bonded sufficiently to withstand a metal strain of 0.001 inch/inch without damage to the glass lining, finished lined pipe not to deviate more than 0.0125 inch per foot of length from a centerline perpendicular to the flange face or square end of the pipe. Fast Fabricators, Inc., Ferrock MEH-32; Ceramic Coating Co., SL-31; VITCO Corp., SG-14.

**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. 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, GLASS AND CERAMIC-LINED
DUCTILE IRON PIPE AND FITTINGS

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<tr>
<td>Fittings</td>
<td>Lined and coated same as pipe.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure; Victaulic.</td>
</tr>
<tr>
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<td>Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face or ASME B16.1, Class 250 raised face. Gray cast iron will not be allowed.</td>
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<tr>
<td>Joints</td>
<td>Mechanical: 250 psi minimum working pressure.</td>
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<tr>
<td></td>
<td>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.</td>
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<tr>
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<td>Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic.</td>
</tr>
<tr>
<td></td>
<td>Flange: Class 125 flat face, or Class 250 raised face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.</td>
</tr>
<tr>
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<td>Branch connections 3 inches and smaller, except from glass-lined pipe, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties. Branch connections, 3 inches and smaller.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.01
CEMENT MORTAR, GLASS AND CERAMIC-LINED
DUCTILE IRON PIPE AND FITTINGS

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<tbody>
<tr>
<td></td>
<td>from glass-lined pipe shall be made with glass-lined tee with a flanged branch for adapting to branch piping.</td>
</tr>
<tr>
<td><strong>Couplings</strong></td>
<td>Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. &lt;br&gt;Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. &lt;br&gt;Mechanical Joint Sleeve Coupling (Solid Sleeve): Long configuration, per ANSI/AWWA C153/A21.53, restrained using Series 100 Megalug, or equal.</td>
</tr>
<tr>
<td><strong>Tapping</strong></td>
<td>Lined ductile iron pipe shall be drilled and tapped in the shop prior to lining application. Location and size of taps shall be clearly shown on shop submittal drawings. Field tapping of ductile iron pipe is not allowed.</td>
</tr>
<tr>
<td><strong>Bolting</strong></td>
<td>Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer’s standard.  &lt;br&gt;Class 125 Flat-Faced Flange: ASTM A307, Grade A carbon steel hex head bolts, ASTM A563, Grade A carbon steel hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.  &lt;br&gt;Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts; ASTM A194/A194M, Grade 8M hex nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.  &lt;br&gt;Class 250 Raised-Face Flange: ASTM A307, Grade B carbon steel hex head bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</td>
</tr>
<tr>
<td><strong>Gaskets</strong></td>
<td>General: Gaskets in contact with potable water shall be NSF 61 certified.  &lt;br&gt;Mechanical and Proprietary Restrained Joints; Water and Sewage Service: Rubber conforming to AWWA C111/A21.11.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.01
CEMENT MORTAR, GLASS AND CERAMIC-LINED
DUCTILE IRON PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mechanical and Proprietary Restrained Joints; Hot Air Service: EPDM or Viton and conforming to AWWA C111/A21.11.</td>
</tr>
<tr>
<td></td>
<td>Full face for Class 125 flat-faced flanges, flat-ring type for Class 250 raised-face flanges. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.</td>
</tr>
<tr>
<td></td>
<td>Gasket pressure rating to equal or exceed the system hydrostatic test pressure.</td>
</tr>
<tr>
<td>Joint Lubricant</td>
<td>Manufacturer’s standard.</td>
</tr>
</tbody>
</table>

**END OF SECTION**
<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:</td>
</tr>
<tr>
<td>Screwed:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&quot; &amp; smaller</td>
<td></td>
<td>Schedule 40.</td>
</tr>
<tr>
<td>Welded:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1/2&quot; thru 10&quot;</td>
<td></td>
<td>Schedule 40.</td>
</tr>
<tr>
<td>12&quot; thru 16&quot;</td>
<td></td>
<td>Schedule 30.</td>
</tr>
<tr>
<td>18&quot; thru 24&quot;</td>
<td></td>
<td>Schedule 20.</td>
</tr>
</tbody>
</table>

| Grooved:                      |                 |                                                                             |
| 2-1/2" thru 6"                |                 | Schedule 40.                                                                |
| 8" thru 12" inch              |                 | Schedule 30.                                                                |
| 14"                           |                 | Standard weight.                                                            |

| External Coating, Exposed Piping (provided with Steel Tanks) | 14” through 24” | Pipe exterior shall be shop coated and field finished in accordance with Section 09 97 13, Steel Tank Coatings. |

| External Coating, Concrete Encased and Buried Piping | 16” | Pipe exterior shall be shop primed and finish coated in accordance with System No. 7, Section 09 90 00, Painting and Coating. |

<p>| Lining | 14” through 24” | Pipe interior shall be shop primed and finish coated in accordance with System No. 1, Section 09 90 00, Painting and Coating. All field welds shall be repaired in accordance with the Specifications. |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joints</td>
<td>2&quot; &amp; smaller</td>
<td>Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; &amp; larger</td>
<td>Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.</td>
</tr>
<tr>
<td>Fittings</td>
<td>2&quot; &amp; smaller</td>
<td>Threaded: 150- 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.</td>
</tr>
<tr>
<td>Branch Connections</td>
<td>2&quot; &amp; smaller</td>
<td>For threaded pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet. Butt-welding or grooved end tee in conformance with Fittings specified above.</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; &amp; larger</td>
<td></td>
</tr>
<tr>
<td>Flanges</td>
<td>2&quot; &amp; smaller</td>
<td>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.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.03
CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt-Welded Systems</td>
<td>2-1/2&quot; &amp; larger</td>
<td>Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.</td>
</tr>
<tr>
<td>Grooved End Adapter Flange</td>
<td></td>
<td>Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic Style 741 or 743; Anvil International, Inc., Gruvlok Figure 7012 or 7013; Shurjoint Model 7041-A. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.</td>
</tr>
<tr>
<td>Cast Iron Mating Flange</td>
<td></td>
<td>AWWA C207, Class D or E, hub or ring type to mate with ASME B16.1, Class 125 cast-iron flange. AWWA C207 Class F hub type or ASTM A105/A105M, ASME B16.5 Class 300 to mate with ASME B16.1 Class 250 cast-iron flange.</td>
</tr>
<tr>
<td>Unions</td>
<td>2&quot; &amp; smaller</td>
<td>Threaded malleable iron, ASTM A197/A197 or ASTM A47/A47M, 150- or 300-pound WOG, meeting the requirements of ASME B16.3.</td>
</tr>
<tr>
<td>Couplings</td>
<td>2-1/2&quot; &amp; larger</td>
<td>Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products. Screwed End: Malleable iron, ASTM A197/A197M or ASTM A47/A47M.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Flanges: Carbon steel ASTM A307, Grade A hex head bolts; ASTM A563, Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.03
**CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE**

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>When mating flange on equipment is cast iron</strong> and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.**</td>
</tr>
</tbody>
</table>
| Gaskets | All flanges | **Water, Steam, and Air Services:** 1/16-inch-thick, compressed inorganic fiber with nitrile binder, rated 400 degrees F. continuous.  
**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 and ASTM D1330, Steam Grade.  
Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.  
**Grooved Couplings:** EPDM per ASTM D2000 for water and oil-free air to 230 degrees F, nitrile for oil vapor in air and oil services to 180 degrees F. |
| 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**
<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>ASTM A312, Type 316L seamless. Pipe wall thickness as noted on Pipe Schedule.</td>
</tr>
<tr>
<td>Joints</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded or flanged at equipment as required or shown.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welded or flanged at valves and equipment.</td>
</tr>
<tr>
<td>Fittings</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F316L.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt Welded: ASTM A403/A403M, Grade WP316L Class W, annealed. Fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.</td>
</tr>
<tr>
<td>Branch Connections</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Tee or reducing tee in conformance with fittings above.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welding tee or reducing tee in accordance with fittings above.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blind Flanges, stainless steel with gaskets as specified herein.</td>
</tr>
<tr>
<td>Unions</td>
<td>2&quot; &amp; smaller</td>
<td>Threaded Forged: ASTM A182/A182M, Grade F316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.08
**STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE**

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Forged Flanges: Type 316 stainless steel, ASTM A193/A193M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M 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: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex nuts and ASTM F436/F436M Type 3 alloy 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/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All Flanges</td>
<td>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.</td>
</tr>
<tr>
<td>Thread Lubricant</td>
<td>2&quot; &amp; smaller</td>
<td>General Service: 100 percent virgin PTFE Teflon tape.</td>
</tr>
</tbody>
</table>

**END OF SECTION**
<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>ASTM A312/A312M Type 316L seamless.</td>
</tr>
<tr>
<td></td>
<td>4&quot; &amp; smaller</td>
<td>Schedule 40S (Sch. 80S for threaded pipe).</td>
</tr>
<tr>
<td>Tubing</td>
<td>3/4&quot; OD &amp; smaller</td>
<td>ASTM A269 Type 316 seamless, soft annealed, 0.083-inch wall thickness minimum.</td>
</tr>
<tr>
<td>Pipe Joints</td>
<td>2&quot; &amp; smaller</td>
<td>Butt-welded or flanged at valves and equipment as required or shown. Threaded connections permitted for connection to instrumentation and only where shown on Drawing. An isolation valve is required immediately before all threaded connections._socket weld or flanged at equipment as required and shown on Drawings. Socket welded fitting are not permitted in sulfuric acid service. Butt-welded or flanged at valves and equipment as required or shown.</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; &amp; larger</td>
<td></td>
</tr>
<tr>
<td>Tubing Joints</td>
<td>All</td>
<td>Flareless compression fitting.</td>
</tr>
<tr>
<td>Pipe Fittings</td>
<td>3/4&quot; &amp; smaller</td>
<td>Threaded: Forged 3000-pound WOG, ASTM A182/A182M, Grade F316 or cast Class 150, ASTM A351/A351M, Grade CF8/304.</td>
</tr>
<tr>
<td></td>
<td>1/2&quot; &amp; larger</td>
<td>Butt Welded: ASTM A403/A403M, Grade WP316L 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.</td>
</tr>
<tr>
<td>Tubing Fittings</td>
<td>All</td>
<td>Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok or Swagelok. Socket Welded: ASTM A182/A182M, Grade F316L, Cajon, Swagelok.</td>
</tr>
<tr>
<td>Item</td>
<td>Size</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pipe Branch Connections</td>
<td>1/2&quot; &amp; larger</td>
<td>Butt Weld Tee or Reducing Tee: In accordance with fittings above forged weldolet, 2,000-pound WOG ASTM A182/A182M, Grade F316L, same inside diameter as branch pipe.</td>
</tr>
<tr>
<td>Tubing Branch Connections</td>
<td>All</td>
<td>Compression type or butt-welded tees or reducing tees in accordance with tubing fittings above.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>Forged: ASTM A182/A182M Rev C Grade F316L, ASME B16.5 Class 150 or Class 300, welding neck, 1/16-inch raised face. Weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Type 316 stainless steel, ASTM A193/A193M, Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All Flanges</td>
<td>1/16-inch-thick Viton or inorganic filled Teflon flat ring type for raised face flanges and full face type for flat face flanges; Garlock or Durlon.</td>
</tr>
<tr>
<td>Thread Lubricant</td>
<td>2&quot; &amp; smaller</td>
<td>General Service: 100 percent virgin PTFE Teflon tape or Nickel pigmented PTFE, designed for stainless steel pipe, Air Force A-A-58092, AA Thread Seal Tape, Inc.</td>
</tr>
</tbody>
</table>

END OF SECTION
<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>All</td>
<td>Materials in contact with potable water shall conform to NSF 61 acceptance.</td>
</tr>
<tr>
<td>Pipe</td>
<td>All</td>
<td>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.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>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.</td>
</tr>
<tr>
<td>Joints</td>
<td>All</td>
<td>Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>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.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All</td>
<td>Flat Face Mating Flange: Full faced 1/8-inch-thick. Raised Face Mating Flange: Flat ring 1/8-inch with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Material: Viton.</td>
</tr>
<tr>
<td>Solvent Cement</td>
<td>All</td>
<td>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.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.10
### POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread Lubricant</td>
<td>All</td>
<td>Teflon Tape.</td>
</tr>
</tbody>
</table>

END OF SECTION
## SECTION 40 27 00.11
CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>Schedule 80 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.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>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.</td>
</tr>
<tr>
<td>Joints</td>
<td>All</td>
<td>Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; ASME B16.1, Class 125 drilling.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>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. Ferric Chloride Service: ASTM A193/A193M, Hastelloy C-276 hex head bolts, ASTM A194/ A194M Hastelloy C-276 hex head nuts and ASTM F436 Type 3 Hastelloy C-276 washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All</td>
<td>Flat Face Mating Flange: Full faced 1/8-inch thick. Raised Face Mating Flange: Flat ring 1/8-inch with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Sodium Hydroxide Service: EPDM. All Other Chemicals: Viton.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.11
CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent Cement</td>
<td>All</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Thread Lubricant</td>
<td>All</td>
<td>Teflon tape.</td>
</tr>
</tbody>
</table>

END OF SECTION
### SECTION 40 27 00.13  
COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Materials in contact with potable water shall conform to NSF 61 acceptance.</td>
</tr>
</tbody>
</table>
| Tubing | Seamless, conforming to ASTM B88 as follows:  
- 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 |
| Fittings | ASTM B75 commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22. |
| Flanges | Class 150, ASTM B75 commercially pure wrought copper, socket joint, ASME B16.24 standard. |
| Bolting | ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. |
| Gaskets | 1/16-inch-thick nonasbestos compression type, full face, Cranite, John Manville. |
| Solder | 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
<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>All</td>
<td>Each contained piping system shall consist of Schedule 80 PVC primary piping system supported within a Schedule 80 clear PVC secondary containment housing. Carrier fitting sizes 1/2-inch through 4-inch will use molded supports minimizing the number of factory assembled field fitting joints. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from PVC and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be located at all low points and at 100 feet intervals, maximum. Drain fittings shall be designed with a clear PVC drip leg and a PVC drain valve so that the secondary containment compartment may be readily drained and manually checked for leaks.</td>
</tr>
<tr>
<td>Carrier Pipe</td>
<td>All</td>
<td>Schedule 80 PVC: Type I, Grade I or Class 1245-4-B conforming to ASTM D1784 and ASTM D1785. Threaded Nipples: Schedule 80 PVC.</td>
</tr>
<tr>
<td>Containment Pipe</td>
<td>All</td>
<td>Schedule 80 Clear PVC: Type I, Grade I or Class 1245-4-B conforming to ASTM D1784 and ASTM D1785. Threaded Nipples: Schedule 80 PVC.</td>
</tr>
<tr>
<td>Leak Detection</td>
<td>All</td>
<td>Visual.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>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. All fittings shall be pre-assembled and pre-tested by the manufacturer. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by manufacturer.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.15A
### POLYVINYL CHLORIDE (PVC) DOUBLE WALL CONTAINMENT PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joints</td>
<td>All</td>
<td>Solvent socket weld except where connection to threaded valves and equipment may require future disassembly. Solvent welded joints shall be made in accordance with ASTM D2855 procedures.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ASME B16.1 drilling.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.</td>
</tr>
</tbody>
</table>
| Gaskets            | All  | Flat Face Mating Flange: Full faced 1/8-inch-thick rubber as specified below.  
Raised Face Mating Flange: Flat ring 1/8-inch rubber as specified below, 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 and as recommended by pipe and fitting manufacturer.  
All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping. |
| Thread Lubricant   | All  | Teflon tape. |
| Manufacturers and Products | All | IPEX USA, LLC.; Clear-Guard™ Asahi/America, Inc.; Pro-Lock™ Spear Manufacturing Co.; Double Containment Or approved equal. |
## SECTION 40 27 00.15B
**CHLORINATED POLYVINYL CHLORIDE (CPVC) DOUBLE WALL CONTAINMENT PIPE AND FITTINGS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>All</td>
<td>Each contained piping system shall consist of Schedule 80 CPVC primary piping system supported within a Schedule 80 clear PVC secondary containment housing. Carrier fitting sizes 1/2-inch through 4-inch will use molded supports minimizing the number of factory assembled field fitting joints. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from PVC and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.</td>
</tr>
<tr>
<td>Carrier Pipe</td>
<td>All</td>
<td>Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441. Threaded Nipples: Schedule 80 PVC.</td>
</tr>
<tr>
<td>Containment Pipe</td>
<td>All</td>
<td>Schedule 80 Clear PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Threaded Nipples: Schedule 80 PVC.</td>
</tr>
<tr>
<td>Leak Detection</td>
<td>All</td>
<td>Visual.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>Schedule to Match Pipe Above: ASTM F439 for socket weld type and ASTM F437 for threaded type.. Fittings shall be manufactured with titanium dioxide for ultraviolet protection. All fittings shall be pre-assembled and pre-tested by the manufacturer. The splitting and re-welding of fittings shall not be permitted. The use of hot gas welding for pressure-retaining joints shall be kept to those locations where deemed necessary by manufacturer.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.15B

**CHLORINATED POLYVINYL CHLORIDE (CPVC) DOUBLE WALL CONTAINMENT PIPE AND FITTINGS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Joints</strong></td>
<td>All</td>
<td>Solvent socket weld except where connection to threaded valves and equipment may require future disassembly. Solvent welded joints shall be made in accordance with ASTM D2855 procedures.</td>
</tr>
<tr>
<td><strong>Flanges</strong></td>
<td>All</td>
<td>One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ASME B16.1 drilling.</td>
</tr>
<tr>
<td><strong>Bolting</strong></td>
<td>All</td>
<td>ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.</td>
</tr>
</tbody>
</table>
| **Gaskets**       | All  | Flat Face Mating Flange: Full faced 1/8-inch-thick rubber as specified below.  
Raised Face Mating Flange: Flat ring 1/8-inch rubber as specified below, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.  
Sodium Hydroxide: EPDM. |
| **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 and as recommended by pipe and fitting manufacturer.  
All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualifications procedures described in ASME B 31.3, Chapter VII for bonding of plastic piping. |
| **Thread Lubricant** | All | Teflon tape. |
| **Manufacturers and Products** | All | IPEX USA, LLC.; Clear-Guard™ Asahi/America, Inc.; Pro-Lock™ Spear Manufacturing Co.; Double Containment Or approved equal |

END OF SECTION
### SECTION 40 27 00.15C
STAINLESS STEEL DOUBLE WALL CONTAINMENT PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>All</td>
<td>Each contained piping system shall consist of stainless steel primary piping system supported within stainless steel secondary containment housing. Carrier fitting sizes 1/2-inch through 4-inch will use manufactured supports minimizing the number of factory assembled field fitting joints. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from stainless steel and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be located at all low points and at 100 feet intervals, maximum. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.</td>
</tr>
<tr>
<td>Carrier Pipe</td>
<td>2&quot; &amp; smaller</td>
<td>Schedule 40S: ASTM A312/A312M, Type 316L seamless, pickled and passivated. Schedule 80S for threaded connections.</td>
</tr>
<tr>
<td>Containment Pipe</td>
<td>2&quot; &amp; larger</td>
<td>Schedule 10S: ASTM A778, “as-welded” grade, Type 316L, pickled and passivated.</td>
</tr>
<tr>
<td>Joints</td>
<td>2&quot; &amp; smaller</td>
<td>Butt-welded or flanged at equipment as required or shown. Threaded connections permitted for connection to instrumentation and only where shown on drawing. An isolation valve is required immediately before all threaded connections.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welded or flanged at valves and equipment.</td>
</tr>
<tr>
<td>Item</td>
<td>Size</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fittings</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded: Forged 3000-pound WOG, ASTM A182/A182M, Grade F316 or cast Class 150, ASTM A351/A351M, Grade CF8/304.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; 2-1/2&quot;</td>
<td>Butt Welded: ASTM A403/A403M, Grade WP316L 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.</td>
</tr>
<tr>
<td></td>
<td>3&quot; &amp; larger</td>
<td>Butt-Welded: ASTM A774/A774M Grade 316L conforming to MSS SP 43, “as-welded” grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.</td>
</tr>
<tr>
<td>Branch Connections</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Tee or reducing tee in conformance with fittings above.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welding tee or reducing tee in accordance with fittings above.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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 Type 316L “as-welded grade”, conforming to MSS SP 43, wall thickness same as pipe.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Type 316 stainless steel, ASTM A193/A193M, Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.15C
STAINLESS STEEL DOUBLE WALL CONTAINMENT PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaskets</td>
<td>All Flanges</td>
<td>1/16 inch-thick Viton or inorganic filled Teflon flat ring type for raised face flanges and full face type for flat face flanges; Garlock or Durlon.</td>
</tr>
<tr>
<td>Thread Lubricant</td>
<td>2&quot; &amp; smaller</td>
<td>General Service: 100 percent virgin PTFE Teflon tape or Nickel pigmented PTFE, designed for stainless steel pipe, Air Force A-A-58092, AA Thread Seal Tape, Inc.</td>
</tr>
<tr>
<td>Manufacturers and Products</td>
<td>All</td>
<td>IPEX USA, LLC.; CustomGuard™ or approved equal.</td>
</tr>
</tbody>
</table>

END OF SECTION
## SECTION 40 27 00.18
### POLYVINYLIDENE FLUORIDE (PVDF) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>PVDF: Type I of ASTM D3222, conforming to ASTM D2837. Use unpigmented PVDF resin and Schedule 80 piping system rated for 230 psi for sizes 3/8 inch to 2-1/2 inches and 150 psi for 3 inches through 12 inches at 73.4°F.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>PVDF as specified under Pipe above. All pressure fittings shall be injection mold for butt fusion.</td>
</tr>
<tr>
<td>Branch Connections</td>
<td>All</td>
<td>Tee or reducing tee in conformance with fittings above.</td>
</tr>
<tr>
<td>Joints</td>
<td>All</td>
<td>Butt Fusion. Temperatures, times, and pressures of fusion shall be according to the manufacturer. Pipe joining equipment shall be provided by the pipe and fitting manufacturer.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>Stub end and polypropylene coated steel backing ring with ANSI, Class 150-pound bolt hole pattern. Follow manufacturers torque and tightening procedures.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Type 316 stainless steel, ASTM A193/A193M, Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All</td>
<td>Shall be low torque, full face to ASME B16.5 dimensions and shall have two concentric, convex, molded rings between center hole and bolt hole circle in Teflon-bonded EPDM or Viton.</td>
</tr>
</tbody>
</table>

END OF SECTION
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Process Piping Specialties

Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

Document Review & Approval:

Originator:

Steven R. Polson, P.E./Lead Process Mechanical

Design Verification Complete:

Qingshan Wang, P.E./Process Mechanical QC Reviewer

Approved:

W. Laird Ellis, Jr. PE/Design Manager
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):
   c. Section VIII Division 1, Boiler and Pressure Vessel Code: UG-127 through 136.

2. American Water Works Association (AWWA):
   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.

3. ASTM International (ASTM):


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. 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.

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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basket</td>
<td>One for each strainer</td>
</tr>
<tr>
<td>Disc seals</td>
<td>One for each strainer</td>
</tr>
<tr>
<td>Special tools required to maintain or dismantle</td>
<td>One complete set</td>
</tr>
</tbody>
</table>

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.

B. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch, unless shown as double arch on Drawings.
5. Thrust Restraint: Control rods to limit travel of elongation and compression based on the piping service test pressure, unless noted otherwise on the Drawings.
6. Manufacturers and Products:
   a. Garlock; Style 204.
   b. Unisource Manufacturing, Inc.; Style 1501.

C. Metal Bellows Connector:

2. Material: Type 316 stainless steel.
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. For BWA system, minimum deflection shall be:
   a. Axial Compression 3.65 inches.
   b. Lateral 1.1 inches.
   c. Angular 10 degrees.

7. Manufacturers and Products:
   b. Metraflex; Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.
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:
   b. Anamet Industrial, Inc.
   c. Unisource Manufacturing, Inc.
   d. Proco Products, Inc.

E. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials:
   a. Glass-filled polypropylene or PVDF with Viton-A or Teflon gaskets as recommended for the service by manufacturer.
   b. Glass-filled polypropylene with EPDM gaskets for sodium hydroxide service.
   c. Type 316 stainless steel with Viton-A or Teflon gaskets for sulfuric acid service.
   d. 
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.
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.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 253.
      2) Smith-Blair, Inc.; Style 441.

C. Transition Coupling for Steel Pipe:

1. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 162.
   b. Smith-Blair, Inc.; Style 413.

D. Flanged Coupling Adapter:

1. Anchor pins where required for thrust restraint.
2. Coupling shall comply with AWWA C219.
3. Flange shall be AWWA C207 Class D.
4. Gasket shall be Nitrile (Buna N).
5. Coupling shall be lined and coated with fusion bonded epoxy in accordance with AWWA C213-01.
6. Manufacturers and Products:
   a. Ductile Iron Pipe:
      1) Romac; Style 400.
      2) Smith-Blair, Inc.; Style 911.
      3) JCM Industries; Model 303.
E. Restrained Flange Adapter:

1. Pressure Rating:
   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.


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.

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 equal.

H. Restrained Stainless Steel Coupling:

1. Shell: Type 304 stainless steel.

2. Gasket: Ethylene Propylene Diene Monomer (EPDM) compounded for water and sewer service.

3. Bolts and Nuts: Type 304 stainless steel.

4. Compatible with Schedule 10S stainless steel piping.
5. Manufacturers and Products:
   b. Victaulic, Model 232S.

2.04 EXPANSION JOINTS

A. Copper Pipe Expansion Compensator:
   1. Material: Stainless steel bellows with female copper solder joint ends.
   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.

B. Galvanized and Black Steel Pipe Expansion Compensator:
   1. Material: All stainless steel.
   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.

C. Flexible Metal Hose:
   1. Type: Close pitch, annular corrugated with single braided jacket.
   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.

2.05 SEAL WATER HOSE

A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.
2.06  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.
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.

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:
   b.  Seal: Buna-N.
   c.  Clamps and Nuts: Stainless steel.
4.  Manufacturer: Smith-Blair; Style 315 or 317.

2.07  OUTLET/TAPPING SADDLES

A.  Materials:

2.  Seal: O-Ring SBR rubber gasket.
3.  Compatible with ductile iron pipe.

B.  Connection: As shown.

C.  Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D.  Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.
2.08 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. Use where modular mechanical seal is required.
2. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
3. Provided with end caps for support during concrete placement.
4. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

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. Use manufacturer’s recommended link material for the specific pipe material.
5. Sleeve: Use molded HDPE sleeve as specified herein.

2.09 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.

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.

2.10 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:
   1. Type, size, quantity, and materials as shown on Drawings and Standard Details.
   2. Manufacturer: SAF-T-FLO.

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.
2.11 STATIC MIXER


B. Construction:

1. Housing Diameter: 14 inches.
2. Ends: CL150 raised faced slip-on flange.
3. Housing and Flanges Material: Type 316/L dual grade stainless steel.
4. No. of Mixing Elements: One.
6. Chemical Injection Quill:
   a. Number: One.
   b. Size: 1/2-inch.
   c. Connection: CL150 raised faced slip-on flange.
   d. Material: Teflon.

C. Mixer Performance:

1. Design Flow Rate: 3,000 gpm.
2. Process Fluid: Water at 13 to 28 degrees C.
3. Reynolds Number: 714792.
4. Shear Rate: 151.9 sec\(^{-1}\).
5. Darcy Friction Factor: 2.72.
6. Pressure Drop (at design flow): 0.8 psi.

D. Manufacturer and Product:

1. Chemineer; Kenics 14.00 UTS 1.
2. Or equal.

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.

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.
   Model A7FL 125.

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.

D. Pump Seal Water Sight Flow Indicators:
   2. Rated 125 psi with NPT screwed ends.
   3. Operate with a minimum flow of 0.25 gpm.
   4. Manufacturers and Products:
      b. Jacoby Tarbox Co.

E. Desiccant Dryer for Sulfuric Acid Tank Vent:
   1. Refillable type desiccant installed on sulfuric acid storage tank vent,
      capable of maximum flow rate of 20 cfm and absorbing a minimum of
      5 pounds of water per desiccant charge.
   2. Manufacturers and Products:
      a. The Protectoseal Company; Series PVC780.
      b. Or approved equal.

F. Chemical Tubing and Fittings:
   1. Chemical System Tubing: Tubing and fittings shall be chemically
      compatible with the specified fluid. PVC tubing shall be smooth-wall,
      nylon reinforced clear PVC tubing suitable for a minimum working
      pressure of 75 psig at 70 degrees F. Burst pressure shall be 300 psig
      minimum. Tubing shall have inside diameter equal to nominal size as
      indicated on the Drawings.
   2. Pipe to Tube Connectors: Connectors for PVC tubing shall be PVC
      insert multi-barb by multi-barb, IPS socket, or NPT thread as required,
      with a rating equal to or greater than the tubing. Tube shall be secured
      to connector with stainless steel hose clamps.
   3. Manufacturers and Products:
      a. Ryan Herco, Herco-Braid Tubing.
      b. Or approved equal.
G. Non-Fragmenting Rupture Discs:

1. Rupture Disc: Type 316 stainless steel construction, full line size, reverse acting, non-fragmentation, 95 percent operating ratio. ASME stamped.

2. Rupture Disc Holder:
   a. Intended for combination use with Pressure Safety Valve.
   b. Type 316 stainless steel construction, suitable for installation between two Class 150 flanges.
   c. 1/4-inch minimum port for monitoring of annular space.

3. Rupture Discs Schedule:

<table>
<thead>
<tr>
<th>Tag Number</th>
<th>Service</th>
<th>Disc Burst Pressure (psig @ °F)</th>
<th>Nominal Pipe Size (inch)</th>
<th>Flow (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLDP-RD-700-A</td>
<td>SLR (5% TS)</td>
<td>40 psig @ 70° F</td>
<td>3</td>
<td>225</td>
</tr>
<tr>
<td>SLDP-RD-700-B</td>
<td>SLW (5% TS)</td>
<td>30 psig @ 70° F</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>SLDP-RD-700-C</td>
<td>TSL (5% TS)</td>
<td>125 psig @ 70° F</td>
<td>1 ½</td>
<td>60</td>
</tr>
<tr>
<td>CHEM-RD-513-C</td>
<td>TAPS</td>
<td>150 psig @ 70° F</td>
<td>1 1/2</td>
<td>7.5</td>
</tr>
</tbody>
</table>

4. Spare: Provide two spares for each type of rupture disc.

5. Manufactures:
   a. Pentair.
   b. Fike Metals Production company.
   c. Approved equal.

H. Spray Nozzle:

1. Fluid driven tank cleaning nozzle.

2. Specifications:
   a. Material: Type 316 stainless steel.
   b. Maximum Tank Diameter: 12 feet (3.7 m).
   c. Flow Rate Range: 2.7 to 33 gpm (12 to 128 l/min).
   d. Pressure Range: 30 to 230 psi (2 to 16 bar).
   e. Maximum Operating Temperature: 300 degrees F (150 degrees C).
   f. Minimum Tank Opening Size: 1-1/4-inch (31 mm).
g. Spray Coverage: 360 degrees.
h. Inlet Connection: 3/8-inch NPT.
i. Provide at core blow muffler and at each of three sludge storage tanks.

3. Manufacturers and Products:
   a. Spraying Systems Co.; Model: TankJet D41800E.
   b. Approved equal.

I. Tank Cleaning Lance:
   1. Mounted on 150-pound raised face flange, 3/8-inch stainless steel pipe with NPT connections, length as identified in Drawings.
   2. Attach above specified spray nozzle to end of lance.
   3. Provide at core blow muffler and at each of three sludge storage tanks.
   4. Manufacturers:
      a. Spraying Systems Co.
      b. 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, minimum of 12 inches, whichever is less, from the termination of any concrete backfill or concrete encasement.

   C. Flexible Joints at Concrete Structures:
      1. Install one joint 18 inches or less from face of structures; joint may be flush with face.
      2. Install a second flexible joint, whether or not shown.
         a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of first joint.
         b. Pipe Diameter Larger than 18 Inches: Within two to three pipe diameters of first joint.
      3. Flexible joint may be mechanical joint, proprietary restrained push-on joint, or restrained coupling suitable for specific pipe material.
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 as shown or in accordance with NFPA 24.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Not allowed.
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.

3.04 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

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. Anchors and Anchor Walls: 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:
   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.


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 using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.

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.

END OF SECTION
Process Valves and Operators

Revision History:

Revision No. | Description          | Date       | Affected Pages |
-------------|----------------------|------------|---------------|
0            | Issue for Construction | June 16, 2017 | All          |

Document Review & Approval:

Originator:
Steven R. Polson, P.E./Lead Process Mechanical

Design Verification Complete:
Qingshan Wang, P.E./Process Mechanical QC Reviewer

Approved:
W. Laird Ellis, Jr. PE/Design Manager
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.
3. American Society of Mechanical Engineers (ASME):
4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. American Water Works Association (AWWA):
   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.
   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):
   e. B61, Standard Specification for Steam or Valve Bronze Castings.
   f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
   i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.


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.

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. Manufacturer’s listing of recommended spare parts for each valve type and actuator.
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.
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 Motor Actuated Valve Schedule and Self-Regulated 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. General: The following specifications are organized by valve type number, which are referenced on the Drawings and in some equipment or system specifications. As a result of changes during design, it is possible that one or more of the following valve types may not be used on the project. The Drawings and other equipment and system specifications govern in terms of which valve types are used.

B. Gate Valves:

1. 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.

2. 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. 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.

C. Globe Valves:

1. Type V240 PVC Globe Valve 2 Inches and Smaller:
   a. Pressure rating of 150 psi at 70 degrees F, with ASTM D1784, Type 1, Grade 1 PVC body, bonnet, stem, and gland. Union bonnet and flanged ends. EPDM or FKM gasket and gland packing.
b. Manufacturers and Products:
   1) ASAHI/AMERICA; Manual Globe Control.
   2) Or approved equal.

D. 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.
      2) Soldered:
         a) Conbraco Apollo; 70-200.
         b) Nibco; S-580-70.

2. Type V301 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Two-piece, full 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. Provide lockable wheel handle or lever where required, lockable in open position.
   b. Manufacturers and Products:
      1) Threaded:
         a) Conbraco Apollo; 77-100.
         b) Nibco; T-585-70.
      2) Soldered:
         a) Conbraco Apollo; 77-200.
         b) Nibco; S-580-70.

3. 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.
4. **Type V307 Stainless Steel Ball Valve 2 Inches and Smaller:**
   a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psig CWP, complies with MSS SP-110.
   
   b. Manufacturers and Products:
      1) Conbraco Apollo; 86A-100 Series.
      2) Nibco; T-595-S6-R-66-LL.

5. **Type V308 Stainless Steel Ball Valve 2 Inches and Smaller:**
   a. Two-piece, standard port, NPT threaded ends, ASTM A351/A351M GR CF8M stainless steel body and end pieces, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 1,500 psig WOG minimum, 150 psi SWP, complies with MSS SP-110.
   
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76-100.
      2) Nibco; T-580-S6-R-66-LL.
      3) Milwaukee; 20SSOR-02.

6. **Type V311 Stainless Steel Ball Valve 2 Inches and Smaller:**
   a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, butt weld ends, schedule to match pipe, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1500 psig CWP.
   
   b. Manufacturers and Products:
      1) Conbraco Apollo; 86A-500/600 Series.

7. **Type V312 Stainless Steel Ball Valve 2 Inches and Smaller:**
   a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, socket weld ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1500 psig CWP.
   
   b. Manufacturers and Products:
      1) Conbraco Apollo; 86A-200 Series.

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, replaceable PTFE 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.

9. Type V335 CPVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 100 degrees F, 80 psi at 140 degrees, with
      ASTM D1784, Type IV, Grade 1 chlorinated polyvinyl chloride
      (CPVC) body, ball, and stem, end entry, double union design,
      with solvent-weld socket ends or single union ball with flanged
      ends drilled to ASME B16.1, replaceable Teflon 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.

10. Type V337 PVDF Ball Valve 2 Inches and Smaller:
    a. Rated 150 psi at 73 degrees F, with ASTM D3222 Type I, Grade 2
       or Type II PVDF body, ball, and stem, end entry, double union
       design, fusion-welded socket ends, replaceable PTFE 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.

11. Type V342 Stainless Steel Ball Valve 3 Inches and Smaller:
    a. Two-piece, flanged, Class 150, full port ball valve, ASTM A276
       GR 316 or ASTM A351/A351M GR CF8M stainless steel body
       and end pieces. Type 316 stainless steel vented ball, blow-out
       proof stem, and packing gland. TFM or reinforced PTFE seats and
       seals. Pressure rating of 150 psi. Stainless steel handle with vinyl
       sleeve.
    b. Manufacturers and Products:
       1) Flow-Tek/Bray; Model F15.
       2) Apollo; 87A-200 Series.
       3) Or approved equal.

12. Type V345 Stainless Steel Ball Valve 3 Inches and Smaller:
    a. Two-piece, flanged, Class 150, full port ball valve, ASTM A276
       GR 316 or ASTM A351/A351M GR CF8M stainless steel body
       and end pieces with actuator mounting pad. Type 316 stainless
       steel vented ball, blow-out proof stem, and packing gland. TFM
       or reinforced PTFE seats and seals. Pressure rating of 150 psi.
    b. Manufacturers and Products:
       1) Flow-Tek/Bray; Model F15.
       2) Or approved equal.

13. Type V350 Alloy 20 Ball Valve 2 Inches and Smaller:
    a. Three-piece, full port, Class 600, ASTM A351, Grade CN7M
       Alloy 20 body and end pieces, NPT ends, Alloy 20 vented ball,
       PTFE seats, seals, and packing, adjustable packing gland,
blowout-proof Alloy 20 stem, stainless steel trim and lever operator with vinyl grip, rated 1200 psig CWP.

b. Manufacturers and Products:
   1) Conbraco Apollo; 86C-100 Series.
   2) Or approved equal.

14. Type V351 Alloy 20 Ball Valve 2 Inches and Smaller:
   a. Three-piece, full port, Class 600, ASTM A351, Grade CN7M Alloy 20 body and end pieces, butt-weld ends, schedule to match pipe, Alloy 20 vented ball, PTFE seats, seals, and packing, adjustable packing gland, blowout-proof Alloy 20 stem, stainless steel trim and lever operator with vinyl grip, rated 1200 psig CWP.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 86C-500/600 Series.
      2) Or approved equal.

15. Type V352 Alloy 20 Ball Valve 6 Inches and Smaller:
   a. Two-piece, flanged, Class 150, full port ball valve, ASTM A351, Grade CN7M Alloy 20 body and end pieces with actuator mounting pad. Alloy 20 vented ball, RPTFE seats, PTFE seals and packing, adjustable packing gland, blowout-proof Alloy 20 stem, stainless steel trim and lever operator with vinyl grip. Pressure rating of 225 psi.
   b. Manufacturers and Products:
      1) Apollo; 87A-500 Series.
      2) Or approved equal.

16. Type V370 PVC 3-Way Ball Valve 4 Inches and Smaller:
   a. Multi-port ball valve rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1, Cell Class 12454 polyvinyl chloride body, ball, and stem, end entry, true union design, ANSI Class 150 flanged ends, PTFE seat, Viton or Teflon O-ring stem seals, L-Port with common branch connection.
   b. Manufacturers and Products:
      1) Hayward; LA Series.
      2) Spears; True Union.
      3) Or approved equal.

E. Plug Valves:

1. Type V400 Eccentric Plug Valve 2 Inches and Smaller:
   a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, threaded ends, lever operator, cast-iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber.
b. Manufacturers and Products:
   1) Pratt; Ballcentric.
   2) DeZurik; Style PEC.
   3) Milliken; Millcentric Series 603.

2. 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.

3. Type V442 Stainless Steel Eccentric Plug Valve 1/2 Inch to 12 Inches:
   a. Stainless steel eccentric plug valve with 2-inch nut actuator, nonlubricated type rated at 150 psi working pressure, Type 316 stainless steel body with flanged ends, plug stainless steel with FKM rubber facing, plug port round or rectangular of no less than 80 percent connecting pipe area, stem bearings lubricated stainless steel, stem seal of FKM and TFE, PTFE grit seals.
   b. Lever operator 2 inches and smaller, totally enclosed and sealed gear operator 3 inches and larger.
   c. Manufacturers and Products:
      1) DeZurik; PEC.
      2) Or 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.

F. 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. Provide NSF/ANSI 61 certificate for each valve.
   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 V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.
   d. Provide epoxy lining and coating in compliance with AWWA C550.
e. Manufacturers and Products:
   1) Pratt; Model 2FII or Triton XR-70.
   2) DeZurik; AWWA Valve.
3. Type V504 Butterfly Valve General Service 4 Inches to 48 Inches:
   a. AWWA C504, Class 150B.
   b. Mechanical joint end type.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.
   d. Provide epoxy lining and coating in compliance with AWWA C550.
   e. Manufacturers and Products:
      1) Pratt; Groundhog.
      2) DeZurik; Buried AWWA Valve.
4. Type V505 Butterfly Valve General Service 3 Inches to 36 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Type 316 stainless steel body, Type 316 stainless steel disc, Type 316 stainless steel shafts, EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.
   d. Manufacturers and Products:
      1) DeZurik; AWWA Valve.
5. Type V520 Solid Polyvinyl Chloride Butterfly Valve 1-1/2 Inches to 8 Inches:
   a. Wafer body type, pressure rated 150 psi at 70 degrees F CWP, solid ASTM D1784, Type I, Grade 1, PVC body and contoured PVC or polypropylene valve disc, stainless steel valve stem, Viton seat, lever operator.
   b. Manufacturers and Products:
      1) ASAHI/America; Type 57.
      2) Spears.

G. Check and Flap Valves:

1. Type V602 Check Valve 2 Inches and Smaller:
   a. All bronze, threaded cap, threaded ends, swing type replaceable Teflon disc and bronze disc holder, rated 150-pound SWP, 300-pound WOG.
   b. Manufacturers and Products:
      1) Walworth; Figure 3412.
      2) Milwaukee; Figure 510.
2. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
   a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, Schedule 80, dual union socket weld ends, rated 150 psi at 73 degrees F, Viton seat and seal, 25 psid cracking pressure.
b. Manufacturers and Products:
   1) Nibco; Chemtrol Tru Union.
   2) ASAHI/America.
   3) Spears; True Union 2000.

3. Type V631 CPVC Ball Check Valve 4 Inches and Smaller:
   a. ASTM D1784 Cell Class 23477B CPVC body, Schedule 80, dual
      union socket weld ends, rated 150 psi at 73 degrees F, 110 psi at
      140 degrees F, Viton seat and seal, 25 psid cracking pressure.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru Union.
      2) ASAHI/America.
      3) Spears; True Union 2000.

4. Type V632 Ball Check Valve 3 Inches and Larger:
   a. Flanged end, iron body valve with cleanout and sinking type
      hollow steel ball, vulcanized nitrile rubber exterior, flanges
      ASME B16.1, Class 125, rated 150-pound working pressure,
      suitable for vertical up or horizontal flow.
   b. Manufacturers and Products:
      1) FLYGT Corp; HDL.
      2) Flomatic Corp.; 408.
      3) Golden Anderson; 240D.

5. Type V633 Ball Check Valve 2 Inches and Smaller:
   a. Socket end, PVC body valve with cleanout and sinking type nitrile
      ball, suitable for vertical up or horizontal flow.
   b. Manufacturers and Products:
      1) Flomatic Corp.; 208S.
      2) Hayward; YC Series.

6. Type V634 Rubber Flapper Check Valve 2 Inches to 24 Inches:
   a. Iron body, ASME B16.1, Class 125 flanges, steel-reinforced
      Buna-N flapper raised seating ring, rated 150-pound CWP.
   b. Manufacturers and Products:
      1) APCO; Series 100.
      2) Val-Matic; “Swingflex.”

7. Type V635 Rubber Flapper Check Valve 2 Inches to 24 Inches:
   a. Stainless steel body, ASME B16.1, Class 125 flanges, steel-
      reinforced Buna-N flapper raised seating ring, rated 150-pound
      CWP.
   b. Manufacturers and Products:
      1) APCO; Series 100.

8. Type V636 Alloy-20 Ball Check Valve 2 Inches and Smaller:
   a. Alloy-20 body, ball and spring, NPT threaded ends, Viton seats,
      seals, 25 psid cracking pressure, rated 1,500 psig CWP.
   b. Manufacturers and Products:
      1) Check-All Valve Mfg. Co.; Type U3.
      2) Or approved equal.
9. Type V692 Flap Valve 4 Inches to 30 Inches:
   a. Flange style frame, cast-iron body, bronze seats on body and cover, bronze hinge pins.
   b. Manufacturers and Products:
      1) M&H Valve; Style 47-02.
      2) Clow Valve; No. F-3012.

10. 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 EPDM.
    b. Manufacturer and Product: Red Valve Co.; Tideflex Check Valve Series TF-1 or 35-1.

11. Type V695 Check Valve 2-Inch to 12-Inch:
    a. All elastomer duckbill design, in-line insert style with flanged end, valve open with approximately 1 inch WC line pressure and return to CLOSED position under zero flow condition, flange drilled to ASME B 16.5, Class 150, elastomer Viton.
    b. Manufacturers and Products:
       1) General Rubber; Flex-Valve In-Line Style 4300.
       2) Red Valve Co.; Tideflex Check Valve Series 37.
       3) Or approved equal.

H. Self-Regulated Automatic Valves:

1. Type V711 Pressure-Reducing Valve 2 Inches and Smaller:
   a. Direct diaphragm, spring controlled, cast-iron body, spring case, composition seat and diaphragm, stainless steel valve stem, NPT threaded ends, 250-psig rated.
   b. Size/Rating: As shown in Valve Schedule.
   c. Manufacturer and Product: Fisher; 95 Series.

2. Type V720 PVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve 1/2 Inch to 2 Inches:
   a. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
   b. PVC body, Teflon or Viton diaphragm, PVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.
   c. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum.
d. Manufacturers and Products:
   1) Plast-O-Matic; Series RVDT.
   2) Griffco; Series BPV.
   3) Primary Fluid Systems; TOP Valve.

3. Type V721 CPVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve 1/2 Inch to 2 Inches:
   a. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
   b. CPVC body, Teflon or Viton diaphragm, CPVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.
   c. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum.
   d. Manufacturers and Products:
      1) Plast-O-Matic; Series RVDT.
      2) Griffco; Series BPV.
      3) Primary Fluid Systems; TOP Valve.

4. Type V722 Stainless Steel Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve 1/2 Inch to 2 Inches:
   a. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
   b. Stainless steel body, Teflon or Viton diaphragm, Teflon piston, stainless steel adjusting bolt and locknut, stainless steel spring and fasteners.
   c. Designed to open when upstream pressure reaches set point, set pressure adjustable from 10 psi to 100 psi, minimum.
   d. Manufacturers:
      1) Primary Fluid Systems, Inc.
      2) Stra-Val.
      3) Or approved equal.

5. Type V723 PVC Pressure Regulating Valve, 1/2 Inch to 1-1/2 Inches:
   a. Diaphragm operated assembly, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
   b. PVC body, Viton seals and diaphragm, coated stainless steel spring, stainless steel adjusting bolt, locknut, and fasteners.
   c. Designed to regulate downstream pressure closing when pressure reaches setpoint; set pressure adjustable from 5 psi to 50 psi.
   d. Manufacturers and Products:
      1) Plast-O-Matic, Series PR.
      2) Hayward; Pressure Regulator.

6. Type V724 CPVC Pressure Regulating Valve, 1/2 Inch to 1-1/2 Inches:
   a. Diaphragm operated assembly, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
   b. CPVC body, Viton seals and diaphragm, coated stainless steel spring, stainless steel adjusting bolt, locknut, and fasteners.
c. Designed to regulate downstream pressure closing when pressure reaches setpoint; set pressure adjustable from 5 psi to 50 psi.

d. Manufacturers and Products:
   1) Plast-O-Matic, Series PR.
   2) Hayward; Pressure Regulator.

7. Type V731 Pressure-Safety Valve 12 Inches and Smaller:
   a. Direct spring controlled, stainless steel body, stainless steel metal seat, stainless steel valve stem, 150-pound raised face flanged ends.
   b. Opens when upstream pressure reaches a maximum set point.
   c. Suitable for air, sludge or water service.
   d. Size, flow and pressure requirements shown in Self-Actuated Valve Schedule.
   e. Gas Service:
      1) Conventional Type, with NPT connections.
   f. Liquid Service:
      1) Conventional Type.
   g. Sludge Service:
      1) Conventional Type.
      2) Install burst disk on inlet side, close coupled to valve.
   h. Manufacturer and Product:
      2) Pentair Crosby; 800 Series (Gas Service).
      3) Approved equal.

8. 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.

9. Type V751 Dual Orifice Sewage Air and Vacuum Valve 1 Inches to 8 Inches:
   a. Valves shall be anti-surge and antishock air release and vacuum break valves suitable for sewage service. Valve shall automatically exhaust air at a high rate air through a full sized orifice during system filling, release air at a lower controlled rate through a small orifice during operation, and allow air to re-enter through a full sized orifice at a high rate during draining or when vacuum occurs. As such, valve shall have four functions in a single chamber: (1) uninterrupted discharge of air/gas during filling; (2) continuous discharge of dis-entrained pressurized
air/gas; (3) unrestricted vacuum break; (4) and pipeline surge protection.

b. The intake/discharge orifice area is equal to the nominal size of the valve. The smaller service orifice shall be as noted in the valve schedule. Valve shall include 1/2-inch test cock connection.

c. Valve shall utilize solid unbreakable HDPE floats with EPDM O-Ring seals. Floats must not deform, leak or experience damage of any kind at twice the design pressure, with floats providing continuous discharge of pressurized air release without levers, pins, springs that can break.

d. Valve shall have a 10-year in-service warranty for all internal components.

e. The valves furnished shall be standard products in regular production by the manufacturer and shall have been in satisfactory and successful operation for a period of at least 5 years.

f. Rated working pressure of 150 psi, 1-inch through 2-inch valves with MNPT threaded connection; 3-inch and larger valves with ASME B16.1 Class 125 flanged inlet; built and tested to AWWA C512.

g. Materials:
   1) Type 304 stainless steel barrel, tie rods, and fasteners. Type 316 stainless steel nozzle. Fusion bonded, epoxy coated ductile iron top and bottom flanges with ABS Polylac Top Cover.
   2) Type 304 stainless steel barrel, flanges, tie rods and fasteners. Type 316 stainless steel nozzle and ABS Polylac Top Cover.
   3) Type 316 stainless steel barrel, flanges, tie rods, nozzle and fasteners. ABS Polylac Top Cover.
   4) Floats: High density polyethylene.

h. Manufacturers and Products:
   1) Vent-O-Mat Series RGX by RF Valves, Inc. Hanover, Maryland.
   2) Or approved equal.

10. Type V780 PVC Conservation Vent Valve 2 Inch to 8 Inches:
   a. PVC end-of-line pressure and vacuum breather vent, suitable for sulfuric acid service, combined pressure and vacuum release valve. Automatically exhaust air during filling of system and allow air to re-enter during draining or when vacuum occurs.
   b. Polyvinyl chloride (PVC) body, cover and hood; PVC pallet assembly components; FEP diaphragms; PVC hardware; Type 316 stainless steel weights, if required.
   c. Self-draining body design to condensate away from seating surface. ASME B16.1 Class 125 flanged inlet and cover outlet.
   d. Manufacturers and Products:
      1) The Protectoseal Company; Series 8540B.
      2) Or approved equal.
11. Type V785 IBC Pressure and Vacuum Vent Valve 2 Inch:
   a. Plastic combined pressure and vacuum release valve designed specifically for IBC totes to maintain a closed system. Polyethylene (PE) Body and Viton gasket and seals.
   b. Vents to be provided by Contractor for owner installation on chemical totes.
   c. Manufacturers and Products:
      1) Snyder Industries, Inc.
      2) Precision IBC, Inc.; Model 1320B.
      3) Or approved equal.

I. Miscellaneous Valves:

1. Type V900 Diaphragm Valve 1/2 Inch to 12 Inches:
   a. Weir type, PFA-lined ductile-iron body with epoxy coated body and topworks, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, locking device, Viton diaphragm and seals, Xylan 1014 coated bolts in accordance with MSS SP-88 Category B.
   b. Manufacturers and Products:
      1) ITT Engineered Valves.
      2) Saunders Valve, Inc.

2. Type V901 Diaphragm Valve 1/2 Inch to 12 Inches:
   a. Straight-through type, PFA-lined ductile-iron body with epoxy coated body and topworks, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, locking device, Viton diaphragm and seals, Xylan 1014 coated bolts in accordance with MSS SP-88 Category B.
   b. Manufacturers and Products:
      1) ITT Engineered Valves.
      2) Saunders Valve, Inc.

3. Type V902 Diaphragm Valve 1 Inch to 8 Inches:
   a. Straightway Type, 316L Stainless Steel Body, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, diaphragm Buna-N, in accordance with MSS SP-88 Category B.
   b. Manufacturers and Products:
      1) ITT Engineered Valves; Dia-Flo.
      2) Approved equal.

4. Type V903 Diaphragm Valve, 1/2 Inch to 4 Inches:
   a. Weir type with PVC Type 1, Grade 1 body, PTFE with EPDM backing diaphragm, double union design, solvent weld socket ends or flanged ends, handwheel operator, position indicator, adjustable travel stop, clear molded acrylic stem cap.
b. Manufacturers and Products:
1) ASAHI/AMERICA; Diaphragm Valve Type 14.
2) ITT Engineered Valves; Dia-Flo.
3) Saunders Valve; Diaphragm Valve.

5. Type V904 Diaphragm Valve, 1/2 Inch to 4 Inches:
   a. Weir type with PVC Type 1, Grade 1 body, PTFE with EPDM backing diaphragm, double union design, solvent weld socket ends or flanged ends, handwheel operator, position indicator, adjustable travel stop, clear molded acrylic stem cap.
   b. Manufacturers and Products:
      1) ASAHI/AMERICA; Diaphragm Valve Type 14.
      2) ITT Engineered Valves; Dia-Flo.
      3) Saunders Valve; Diaphragm Valve.

6. Type V916 Cast Stainless Steel Mud Valve 4 Inches to 20 Inches:
   a. Heavy-duty CF8M stainless steel yoke, flange, guides, and gate; reinforced PTFE seat mechanically retained with Type 316 stainless steel fasteners, non-rising stem. Stainless steel casting to be passivated per ASTM A380. Type 316 stainless steel one-piece stem shall be guaranteed against galling with rolled threads or cast/cut thread with permanently bonded anti-galling compound.
   b. 2-inch square nut with one-piece Type 316 stainless steel removable Tee-handle valve wrench of sufficient length to locate handle 3 feet above the finished floor.
   c. Manufacturers:
      1) Troy Valve.
      2) Trumbull Industries, Inc.

7. Type V941 Solenoid Valve 3/8 Inch to 2 Inches, Slow Closing:
   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 table attached to this Specification.
   b. Include snubber system to control closing speed and prevent water hammer.
   c. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.
   d. Manufacturers and Products:
      1) ASCO; 2/2, Series 8221.
      2) Skinner; Anti-Water Hammer and Slow Closing.

8. Type V970 Stainless Steel Dry Disconnect Valve 2 Inches and Smaller for Sulfuric Acid Service:
   a. Type 316 stainless steel construction, double ball valve cam-lock assembly for transfer of sulfuric acid. Valves self-locking to prevent disconnect when valves are open, and to prevent valve from opening when not connected.
b. Rated 100 psig max operating pressure, 300 degrees F maximum operating temperature.
c. Seals and valve seats PTFE, or other approved material.
d. Manufacturers and Products:
   1) Banjo Dry-Mate 316SS; DM200ASS and DM200DSS.
   2) 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 Operators, 120 Volts:

1. General:
   a. Unit shall be low profile to reduce amount of required space and weigh 15 pounds or less.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of the valve.
   c. Provide operator mounting bracket to mount operator to valve providing minimal torque to piping system when operating.

2. Operator Operation, General:
   a. Suitable for full 90-degree rotation of quarter-turn valves.
   b. Manually override handwheel.
   c. Mechanical valve position indication.

3. Electronic Control:
   a. Torque Limiting Switches: Two single pole, double throw mechanical switches. Switches operate at any point in valve travel.
   b. Jammed-valve detection and protection.
   c. Motor over-temperature detection and protection.
   d. Travel limit switches, single pole double throw.

4. Open-Close (O/C) Service:
   a. Duty cycle for intermittent ON-OFF operation shall be 25 percent.
   b. Operator shall power to OPEN and power to CLOSE.
   c. Local Indication and Control:
      1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
      2) Integral Red OPENED and Green CLOSED pilot-lights.
      3) Integral LOCAL-OFF-REMOTE (L-O-R).
      4) Integral OPEN maintained switch which causes the valve to stroke full OPENED, even if OPEN switch is released, while L-O-R switch is in LOCAL.
      5) Integral CLOSE maintained switch which causes valve to stroke full CLOSED, even if CLOSED switch is released, while L-O-R switch is in LOCAL.
   d. Remote Indication and Control:
      1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
      2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
      3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
   e. Modulating (M) Service:
      1) Operator rated for continuous duty with servo shall be rated for 100 percent modulating operation.
      2) Operator shall modulate based on an externally applied 4 mA to 20 mA dc signal.
3) Operator shall be equipped with an electronic servo module for valve modulation.
   a) Module shall provide serial communications with provided cable for setup of valve operation.

f. Local Indication and Control:
   1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
   2) Integral Red OPENED and Green CLOSED pilot-lights.
   3) Integral LOCAL-OFF-REMOTE (L-O-R).
   4) Integral OPEN momentary switch which causes valve to stroke towards OPENED, as long as OPEN switch is held, while L-O-R switch is in LOCAL.
   5) Integral CLOSE momentary switch which causes valve to stroke towards CLOSED, as long as CLOSED switch is held, while L-O-R switch is in LOCAL.
   6) Position valve proportionally 0 to 100 percent OPEN with external 4 mA to 20 mA dc signal while in REMOTE.

g. Remote Indication and Control:
   1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
   2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
   3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
   4) Current Position Transmitter, 4 mA to 20 mA dc signal in proportion to 0 percent to 100 percent OPENED, with 0.5 percent accuracy and 0.5 percent repeatability, capable of driving a 750-ohm load, for connection to and monitoring by Plant Control System.

5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.


C. 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 multturn valves, as applicable.
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. Red OPEN and Green CLOSED pilot-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. Fail Closed (FC) Service:
   a. Spring-return actuator shall return to the closed position in the event of power loss.
   b. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
   c. LOCAL-OFF-REMOTE Selector Switch:
      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. Red OPEN and green CLOSED pilot-lights.
   e. Integral reversing motor starter with built-in overload protection.

6. 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.

7. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.

8. Manufacturers and Products:
   a. Rotork Controls; IQ Series.
   b. Flowserve Limitorque; L120 MX Series.

2.07 ACCESSORIES

   A. Tagging: 1-1/2-inch diameter stainless steel tag attached with No. 16 stainless steel jack chain for each valve operator and valve, bearing valve tag number shown on Electric Actuated Valve Schedule, and Self-Regulated Valve Schedule on drawing.

   B. Limit Switch: Factory installed NEMA 4X limit switch by actuator manufacturer.

   C. T-Handled Operating Wrench:

      1. Operating wrenches, 2-inch square nut, length as required to accommodate buried valve depth below grade, plus 3 feet abovegrade to handle. A separate T-handled wrench shall be provided for the INF/PLE valves at the MTF; and the FW valves at the MTF.
2. Manufacturers and Products:
   b. Clow No.; F-2520.
   c. Or approved equal.

D. Extension Bonnet (Neck Extension) for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator. Connection to valve shall be watertight.

1. Manufacturers and Products:
   a. Pratt.
   b. DeZurik.

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.

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.

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.
H. 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.
5. UL Listed and FM Approved.
6. Manufacturers and Products:
   a. Clow; Style 2945.
   b. Mueller; A-20806.

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. Install safety isolation valves on compressed air.

   G. Locate valve to provide accessibility for control and maintenance. Install
      access doors in finished walls and plaster ceilings for valve access.

   H. 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.
I. 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.

J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

K. 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 MANUFACTURER’S SERVICES

A. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.
3.04 SUPPLEMENTS

A. The supplements listed below are a part of this Specification:

1. Electric Actuated Valve Schedule (see Drawings).
2. Self-Regulated Valve Schedule (see Drawings).

END OF SECTION
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Plunger Valves

Revision History:

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<tr>
<th>Revision No.</th>
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<td>0</td>
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Document Review & Approval:

Originator: Steven R. Polson, P.E./Lead Process Mechanical

Design Verification Complete:

Approved: W. Laird Ellis, Jr. PE/Design Manager
SECTION 40 27 02.02
PLUNGER VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. Furnish horizontal in-line plunger valve ANSI 150 class assemblies, complete with electric modulating type actuator and aeration device specified for flow control and isolation, factory tested, and operable, as shown on Drawings, and as specified herein.

1.02 REFERENCES

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

1. American National Standards Institute (ANSI):
   a. B1.20.1, Pipe Threads, General Purpose (Inch).

2. American Iron and Steel Institute (AISI):
   a. 304, Austenitic Stainless Steel (maximum percent: 0.08C, 2.0 Mn, 1.0 Si, 18-20 Cr, 8-10.5 Ni).
   b. 420, Martensitic Stainless Steel (minimum percent: 0.15C, maximum percent: 1.0 Mn, 1.0 Si, 12-14 Cr, 0.0 Ni,).

3. ASTM International (ASTM):
   b. A216, Specification for Steel Casting, Alloy, Specially Heat-Treated, for Pressure Containing Parts, Suitable for High Temperature Service.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s data and descriptive literature. Include catalog data, preliminary performance testing procedures, quality control procedures, calculations, detailed construction sheets showing all valve parts and descriptions of materials of construction with and applicable USA material specifications. Identify valve by tag number to which the catalog data and detail sheets pertain.
b. Factory developed production drawings that clearly show valve dimensions, laying length, port size, component parts, and materials of construction.

c. Modeling results for both estimated noise levels in decibels and for cavitation and its control through the complete stroke of the valve and through all flow rates.

d. Assembly drawings that clearly shows dimensions and orientation of valve actuator as installed on the valve. Clearly show location of internal stops for gear actuator. Provide valve actuator safety verification through the complete stroke specifically noting values for both break torque under maximum differential as well as maximum dynamic torque. Valve manufacturer’s compliance shall be factory signed and dated.

e. Actuator sizing calculations.

f. Actuator product data and literature, including travel times from full closed to full open.

g. Shop coating and lining specifications, which clearly identify all valve linings and coatings.

h. Coating and lining test reports that report and verify the valve interior lining condition is tested for absence of holidays, and lining thickness. Describe test results and repair procedures for each valve. Do not ship valves to project site until the reports have been approved by the Engineer and accepted by the Owner.

i. Purchaser Furnished Data: Subject to Engineer approval.

j. Operating Conditions: Furnish valve-operating conditions, design criteria, process criteria, and facility drawings sufficient in detail and extent used by the Manufacturer to properly customize plunger valve performance.

B. Informational Submittals:

1. Valve summary data sheet that provides the station, valve structure, type, manufacturer, size, pressure rating, minimum and maximum flow valve opening percentages, zeta value upstream and downstream, drilling pattern and model number of each valve; and type, manufacturer and model number of the valve actuator.

2. Hydrostatic test reports, functional performance test reports, and any other required test reports. Hydrostatic test reports shall be presented which reflects the requirement of the test procedures.

3. Factory export packaging specifications, applicable to overseas shipping via surface carrier.

4. Quality assurance program certificate of compliance.

5. Furnish Operations and Maintenance Manual for valve(s) in accordance with Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer’s Certificate of Compliance and Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage 1 complete set of special tools required to maintain or dismantle the plunger valve.

1.05 QUALITY ASSURANCE

A. Manufacturer shall be ISO 9001 and ISO 14001 Certified.

B. Shop Inspection: The manufacturer shall provide a 4-week advance notice to the Engineer prior to performing tests, and shall allow full access to designated Owner’s representatives for inspection of manufacturing facilities and processes, and any specified testing. The manufacturer shall perform all testing at manufacturer’s cost.

C. Shop Testing: Plunger valve shall be shop tested prior to shipment in accordance with the following minimum standards:

1. Hydrostatic Test: Plunger valve shall be hydrostatically tested to withstand 1.5 times of the valve’s maximum design operating pressure rating. Zero leakage is allowed in either direction.

2. Functional Flow Performance Test: Plunger valve shall be subjected to an operational/test using potable water. The test procedure shall include three complete open/close cycles of operation with the valve actuator settings in place (limit switches, torque switches, pilot pressure settings, etc.).

1.06 EXPERIENCE AND SERVICE RESPONSE

A. The valve manufacturer shall have a minimum of 10 years of experience in the production and sales of plunger valves. The valve manufacturer shall also have at least 25 installed plunger valve references that have been in operation in the last 5 years.

B. The valve manufacturer shall provide 24-hour manufacturer’s response for any field service requirement. Approved service agents, licensee(s), or representatives of the manufacturer shall be permitted as long as the valve manufacturer is present. The valve manufacturer shall be responsible for its authorized agents and licensees. A detailed manufacturers signed service call write up, inclusive of photo-documentation, shall be provided without exception, by the valve manufacturer. The valve manufacturer shall be required to know and keep data files on all work performed, modifications and
remediations as well as the agents performing the work. This data shall be permanently kept with the manufacturer regardless of licensee.

1.07 WARRANTY

A. The plunger valve manufacturer shall warrant its products, including actuators incorporated in the work, to be free from defects in materials, workmanship and performance for a period of 5 years from the date of Substantial Completion. Upon notice by the Owner, any damage or defect found during the warranty period shall be promptly repaired or replaced by the manufacturer at no cost to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer shall furnish all components required including the plunger valve, actuator, orifice plate, aeration system, base plate, fasteners, painting, and all other components required for a complete functional valve assembly.

2.02 PLUNGER VALVE MANUFACTURER

A. ERHARD GmbH and Co.; Model RKV, Cascade Consultants LLC.

B. VAG-Armaturen GmbH, RIKO Plunger Valve, Rodney Hunt.

C. Or approved equal.

2.03 PLUNGER VALVE PERFORMANCE REQUIREMENTS

A. Performance: Valve shall be designed to operate smoothly throughout the specified flow range without cavitation, excessive noise, or vibration for the conditions stated below.

1. Valve shall be designed for a maximum operating pressure of 250 psi.
2. Valve design shall, if recommended by manufacturer, include cavitation control features to break the heads and flows. Cavitation control features shall (both at high head break and at low head break operating conditions) not cause blockage in valves requiring maintenance other than simply opening or closing valve to dislodge materials and flush water out of valve.
3. The design currently provides six diameters of straight run downstream of the valve. Valve manufacturer shall notify Engineer in writing of any risk of cavitation damage to the piping downstream of the plunger valves due to the operating conditions indicated on Drawings and Specifications and suggest elongating straight piping downstream of the valve if such modifications are deemed necessary to protect the downstream piping (including valves) from cavitation damage. This
shall be done in the first equipment submittal to allow the Engineer the opportunity to revise the piping arrangement. Contractor shall defer ordering piping and isolation valves until a determination has been made regarding the need for piping revisions.

B. Noise: Operating noise levels shall not exceed 95 decibels (dBA) at a distance of 3 feet from the valve at the normal flow point. Material stresses shall not exceed 1/5 of the ultimate or 1/3 of the yield strength of the material.

C. 14-inch, Flow Control Plunger Valve Operation Data: Intended valve use is to provide flow control and energy dissipation for breaking head from a maximum of 57.6 psia static pressure to 24.1 psia.

1. Downstream Pressurized Discharge:
   a. Normal Operating Range: 100 to 2750 gallons per minute (gpm).
   b. Maximum Inlet Pressure: 57.6 psia (at 100 gpm).
   c. Minimum Inlet Pressure: 26.3 psia (at 2750 gpm).
   d. Maximum Outlet Pressure: 24.3 psia (at all flow conditions).
   e. Minimum Outlet Pressure: 24.1 psia (at all flow conditions).
   f. Discharge to gravity flow pipe approximately 30 feet downstream and vertically above valve, as shown on the Drawings.
   g. Operating Function: Modulating/throttling flow control valve. Valve shall function as modulating flow control valve with flow setting and flow “dead band” width setting selected by operator. Flows will be read at a meter upstream of valve.

2.04 PLUNGER VALVE OPERATING REQUIREMENTS

A. Valve Assembly Components: Plunger valve assembly shall consist of a flanged short conical inlet section having an internal cone to divert the water flow into the annular chamber of the body section.

B. An oval body section with an inner annular chamber shall be formed by the body shell. The plunger with custom designed cylinder control trim is part of internal slider-crank mechanism and is driven by an AWWA worm gear. The control trim cylinder shall be field removable and replaceable with alternate control trim when hydraulic conditions change or new operating parameters are required.

C. The plunger shall move in an axial flow direction to reduce or enlarge the annular flow cross-section through slots in a degressive manner, and the medium will flow through the customized regulating cylinder from the outer annular chamber to the inner chamber of the plunger, providing for flow control.
D. The seals of the plunger valve shall allow the valve to be drip and bubble tight in both flow directions for the long term. The outside of the plunger shall seat against a back-seal. The O-ring shall deflect and seal in both axial directions. The seal shall be insensitive to debris. The elastomeric profile sealing ring shall seat leak tight at the downstream end of the plunger. The elastomeric profile sealing ring shall be mechanically retained in either the downstream flange of the valve body or directly on the face of the plunger. Valve shaft seals shall prevent the long term potential of water entering into the gear case. The valve operating shaft shall have O-ring seals. The O-ring seals shall maintain a drip tight seal regardless of modulation cycles or inactivity.

E. The minimum closure time of the plunger valve from full open to full close shall be 1 minute.

F. Valve shall be provided with 4 integral feet per each 180-degree circumference. There shall be four total lifting lugs, one per each foot. The four lifting lugs shall be factory drilled and tapped. They shall be sufficiently broad in placement to assist with rigging of an unbalanced load.

G. The valve shall function properly and without issue within any 180-degree flange rotation.

2.05 PLUNGER VALVE DESIGN FEATURES

A. Plunger valve shall be either a one-part or two-part body design with interior geometry that provides water flow that is guided around a streamlined internal body. The design shall feature a geometrically optimized design, a continuous annular cross-sectional reduction from inlet to throttle cross-section, and continuous rise of flow velocity to the exit without producing cavitation.

B. Plunger valve design shall feature a customized designed plunger with tailored anti-cavitation trim to minimize cavitation. The plunger shall be seated against the upstream O-ring and an elastomeric seat located in body downstream flange with the valve in the closed position. Orifice shall be fully closed when the valve is placed in the closed position. The elastomeric seat shall be properly kept in position. The profile seat ring shall not be penetrated by fasteners, exposed to the flow stream in the open position, and shall not be subject to cold flow of the elastomer.

C. Plunger valve design, when open during operation, shall feature plunger assembly movement in the upstream side direction to release water through the orifice.

D. Plunger valve design shall feature advance and retract axial strokes of the plunger, guided in the internal body by an internal slider-crank mechanism of stainless steel. The provided actuator shall include a mechanical stop in the open and closed positions. The plunger shall slide and be contained in the
axial position by guide rails. The guide rails shall be completely fused to the valve body in an overlay weld process to prevent any gaps or corrosion pathways. Guide rails which are bolted to the valve body are not acceptable, due to concerns over long-term operability and corrosion protection. The guide rails shall be bronze and shall be positioned around the plunger in a quantity to reduce the potential for damaging harmonic vibration, clogging or excessive wear. The guide rails shall be low to no lead and very low zinc content to prevent dezincification.

E. Motion shall be controlled by means of electric actuator attached to the body section.

F. The design of the annular throat cross section in any position of the plunger shall ensure linear regulation of flow. Flow rate as a function of pressure drop across the valve shall be linear to within 3 percent.

G. The valve may use a vaned ring, slotted cylinder, or perforated cylinder, as determined by the manufacturer to be most appropriate for the operating conditions defined herein.

H. Actuator for plunger valve shall be as specified in Section 40 27 02, Process Valves and Operators.

I. Flanged connections shall mate with adjacent flanges, which will be AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face.

J. The movement of the plunger shall be controlled by means of maintenance free irreversible, self-locking, quarter turn, AWWA worm gear unit with externally adjustable mechanical stops to limit valve travel in both the open and closed positions. The valve stroke shall equal 90 degrees plus or minus 2 degrees, whereby the mechanical stops of the worm gear shall be engaged before the full extension or retraction of the plunger. In no instance shall the full output torque of actuator be allowed to be transmitted to the valve at its end of travel, either open or closed, without engaging the travel stops of the worm gear first. The AWWA worm gear unit shall be operated by an electric actuator.

K. Plunger Valve Base Plates. Submit and obtain approval for, and provide, base plates for plunger valve. Base plates must be able to be unbolted to remove the valve from the adjacent process piping by sliding the valve up to 3 inches horizontally away from the upstream flange before it is lifted vertically. Base plates shall be designed to secure valve to a reinforced concrete base.
## 2.06 MATERIAL REQUIREMENTS

A. Principal Component Parts Materials of Valve Construction:

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<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Material</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Valve Body</td>
<td>All</td>
<td>Ductile Iron</td>
<td>ASTM A536, GR. 60, 40, 18</td>
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<td>Plunger</td>
<td>All</td>
<td>Stainless Steel</td>
<td>AISI 304</td>
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<tr>
<td>Regulating Cylinder</td>
<td>All</td>
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<td>AISI 304</td>
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<td>Shaft Bushing</td>
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<td>ASTM C90800/CuSn12</td>
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<tr>
<td>Crank Shaft</td>
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<td>AISI 420</td>
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<tr>
<td>Crank Mechanism</td>
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<td>AISI 304</td>
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<tr>
<td>Seat/Retaining Ring</td>
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<td>AISI 304</td>
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<tr>
<td>Plunger Guide Rails</td>
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<td>Bronze welded overlay</td>
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<td>O-Rings, Actuator Shaft</td>
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<td>Hardness A: 80, (=/- 5). Elongation &gt;200%, Tensile &gt;12 N/mm, Elasticity &gt;25%</td>
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<tr>
<td>Item</td>
<td>Size</td>
<td>Material</td>
<td>Specification</td>
</tr>
<tr>
<td>--------------</td>
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<td>--------------------</td>
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<tr>
<td>Worm Gearbox</td>
<td>All</td>
<td>Housing: Ductile Iron GGG-40</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Worm Wheel: GGG-60 or bronze</td>
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<td></td>
<td></td>
<td>Coupling: Quenched and tempered steel acc. to 10083-2</td>
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<td></td>
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<td>Input Drive Shaft (Secondary Gear): Stainless steel 10088-3</td>
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B. Fasteners: All studs, bolts, washers, and nuts in contact with water shall be Type 304 or Type 316 stainless steel.

C. All materials of moving components in contact with each other shall be of dissimilar hardness to prevent galling. The valve shall be moved through an open-close-open cycle three times after final assembly and prior to shipment to ensure this requirement.

D. The valve body manufacturer coating process shall include post preparation and coating application assurances of targeted performance. The manufacturer shall utilize and incorporate a QC process that includes Coating thickness Testing, Holiday Free Testing, Cross Linkage Testing, Impact Resistance Testing, Coating Adhesion Testing and Cathodic Disbonding Testing. The Quality Compliance testing shall remain on record with the manufacturer and available for review and approval.

E. The valve body shall be blast coated to near white metal in accordance with SSPC Specifications SP 10. Coating shall take place within 12 hours of the blast cleaning process.

F. The applied coating shall be tested, signed, and dated-verified holiday free with a dry film thickness as specified in Section 09 90 00, Painting and Coating, System No. 29.

2.07 AERATION DEVICES AND ORIFICE PLATES

A. Manufacturer shall determine whether a venting device is needed based on the stated operating conditions and the piping configuration as shown on the Drawings. Where determined to be needed by the manufacturer, the anti-cavitation venting device shall be mounted directly downstream of the plunger valve with air intake connecting piece on the top of venting system. The venting shall be in annular flow shape directly at the outlet of the plunger valve.
B. The anti-cavitation venting device shall be manufactured out of ASTM A283 steel with one flat faced ANSI/ASME B16.5, Class 150 at upstream side, flanges with one flat faced ANSI/ASME B16.5, Class 150 at downstream side, flange on the top of anti-cavitation venting device.

PART 3 EXECUTION

3.01 INSTALLATION

A. Valve installation shall be in strict accordance with the manufacturer's printed recommendations, and the Contract Documents.

B. Install valve and supports such that excessive loads are not induced on valve flanges.

C. Actuator orientation to be installed as shown on Drawings.

D. Anchorage and bracing shall be in accordance to Section 01 88 00, Anchorage and Bracing.

3.02 WORKMANSHIP

A. Valve shall be free from manufacturing defects and shall be manufactured under the direction of a registered professional engineer.

B. All carbon steel components shall be coated with fusion bonded epoxy in accordance with System No. 29 in Section 09 90 00, Painting and Coating. A Certificate of Compliance with the purchaser’s material specifications, and the manufacturer’s quality assurance program shall be furnished with each valve.

3.03 FIELD TESTING AND PERFORMANCE

A. Manufacturer shall furnish all required startup assistance and inspection of installed valve at the Owner’s facility.

B. Plunger valve shall be subjected to onsite performance testing as part of the commissioning activities in accordance with a written performance test plan. To the extent possible, the valve shall be subjected to variable flow conditions, and the resulting control settings, flow, upstream and downstream pressures, noise levels, and vibration levels shall be documented and compared to the manufacturer’s shop test results. Operational flow testing shall be performed on the valve to verify the following:

1. Simulate valve operation using local and remote control.
2. In-place (Field) Leakage Test: Field leak test the valve prior to the flow testing with the Stormwater Tank at its maximum level with the valve in the closed position with zero leakage.
3. Operate valve at maximum flow demonstrating maximum allowed pressure drop across the valve.

4. Operate valve from minimum to maximum flow. Using the specified electric motor actuator, operate valve–actuator assembly demonstrating the ability to adjust flow at increments of 5 percent of maximum design flow throughout the full stroke range. This testing and valve cycling shall commence with the Stormwater Tank at its maximum operating level. Valve shall then be operated continuously at an automatically controlled flow rate of 2,500 gpm until the Stormwater Tank is emptied, to demonstrate successful flow control over the range of static head conditions. For all tests, record flow, upstream and downstream pressure, valve position set points and actuator motor inrush current. Submit all test results of forecasted operating curves and actual test results. The return flow system demonstration and testing shall be conducted prior to commissioning of the Base Flow Pump Station (BFPS), and the return flow will exit the facility by flowing upstream through influent channel to the Intake Structure, and to the creek. Later, as part of the controls system testing, the stormwater return system shall be operated in conjunction with the BFPS to demonstrate successful control of the stormwater return augmentation of the base flow to provide the specified total base flow of 3,000 gpm.

5. Demonstrate successful “high-pressure” cavitation control operation.

6. Demonstrate that the valve meets specified noise requirements.

7. All Operational Flow Testing and In-place (Field) Leakage Tests shall be conducted during the construction period (not the 5 year warranty period), and shall be witnessed by the Engineer and manufacturer's representative. Test results shall be jointly certified by Engineer or its representative, manufacturer’s onsite representative, and the Contractor.

8. If the valve fails any of the tests, it shall be corrected by the manufacturer within 30 days at the manufacturer’s expense.

3.04 MANUFACTURER 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. 1/2 person-day for prestartup classroom or Site training.
4. 1/2 person-day for facility startup.
B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

C. Provided Operation and Maintenance Manuals shall be in accordance with Section 01 78 23, Operation and Maintenance Data.

END OF SECTION
Parshall Flumes
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):

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: Test results of fiberglass reinforced plastic laminate.
2. Shop Drawings:
   a. Critical dimensions, jointing and connections, fasteners and anchors.
   b. Materials of construction.
   c. Sizes, spacing, and locations of structural members, connections, attachments, openings, fasteners, and loads.

B. Informational Submittals: Manufacturer’s installation instructions.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store products indoors and protect from construction traffic and damage.

PART 2 PRODUCTS

2.01 PARSHALL FLUMES

A. Size (Throat Width):

B. Material: Fiberglass reinforced plastic:

1. Tensile Strength (ASTM D638): 14,000 psi.
2. Flexural Strength (ASTM D790): 25,000 psi.
3. Flexural Modulus (ASTM D790): 1,000,000 psi.
6. Temperature Limit: 150 degrees F.
7. Temperature Limit: 200 degrees F.

C. Construction: One-piece, fiberglass reinforced plastic, with integral stiffening ribs to make unit self-supporting and eliminate external bracing.

1. For flumes to be embedded in concrete, provide temporary internal bracing.
2. Size(s): Indicated on Drawings.
3. Provide standard height of flume.

D. Dimensions: Flume dimensions and configuration shall comply with the standard dimensions as originally established by the U.S. Natural Resources Conservation Services. Throat width tolerance shall not exceed plus or minus 1/64-inch; all other dimensional tolerances shall not exceed plus or minus 1/32 inch.

E. Accessories:

1. Staff gauge graduated in feet, with 1-inch divisions per foot. Numbers shall be readable from working surface adjacent to flume channel. Locate staff gauge at normal measurement location, two-thirds of distance from throat entrance to upstream end of flume insert.

F. Manufacturers:

1. Warminster Fiberglass Co.
2. Plasti-Fab.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
3.02 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer.

C. Set flume at elevation shown on Drawings.

D. Set floor of flume at inlet end level with flow and across flow. Set side walls plumb. Set top flanges level, each side.

E. Fasten flume securely to prevent flotation or twisting during placement of grout.

F. Brace flume from side to side inside insert to prevent warping of flume walls during grout placement.

G. Place grout along sides and bottom of flume to ensure complete filling without voids and displacement of flume. Stage placement in alternating lifts, one-third height on each side of flume.

3.03 ADJUST AND CLEAN

A. Clean surfaces in accordance with manufacturer’s instructions.

B. Remove trash and debris, and leave the site in a clean condition.

END OF SECTION
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Process Piping Insulation

Revision History:

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<th>Date</th>
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Document Review & Approval:

**Originator:**
Steven R. Polson, P.E./Lead Process Mechanical

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**Design Verification Complete:**
Qingshan Wang, P.E./Process Mechanical QC Reviewer

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**Approved:**
W. Laird Ellis, Jr. PE/Design Manager

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PART 1 GENERAL

1.01 REFERENCES

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

2. ASTM International (ASTM):
   h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
4. Underwriters Laboratories Inc. (UL).
1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s descriptive literature.

B. Informational Submittals:
   1. Letter from insulation system manufacturer stating that:
      a. Installer is qualified to do the work and meets the quality assurance minimum experience requirements.
   2. Installer Qualifications:
      a. List of references substantiating experience. Include projects with at least 3 years of successful service history, including project name and location, names of Owner and Engineer, and description of product used and installation procedures.
      b. Certification from insulation system manufacturer showing current status as an approved installer.

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.
   8. Smoke Developed Index: Less than 50 per ASTM E84.
   9. Manufacturers and Products:
      a. Nomaco; K-Flex.
      b. Armacell; AP Armaflex.

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.
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. Type 3—Foamglass:
   1. Material: Cellular glass per ASTM C552.
   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.
   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.

D. Type 4—Removable Insulation Jackets:
   1. 1-inch thick fiberglass needled mat insulation, Type E fiber, 11 pounds per cubic foot density.
   2. Temperature Rating: Up to 450 degrees F.
   3. Inner and Outer Jackets: 16.5 ounces per square yard PTFE Teflon impregnated fiberglass cloth, impervious to moisture, and suitable for outdoor exposure.
   4. Tri-fold PTFE Teflon fiberglass cloth binder encapsulating raw jacket edged, double sewn lock stitch using Teflon coated fiberglass thread, with a minimum of 7 stitches per inch.
   5. Jacket shall be fastened using a stainless steel D-ring strap with Velcro tab system. System shall include a Type 304 stainless steel D-ring placed 1/2-inch from the closing seam edge. The pulldown strap placed along the closing seam edge not more than 8 inches apart. Pulldown
strap shall have a Velcro section, 1-inch by 6 inches, perimeter stitched to the strap. All closing seams shall have a 1-1/2-inch extended fabric flap placed along the stationary strap side of the closing seam.

6. Blankets and cover jackets shall be custom designed for the piping systems. No standard blanket designs will be accepted.

7. Blanket system shall include an instruction package that includes assembly drawings, material list, and installation instructions.

8. Removable insulation jacket system shall be by:
   a. Insultech, Indianapolis, Indiana.
   c. Coverflex Manufacturing Inc., Houston, Texas.
   d. 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 and Stainless 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.
   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.

B. Type F2—Paint:
   1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
   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.

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.
   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.

PART 3 EXECUTION

3.01 APPLICATION

A. General:
   1. Insulation shall be installed by a manufacturer’s approved installer. 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 where required on hot service 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 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.

G. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.
H. 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.

I. 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, color coded PVC jacketing and removable jacket insulation do 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

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<td>40 to 100 deg F</td>
<td>Type 2 -- Outside lines above grade. Type 3 -- From 1' above grade to 2' below grade</td>
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<td>Type 2 -- Outside lines above grade. Type 3 -- From 1' above grade to 2' below grade</td>
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<td>F4 on Type 3</td>
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<tr>
<td>Process Drains</td>
<td>D</td>
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<td>40 to 100 deg F</td>
<td>Type 2 -- Outside lines above grade. Type 3 -- From 1' above grade to 2' below grade</td>
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<td>F4 on Type 3</td>
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<sup>1</sup> Pipe Size: Insulation Thickness, Inches:<sup>2</sup>

- 1/4-3: 1
- 3.5-10: 1.5
- 12-16: 2
- 18-24: 2.5
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<tr>
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<td></td>
<td></td>
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<td></td>
<td>TSL</td>
<td></td>
<td></td>
<td>F3</td>
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<td></td>
<td>DCT</td>
<td></td>
<td></td>
<td>F4 on Type 3</td>
</tr>
<tr>
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<td>Pipe Size: Insulation Thickness, Inches:</td>
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<td>1/4-3: 1</td>
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<td>3.5-10: 1.5</td>
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<td></td>
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<td></td>
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<td></td>
<td>12-16: 2</td>
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<td>Throat Thickness</td>
<td>Fluid Temperature (degrees F)</td>
<td>Insulation</td>
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<td>------------------------------</td>
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</tr>
<tr>
<td>Gravity Filter System</td>
<td>BWW</td>
<td></td>
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<tr>
<td>PE–Personnel Exposure</td>
<td>BWA</td>
<td></td>
<td>&gt;140</td>
<td>Type 2</td>
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<td></td>
<td>Minimum 1.5” thick</td>
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</table>

*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.
**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Process Piping Leakage Testing

### Revision History:

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<th>Description</th>
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### Document Review & Approval:

**Originator:**

Steven R. Polson, P.E./Lead Process Mechanical

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**Design Verification Complete:**

Qingshan Wang, P.E./Process Mechanical QC Reviewer

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**Approved:**

W. Laird Ellis, Jr./Design Manager

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SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
   a. Submit prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.


PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

2. Wait 5 days minimum after concrete thrust anchoring for the HDPE piping is installed to perform pressure tests. If high-early strength cement is used, wait may be reduced to 2 days.

3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
   b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
5. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.
6. Test Pressure: As indicated on Piping Schedule, or as specified by equipment manufacturer.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:
   1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
   2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
   3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:
   1. Perform testing on installed piping prior to application of insulation.
   2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
   3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
   4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
   5. Examine joints and connections for leakage.
   6. Correct visible leakage and retest as specified.
   7. Leave pipe full of water after repair of leaks.

C. Buried Piping:
   1. Test after backfilling has been completed.
   2. Expel air from piping system during filling.
   3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
   4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
   5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

\[ L = \frac{SD(P)^{1/2}}{148,000} \]

where:

- \( L \) = Allowable leakage, in gallons per hour.
- \( S \) = Length of pipe tested, in feet.
- \( D \) = Nominal diameter of pipe, in inches.
- \( P \) = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Perform on pipes as noted in the Piping Schedule in the Drawings.

C. Fluid: Oil-free, dry air.

D. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

E. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

F. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.
3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:
   1. Hydrostatic Head:
      a. At least 6 feet above maximum estimated groundwater level in section being tested.
      b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
   2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:
   1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.05 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:
   1. Calibrate gauges with standardized test gauge provided by Engineer at start of each testing day. Engineer will witness calibration.
   2. Install gauges, air piping manifolds, and valves at ground surface.
   3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
   4. Restrain plugs used to close sewer lines to prevent blowoff.
B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 psi to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed using values from following table:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Diameter (Inches)</td>
<td>Time per Foot up to Length in Col C (Seconds)</td>
<td>Test Length (Feet)</td>
<td>Test Time for any Length Between Col C &amp; E (Min:Sec)</td>
<td>Length at Which Time in Col F Applies (Feet)</td>
<td>Time per Foot for Total Length (Seconds)</td>
</tr>
<tr>
<td>4</td>
<td>0.18</td>
<td>636</td>
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<td>1,114</td>
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<td>6</td>
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<td>15</td>
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<td>106</td>
<td>11:20</td>
<td>187</td>
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</table>

Example: 15-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50

*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.
3.06 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Instrumentation and Control for Process Systems

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Document Review & Approval:

**Originator:**
Dennis J. Thomas PE/I&C Lead

**Design Verification Complete:**
Roger W. Harte PE/I&C QC

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager

*Digitally signed by W. Laird Ellis, Jr.*
*Date: 2017.06.27 13:34:51 -06'00'*
PART 1 GENERAL

1.01 SUMMARY

A. General: Process Instrumentation and Control (PIC) System Integrator to provide labor, hardware, wiring and specialty cables, tools, documentation, testing, and training of Owner personnel as required to control and operate the OF 200 WWTP. The Engineer will provide programming software and services. The new WWTP will be consist of Headworks and the Main Treatment Facility (MTF). Headworks and MTF are approximately 2/3 mile apart. The control system will consist of a Headworks PLC and two MTF PLCs, all connected via an Ethernet network. The two main facilities, Headworks and MTF will be connected via a 24-pair single mode fiber optic cable.

B. The Control System at OF200 will consist of three Plant PLCs. PLC-1 will be located in the Electric Room at the Headworks. PLC-2 will be located in the Electrical Room at the Water Treatment Plant. PLC-3 will handle the filter functions. Each Filter Press will have its own Vendor supplied PLC (941002-LCP-718-A, and 941002-LCP-718-B). The Filter Press PLCs shall be of the same manufacturer as the Plant PLCs. All Adjustable Frequency Drives (AFDs) and Constant Speed (CS) drives will connect to the SCADA system via Ethernet TCP. Small metering pumps used for chemical addition will be hardwired to one of the main plant PLCs. Each filter will have its own control station with a small panelview connected to the Filter PLC via Ethernet.

1. The Control Room will be inside the Water Treatment Plant and will communicate with Headworks PLC-1 via Ethernet over fiber. PLC-2 and PLC-3 will communicate to the control room over Ethernet (refer to Drawing I941001-F-002 for more detail). The control system configuration shall include two SCADA workstations dedicated to the SCADA system to be installed in the Control Room in the Treatment Building. A separate engineering workstation will allow selected staff to perform non-control system functions. In addition, a “video wall” will be provided consisting of four 48-inch flat screens.

2. PDMS Power Device Monitoring System a complete Power Data Monitoring System (PDMS) shall be provided to include a power data monitoring for each MCC and unit substation. The PDMS shall utilize the same communication protocol as the PLC network. The network shall allow direct access to the data provided by the PDMS for implementing automatic control if required. The PDMS will be by a
manufacturer that offers an off-the-shelf system solution to include the power monitoring devices as well as the Windows-based monitoring and reporting software. For security reasons, the PDMS shall utilize a network separate from the SCADA system. For the same reason, the PDMS is to have no ability to control any electrical power distribution equipment. Access to the PDMS will be controlled by user name and password. Power monitors shall be configured with an Ethernet port and utilize a non-proprietary communication protocol, such as TCP/IP for data communication. Local displays shall be provided for each power monitor. Power monitors shall be capable of measuring, displaying and reporting.

3. **PDMS software** shall provide users with web-based access to system status, historical data and trends of the measured parameters. It shall be possible to implement alarm messages for out-of-range values.
   a. Voltage (line-to-line).
   b. Voltage (line-to-neutral).
   c. Phase current.
   d. Neutral current.
   e. Power factor.
   f. Total apparent power.
   g. Total real power.
   h. Total reactive power.
   i. Total harmonic current distortion.
   j. Total harmonic voltage distortion.

4. **PDMS Computer** will be located in the control room and will be provided with a dedicated UPS.

5. Transmitters “Smart” microprocessor-based field transmitters shall be installed wherever possible. All field transmitters shall be provided with a local signal indicator calibrated in percent or actual engineering units. The signal indicator should be integral to the field instrument if possible and may be an analog or discrete type.

C. **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 and associated IO cards etc.
4. Applications Software: Programming Provided by Engineer for PLCs, HMI, and OITs. All Software provided by Contractor. Work related to supporting this activity includes:
a. Early delivery of programming equipment to Engineer’s office.
b. Setup and demonstration testing of programming equipment at Engineer’s office.
c. Delivery of PLCs equipment to staging site provided by Contractor.
d. Demonstration testing at staging site.
e. Assistance with onsite checkout of applications software.
f. For additional related requirements refer to:
   1) Article Sequencing and Scheduling in this section.
   2) Sections that cover the equipment for which Engineer will provide applications software.

1.02 REFERENCES

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

2. ASTM International (ASTM):
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.
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.
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.
10. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.03 DEFINITIONS

A. Abbreviations:

1. DCU: Distributed Control Unit.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. HVAC: Heating, Ventilating, and Air Conditioning.
5. I&C: Instrumentation and Control.
11. PLC: Programmable Logic Controller.
12. RTU: Remote Terminal Unit.
13. SCADA: Supervisory Control and Data Acquisition.
15. SSDT: Staging Site Demonstration Test.

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.
   c. Transmitter Type: Number 2, two-wire.
   d. Transmitter Load Resistance Capacity: Class L.
   e. 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 120V ac sources as indicated.
   a. Discrete Inputs: Dry contact in field rated for 120 volts alternating current (AC), powered from 120V ac source in the cabinet
   b. Discrete Outputs: 16 points per card, with interposing relays in the cabinet rated for 10 amperes at 120V ac.
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. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings. 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.

2. PIC design as shown and specified includes:
   a. Functional requirements, performance requirements, and component specifications.
   b. P&IDs, block diagrams, and network diagrams.

3. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

B. 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:

   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. Instrument List:
   a. Engineer will provide an initial Instrument List in Microsoft Excel. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
b. Applicable fields to be completed include, but are not limited to:

<table>
<thead>
<tr>
<th>Instrument List Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>Tag Number</td>
</tr>
<tr>
<td>Loop Number</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Manufacturer and complete model number</td>
</tr>
<tr>
<td>Size and scale range</td>
</tr>
<tr>
<td>Setpoints</td>
</tr>
<tr>
<td>Reference P&amp;IDs, Electrical, Mechanical, Interconnection Drawings and Installation Details Drawings</td>
</tr>
<tr>
<td>Instrument detail number</td>
</tr>
</tbody>
</table>

c. Submit updated version of Instrument List.
d. Electronic Copies: Microsoft Excel.

4. 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.
5. 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.

6. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and location of front of panel devices.
   b. Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Submit electronic copies of Drawings.

7. 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.

8. 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. 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.

9. 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. One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
h. 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.

10. 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.

11. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
   a. Required voltages, currents, and phases(s).
   b. Maximum heat dissipations Btu per hour.
   c. Calculations.
   d. Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated
internal steady state temperature for ambient air temperatures of 110 degrees F.

12. 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.

13. Installation Details: Include modifications or further details required and define installation of I&C components.

14. Spares, expendables, and test equipment.


16. PLC I/O List:
   a. Managed by Engineer:
      1) During construction Engineer will maintain PLC I/O List and give electronic Microsoft Excel copies to PIC System Integrator.
      2) Engineer will assign PLC I/O points to specific chassis, slot, and point addresses.
   b. PLC I/O List Changes: Changes to PLC I/O List reflecting actual equipment and instrumentation provided.
      1) Mark up electronic file of latest PLC I/O List from Engineer. Highlight changed cells with yellow, new rows with red, and rows to be deleted with green.
      2) Submit marked up copies changes at 30-day intervals.

17. Shop Drawings for Changes Impacting PLC and SLDC Programming:
   a. Submit details of changes required to PLC and SLDC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.
   b. Submit changes at 30-day intervals.

18. Color schedule for control panels.

19. Applications Software Documentation: For equipment for which Engineer does not provide applications software provide:
   a. Complete configuration documentation for microprocessor based programmable devices.
   b. For each device, include program listings and function block diagrams, as appropriate, showing:
      1) Functional blocks or modules used.
      2) Configuration, calibration, and tuning parameters.
      3) Descriptive annotations.
   c. Refer to PIC subsections for additional requirements.
C. Informational Submittals:

1. Statements of Qualification:
   a. PIC System Integrator.
   b. PIC System Integrator’s site representative.
   c. 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.
         a) Loop diagrams.
         b) 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. Staging Site Demonstration 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 when tests are completed.
   c. 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.
   d. 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: Minimum of 10 years’ experience providing, integrating, installing, and starting up similar systems as required for this Project.
2. PIC System Integrator’s Site Representative: Minimum of 5 years’ experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. PIC Schedule Coordination Meeting:
   b. Purpose: Discuss Engineer’s comments and resolve scheduling issues.

2. Training Coordination Meeting:
   b. Purpose:
      1) Resolve required changes to proposed training plan.
      2) Identify specific Owner personnel to attend training.

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. Shop Drawing Reviews by Engineer:
   a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.

2. Test Prerequisite: Associated test procedures Submittals completed.

3. Training Prerequisite: Associated training plan Submittal completed.

4. Functional Test Part 1 Prerequisite:
   a. PLC and HMI installation complete.
   b. Component calibration sheets completed and approved.

5. Functional Test Part 2 Prerequisite:
   a. Functional Test Part 1 completed.
   b. Applications software integration documented as complete.

6. Performance Test Prerequisite: Functional Test Part 2 completed and facility started up.

1.09 MAINTENANCE

A. Maintenance Service Agreement:

1. Duration of 1 year unless otherwise noted in PIC subsections.

2. Start on date of Substantial Completion.

3. Performed by factory-trained service engineers with experience on PIC systems to be maintained.

4. PIC Systems Covered: PIC components, PLC, and HMI.

5. Materials and labor for preventive maintenance and monthly Site visits for length of agreement.

6. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m. Monday through Friday.

7. Response Time: Service engineer shall be onsite within 8 hours of request by Owner.

8. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.

9. Repair or replace components or software found to be faulty.

10. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.

11. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone Support: As specified in PIC subsections.

C. Software Subscription: As specified in PIC subsections.
1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

<table>
<thead>
<tr>
<th>Description</th>
<th>Percent of Each Type and Size Used</th>
<th>No Less Than</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annunciator light bulbs</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>dc power supplies</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Fuses</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Indicating light bulb</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Relays</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Terminal Blocks</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hand Switches and Lights</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Surge Suppressors</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

D. Expendables: For following items provide manufacturer’s recommended 2-year supply, unless otherwise noted.

1. Chemical for analyzers.
2. Corrosion-inhibiting vapor capsules.
3. pH sensor overhaul kits: Two.
4. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

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.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.

C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Reference PLC Equipment List in Article, Supplements, and PLC components in Control Panel Schedule.

2.04 UNINTERRUPTABLE POWER SUPPLY (UPS)

A. Each control panel shall have a UPS for the purpose of supplying power in the event of a short power outage. UPS battery backup shall have enough capacity to energize the equipment for 20 minutes after a power failure. UPSs will not power field sensors or field equipment.

B. Reference Section 40 91 00, Instrumentation and Control Components, Y40 Uninterruptable Power Supply (UPS).

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: 20 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. NEC Classification: Nonhazardous.

4. Inside, Corrosive:
   a. Temperature: 20 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. Corrosive Environment: Chlorine gas.
   d. NEC Classification: Nonhazardous.

5. Inside, Hazardous:
   a. Temperature: Minus 20 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: Minus 20 degrees F to 104 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. NEC Classification: Nonhazardous.

7. Outside, Corrosive:
   a. Temperature: Minus 20 degrees F to 104 degrees F.
   b. Relative Humidity: 0 to 100 percent.
   c. Corrosive Environment: Chlorine gas.
   d. NEC Classification: Nonhazardous.

8. Outside, Hazardous:
   a. Temperature Minus 20 degrees F to 104 degrees F.
   b. Relative Humidity: 0 to 100 percent
   c. NEC Classification: As shown on Electrical Drawings.

B. Standard Service Conditions for Panels and Consoles: Unless otherwise noted, in Instrument List and Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:
1. Freestanding Panel and Consoles:
   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. Location and Inscription: Refer to Example Control Panel Layouts and Control Panel Schedule drawings.
   2. Materials: Laminated plastic attached to panel with stainless steel screws.
   3. 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.
   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.
   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.
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.
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.
B. Organization: By unit process and loop number.
C. Loop Subheadings:

1. Hardwired Special Functions: Clarifies functional performance of loop, including abstract of interlocks for hard wired logic, for example in MCCs and control panels.
2. PLC Special Functions: Specifies nonstandard PLC functions. When required for clarification, additional definition is shown by logic diagrams or sequence diagrams on Drawings.

3. HMI Special Functions: Specifies nonstandard HMI functions.

2.10 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.

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 10 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:

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.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles, assemblies, 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.

2.11 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. Instrument Arrangements: As shown on Drawings.
3. Panel Component Schedule: Refer to Control Panel Schedule in Article Supplements which provides a list by local control panel of major panel-mounted components for each panel. In case of a conflict between this list and Instrument List, Instrument List takes precedence. In case of a conflict between Panel Component Schedule and P&IDs, P&IDs take precedence.
4. 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.
5. 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.
6. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.
7. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Size 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): Size 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.


3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Stainless steel lockable quick-release clamps.

4. Manufacturers:
   b. H. F. Cox.
E. 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.

F. 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.

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. Surge suppressors will be provided for all analog signals that originate outside buildings. All field instruments that require a 120-volt power source shall have 120-volt surge suppressors.
   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:
   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.

<table>
<thead>
<tr>
<th>Tag Function</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>OO</td>
<td>ON</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>Black</td>
</tr>
<tr>
<td>OC</td>
<td>OPEN</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>CLOSE</td>
<td>Black</td>
</tr>
<tr>
<td>OCA</td>
<td>OPEN</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>CLOSE</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
<td>Black</td>
</tr>
<tr>
<td>OOA</td>
<td>ON</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
<td>Black</td>
</tr>
<tr>
<td>MA</td>
<td>MANUAL</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
<td>Black</td>
</tr>
<tr>
<td>SS</td>
<td>START</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>STOP</td>
<td>Black</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET</td>
<td>Black</td>
</tr>
<tr>
<td>EMERGENCY STOP</td>
<td>EMERGENCY STOP</td>
<td>Red</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Tag Function</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>ON</td>
<td>Red</td>
</tr>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>Green</td>
</tr>
<tr>
<td>OPEN</td>
<td>OPEN</td>
<td>Red</td>
</tr>
<tr>
<td>CLOSED</td>
<td>CLOSED</td>
<td>Green</td>
</tr>
<tr>
<td>LOW</td>
<td>LOW</td>
<td>Amber</td>
</tr>
<tr>
<td>FAIL</td>
<td>FAIL</td>
<td>Amber</td>
</tr>
<tr>
<td>HIGH</td>
<td>HIGH</td>
<td>Amber</td>
</tr>
<tr>
<td>AUTO</td>
<td>AUTO</td>
<td>White</td>
</tr>
<tr>
<td>MANUAL</td>
<td>MANUAL</td>
<td>Yellow</td>
</tr>
<tr>
<td>LOCAL</td>
<td>LOCAL</td>
<td>White</td>
</tr>
<tr>
<td>REMOTE</td>
<td>REMOTE</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

b. Lettering Color:
   1) Black on white and amber lenses.
   2) White on red and green lenses.

G. 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.


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.

H. 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.

I. 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.
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.

2.12 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.

2.13 EQUIPMENT GROUPS

A. PLC Equipment Group 1 for Engineer’s Office. Plc Processor, racks and IO cards.

B. HMI Computers.

2.14 TEST EQUIPMENT AND TOOLS

A. Digital Multimeter:

1. Type: Industrial True RMS Digital Multimeter, CAT IV 600V protection with test leads, removable test probes, long reach alligator clips, magnetic hanger, temperature probe, and carrying case.
2. Quantity: 2.
3. Manufacturers and Products:
   a. Fluke; Model 87V/E Industrial Electrician Combo Kit.
   b. Greenlee; Model DM-860.
   c. Extech; Model EX530.

B. 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.

C. DC Digital Process Signal Calibrator:
   1. Type: Portable, two-channel, with test leads, rechargeable batteries, charger, and carrying case.
   2. Quantity: 2.
   3. Manufacturers and Products:
      a. Transmation; Model 1045-01.
      b. Fluke; Model 789.
      c. Extech; Model CMM17.

D. Datalogger:
   1. Type: Portable Handheld Multichannel Datalogger, USB communications, Graphical Display, with Analysis Software.
   2. Quantity: 1.
   3. Manufacturers and Products:
      a. Graphtec; Model GL200A.
      b. Omega; Model OM-DAQPRO-5300.

E. 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.
   4. Manufacturers and Products:
      a. Transmation; Model 1091PLUS-LP.
      b. Fluke; Model 717/718.
      c. Heise; Model PTE-1.
F. Pressure Pump Kit:

1. Type: Hand pump (0 to 600 psig), calibration labels, tubing, fittings, and carrying case.
2. Quantity: 1.
3. Manufacturers and Products;
   a. Transmation; Pump Kit 22980P-300.
   b. Fluke; Model 700PTP-1.
   c. Heise; Model TP1-40.

G. Small Tool Kit:

1. Type: Kit of instrument maintenance tools in soft, zipper case.
2. Quantity: 1.
3. Manufacturer and Product: Jensen Tools; Model JTK-47GC Field Engineer’s Kit.

H. Large Tool Kit:

1. Type: Kit of instrument maintenance tools in high-density polyethylene case.
2. Quantity: 1.
3. Manufacturer and Product: Jensen Tools; Model JTK-17LST.

I. Screw Starters:

1. Type: Kits of slotted screw starters with magnetic retrievers.
2. Quantity: 1.
3. Manufacturer and Products: Jensen Tools; Models 23B021 and 23B023.

J. Terminal Kit:

1. Type: Kit of solderless terminals and cable ties.
2. Quantity: 1.

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.
   f. For PIC systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.

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. Operation of communications between the PLC system, single loop controllers (SLC).
7. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
   a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
   b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
   c. All required and shown functions for 100 percent of loops.
8. Nonloop-Specific Functions:
   a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
   b. Timing: Include tests for timing requirements.
   c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. 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.
11. Make following documentation available to Engineer at test site both before and during FDT:
    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.
12. 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.
D. Staging Site Demonstration Test (SSDT):

1. Scope: Demonstrate that the specified PIC equipment and standard software has been properly installed at staging site and is ready for applications software development by Engineer.
2. Refer to PIC subsections for additional details.

2.16 MAINTENANCE OF PROGRAMMING EQUIPMENT

A. Provide for maintenance of programming equipment while at Engineer’s office. Repair or replace failed equipment within 2 days of notice by Engineer.

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. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.
3. Refer to UCOR test plan.

D. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation. Divide Functional Test for each facility into two parts.
2. Functional Test Part 1: Performed by PIC System Integrator to test and document PIC, excluding Engineer provided applications software, is ready for operation. For PIC Subsystems for which Engineer provides applications software, provide sufficient temporary software configuring to allow testing of these subsystems.
   a. Loop/Component Inspections and Tests:
      1) These inspections and tests will be spot checked by Engineer.
      2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
      3) Provide space on forms for signoff by PIC System Integrator.
      4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
         a) Project name.
         b) Loop number.
         c) Tag number for each component.
d) Checkoffs/Signoffs for Each Component:
   (1) Tag/identification.
   (2) Installation.
   (3) Termination wiring.
   (4) Termination tubing.
   (5) Calibration/adjustment.

e) Checkoffs/Signoffs for the Loop:
   (1) Panel interface terminations.
   (2) I/O interface terminations with PLCs.

f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.

g) Total loop operational.

h) Space for comments.

5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs I/O module and include the following:

a) Project name.

b) Loop number.

c) Component tag number or I/O module number.

d) Component code number for I&C elements.

e) Manufacturer for I&C elements.

f) Model number/serial number for I&C elements.

g) Summary of Functional Requirements; For Example:
   (1) Indicators and recorders, scale and chart ranges.
   (2) Transmitters/converters, input and output ranges.
   (3) Computing elements’ function.
   (4) Controllers, action (direct/reverse) and control modes (P, I, D).
   (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
   (6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
   (1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
   (2) Discrete Devices: Actual trip points and reset points.
   (3) Controllers: Mode settings (P&ID).
   (4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
   (5) Space for comments.
b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
d. FDT-Repeat:
   1) Repeat SSDT onsite with installed PIC equipment and software.
   2) As listed in PIC subsections, certain portions of SSDT may not require retesting.
   3) Use SSDT test procedures as basis for this test.
   4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original SSDT shall be witnessed.

3. Functional Test Part 2: Combined effort between Contractor, PIC System Integrator, and Engineer to confirm PIC, including applications software, is ready for operation.
   a. Prerequisite: Completion of Functional Test Part 1.
   b. Joint test with Engineer. Repeat of Engineer’s SSDT application software tests, except using real field sensors and equipment. Plant interlocking and communications with PLCs, tested on loop-by-loop basis.
   c. Test procedures provided by Engineer based on Functional Test Part 1 and on SSDT application software tests.
   d. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

4. Functional Test:
   a. Scope: Confirm PIC, including applications software, is ready for operation.
   b. Refer to PIC subsections for additional requirements.
   c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

5. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

E. Performance Tests Prior to Facility Startup: Reference the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.
F. 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 SSDT 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 SSDT.

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 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative: As required by each PIC subsection.

B. Specialty Equipment: For certain components or systems provided under this section, but not manufactured by PIC System Integrator, provide services of qualified manufacturer’s representative during installation, startup, demonstration testing, and training. Provide original equipment manufacturer’s services for:

C. See Section 01 43 33, Manufacturers’ Field Services.
3.05 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. Management Seminar:

1. Length: 2 days.
2. Location: Owner’s facility.
3. Objective: Provide overview for nonoperations and maintenance personnel for understanding the PIC.
4. Attended by management, engineering, and other nonoperations and nonmaintenance personnel.
5. Primary Topics:
   a. PIC Overview: How hardware and software are used for operation and control of facilities.
   b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
   c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
   d. Management-oriented explanation of data management displays and printouts.
   e. Walk-through of installed systems.

C. 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: 5 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: 5 instructor days.
   b. Number of Training Sessions: Two.
   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.

3.06 CLEANING
   A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 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.
3.08 SUPPLEMENTS

A. Supplements listed below, follows “End of Section,” are part of this Specification.

1. Loop Specifications: See Loop Narratives in Section 40 96 00, Process Control Narratives.
2. 01, Instrument List.
3. 02, Example PLC Equipment List.
4. 03, PLC Input/Output List.
5. 04, Control Panel Schedule.
6. Preparation for Testing and Functional Test Forms:
   a. 05, Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
   b. 06, Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
   c. 07, I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
7. 08, 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.

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## Instrumentation and Control

**JUNE 30, 2017 FOR PROCESS SYSTEMS**

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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC-5/40E Processor</td>
<td></td>
<td>1</td>
<td>1785-L40E</td>
<td>Allen-Bradley</td>
<td>For first I/O chassis in this LCP</td>
</tr>
<tr>
<td>Remote I/O Adapter</td>
<td></td>
<td>*</td>
<td>1771-ASB</td>
<td>Allen-Bradley</td>
<td>For additional I/O chassis in this LCP</td>
</tr>
<tr>
<td>Power Supplies</td>
<td></td>
<td>*</td>
<td>1771-P4R</td>
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<td></td>
</tr>
<tr>
<td>Isolated Analog Inputs</td>
<td></td>
<td>*</td>
<td>1771-NIV</td>
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<td></td>
</tr>
<tr>
<td>Isolated Analog Outputs</td>
<td></td>
<td>*</td>
<td>1771-OFE2</td>
<td>Allen-Bradley</td>
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<tr>
<td>120V ac Isolated Discrete Inputs</td>
<td></td>
<td>*</td>
<td>1771-ID16</td>
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</tr>
<tr>
<td>General-Purpose 24V ac/dc Discrete Inputs</td>
<td></td>
<td>*</td>
<td>1771-IND</td>
<td>Allen-Bradley</td>
<td>For Yokogowa SLDCs</td>
</tr>
<tr>
<td>Isolated Relay Discrete Outputs</td>
<td></td>
<td>*</td>
<td>1771-OW16/B</td>
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</tr>
<tr>
<td>RIO-1</td>
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<td>RIO</td>
<td>Allen-Bradley</td>
<td>Remote to 72PLC01</td>
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<tr>
<td>16 Slot I/O Chassis</td>
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<td>*</td>
<td>1771-A4B</td>
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<tr>
<td>Power Supplies</td>
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<td>*</td>
<td>1771-P4R</td>
<td>Allen-Bradley</td>
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<tr>
<td>Remote I/O Adapter</td>
<td></td>
<td>*</td>
<td>1771-ASB</td>
<td>Allen-Bradley</td>
<td>For each I/O chassis in this LCP</td>
</tr>
<tr>
<td>Isolated Analog Inputs</td>
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<td>1771-NIV</td>
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<td>Isolated Analog Outputs</td>
<td></td>
<td>*</td>
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<td>Allen-Bradley</td>
<td></td>
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<tr>
<td>120V ac Isolated Discrete Inputs</td>
<td></td>
<td>*</td>
<td>1771-ID16</td>
<td>Allen-Bradley</td>
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<tr>
<td>General-Purpose 24V ac/dc Discrete Inputs</td>
<td></td>
<td>*</td>
<td>1771-IND</td>
<td>Allen-Bradley</td>
<td>For Yokogowa SLDCs</td>
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<td>RIO-2</td>
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<td>RIO</td>
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<tr>
<td>[In Real List Details for RIO-2 are same as RIO-1]</td>
<td></td>
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<tr>
<td>SPARE</td>
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<td>PLC</td>
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<td>1</td>
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<td>Allen-Bradley</td>
<td></td>
</tr>
<tr>
<td>PLC-5/40E Processor</td>
<td></td>
<td>1</td>
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<td></td>
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<td>Qty.</td>
<td>Model</td>
<td>Manufacturer</td>
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<tr>
<td>-------------------------------------</td>
<td>--------------------------------------------</td>
<td>------</td>
<td>----------</td>
<td>--------------</td>
<td>-------------------------------------</td>
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<td>Isolated Analog Outputs</td>
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<td>[2]</td>
<td>1771-OFE2</td>
<td>Allen-Bradley</td>
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<tr>
<td>120V ac Isolated Discrete Inputs</td>
<td></td>
<td>[2]</td>
<td>1771-ID16</td>
<td>Allen-Bradley</td>
<td></td>
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<tr>
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<td>[1]</td>
<td>1771-IND</td>
<td>Allen-Bradley</td>
<td>For Yokogawa SLDCs</td>
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<tr>
<td>STANDARD SOFTWARE</td>
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<td>DTAM Software Development Package</td>
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<td>PLC-5 Programming Software</td>
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<td>3</td>
<td></td>
<td>Allen-Bradley</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Where Allen-Bradley products are listed they are specified as no substitutions allowed.

Note 2: Where asterisk (*) appears in the "Qty." column, refer Article Programmable Logic Controllers for requirements regarding quantity of items to be provided.

Note 3: For the SPARE PLC, I/O modules quantities are listed in square brackets as [n]. Include these I/O modules in Spare PLC when shipped to Engineer’s Office. These I/O modules may be counted as part of specified spare I/O modules.
# CONTROL PANEL SCHEDULE

<table>
<thead>
<tr>
<th>Service (Location)</th>
<th>Mounting</th>
<th>NEMA 250 Rating</th>
<th>Dimensions (Nominal)</th>
<th>FDT</th>
<th>Fan</th>
<th>Space Heater</th>
<th>Serv. Lights, Outlets</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEADWORKS CONTROL PANEL PLC1</td>
<td>Free Standing pad mounted</td>
<td>Nema 12</td>
<td>70” 72” 24”</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Inside Heated</td>
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<tr>
<td>WATER TREATMENT CONTROL PANEL PLC2</td>
<td>Free Standing pad mounted</td>
<td>Nema 12</td>
<td>70” 72” 24”</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Inside Heated</td>
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<tr>
<td>FILTER AND BACKWASH CONTROL PANEL PLC3</td>
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<td>Nema 12</td>
<td>70” 72” 24”</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Inside Heated</td>
</tr>
<tr>
<td>FILTER PRESS PLC A</td>
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<td>Nema 4X</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Inside Heated</td>
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<tr>
<td>FILTER PRESS PLC B</td>
<td>Free Standing pad mounted</td>
<td>Nema 4X</td>
<td>TBD TBD TBD</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Inside Heated</td>
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<tr>
<td>FILTER A LOCAL CONTROL PANEL</td>
<td>Free Standing Console Mount</td>
<td>Nema 4X</td>
<td>48” 24” 18”</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Inside Heated</td>
</tr>
<tr>
<td>FILTER B LOCAL CONTROL PANEL</td>
<td>Free Standing Console Mount</td>
<td>Nema 4X</td>
<td>48” 24” 18”</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Inside Heated</td>
<td>Inside Heated</td>
</tr>
<tr>
<td>FILTER C LOCAL CONTROL PANEL</td>
<td>Free Standing Console Mount</td>
<td>Nema 4X</td>
<td>48” 24” 18”</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Inside Heated</td>
<td>Inside Heated</td>
</tr>
<tr>
<td>FILTER D LOCAL CONTROL PANEL</td>
<td>Free Standing Console Mount</td>
<td>Nema 4X</td>
<td>48” 24” 18”</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Inside Heated</td>
<td>Inside Heated</td>
</tr>
<tr>
<td>FILTER E LOCAL CONTROL PANEL</td>
<td>Free Standing Console Mount</td>
<td>Nema 4X</td>
<td>48” 24” 18”</td>
<td>Yes</td>
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<td>Yes</td>
<td>Inside Heated</td>
<td>Inside Heated</td>
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<td>FILTER F LOCAL CONTROL PANEL</td>
<td>Free Standing Console Mount</td>
<td>Nema 4X</td>
<td>48” 24” 18”</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Inside Heated</td>
</tr>
<tr>
<td>Truck Unloading Panel at Ferric Chloride Tank</td>
<td>Wall mount</td>
<td>Nema 4XP</td>
<td>24” 24” 8”</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Outside</td>
</tr>
<tr>
<td>Truck Unloading Panel at Sulfuric Acid Tank</td>
<td>Wall mount</td>
<td>Nema 4XP</td>
<td>24” 24” 8”</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Outside</td>
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<tr>
<td>HEADWORKS NETWORK INTERFACE PANEL</td>
<td>Wall mount</td>
<td>Nema 12</td>
<td>24” 24” 12”</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>Inside Heated</td>
</tr>
<tr>
<td>MTF NETWORK INTERFACE PANEL</td>
<td>Wall mount</td>
<td>Nema 12</td>
<td>24” 24” 12”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Inside Heated</td>
</tr>
</tbody>
</table>

**FDT:** Factory Demonstration Test Required

All Dimensions: approximate, contractor to layout according to space required to house required equipment

SS: Stainless Steel Required

Vendor Supplied

Power line surge suppressors will be provided for all control panels

Surge suppressors will be provided for all analog signals that originate outside buildings

All field instruments that require a 120-volt power source shall have 120-volt surge suppressors

Allow for at least a 25 percent increase in space requirements

Provide 20% spare terminal space

---

specific IO counts for each Panel

- Discrete inputs: Dry contact in field rated for 120 volts AC, powered from 120 volt AC source in the cabinet
- Discrete outputs: 16 points per card, with interposing relays in the cabinet rated for 10 amperes at 120 volts AC
- Analog inputs: 4 to 20 mA DC at 24 volts DC into 750 ohms, powered from the PLC cabinet or field
- Analog output: 4 to 20 mA DC at 24 volts DC into 750 ohms, powered from the PLC output module
### 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)

<table>
<thead>
<tr>
<th>Tag Number</th>
<th>Delivered</th>
<th>Tag ID Checked</th>
<th>Installation</th>
<th>Termination Wiring</th>
<th>Termination Tubing</th>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE/FIT-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Feb-7-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>N.A.</td>
<td>May-6-90 VDA</td>
</tr>
<tr>
<td>FIC-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>Apr-4-90 DWM</td>
<td>May-4-90 VDA</td>
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<td>FSH-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>Apr-4-90 DWM</td>
<td>May-7-90 VDA</td>
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</tr>
<tr>
<td>FAH-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>Apr-4-90 DWM</td>
<td>May-7-90 VDA</td>
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</tr>
<tr>
<td>FCV-10-2</td>
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<td>Mar-2-90 DWM</td>
<td>Apr-20-90 DWM</td>
<td>Apr-30-90 DWM</td>
<td>May-16-90 VDA</td>
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### REMARKS: None.

Loop Ready for Operation: By: D.W. Munzer  Date: May-18-90  Loop No.: 10-2
**FUNCTIONS**

<table>
<thead>
<tr>
<th>RANGE</th>
<th>VALUE</th>
<th>UNITS</th>
<th>COMPUTING FUNCTIONS? N</th>
<th>CONTROL? N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale:</td>
<td>1-14</td>
<td>pH units</td>
<td></td>
<td>Modes? P / I / D</td>
</tr>
<tr>
<td>Transmit/ Convert? Y</td>
<td>Input:</td>
<td>1-14</td>
<td>pH units</td>
<td>SWITCH? N</td>
</tr>
<tr>
<td>Output:</td>
<td>4-20</td>
<td>mA dc</td>
<td></td>
<td>Unit Range:</td>
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**ANALOG CALIBRATIONS**

**REQUIRED**

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<tr>
<th>Input</th>
<th>Indicated</th>
<th>Output</th>
<th>Increasing Input</th>
<th>Decreasing Input</th>
<th>Number</th>
<th>Trip Point</th>
<th>Reset Pt.</th>
<th>Trip Point</th>
<th>Reset Pt.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indicated</td>
<td>Output</td>
<td>Increasing Input</td>
<td>Decreasing Input</td>
<td>Number</td>
<td>Trip Point</td>
<td>Reset Pt.</td>
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<td>Reset Pt.</td>
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<td>1.0</td>
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<td>2.3</td>
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<td>20.0</td>
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**CONTROL MODE SETTINGS:**
P: N.A.
I: 
D: 

**NOTES:**
1. Need to recheck low pH calibration solutions.

**Component Calibrated and Ready for Start-up**

By: J.D. Sewell
Date: Jun-6-92
Tag No.: AIT-12-6 [pH]
### I&C VALVE ADJUSTMENT SHEET—EXAMPLE

**PARTS**

<table>
<thead>
<tr>
<th>Body</th>
<th>Type: Vee-Ball</th>
<th>Mfr: Fisher Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size: 4-inch</td>
<td>Model: 1049763-2</td>
</tr>
<tr>
<td></td>
<td>Line Connection: 159 # ANSI Flanges</td>
<td>Serial #: 1003220</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operator</th>
<th>Type: Pneumatic Diaphragm</th>
<th>Mfr: Fisher Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Action: Linear – Modulated</td>
<td>Model: 4060D</td>
</tr>
<tr>
<td></td>
<td>Travel: 3-inch</td>
<td>Serial #: 2007330</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Positioner</th>
<th>Input Signal: 3-15 psi</th>
<th>Mfr: Fisher Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Action: Direct - air to open</td>
<td>Model: 20472T</td>
</tr>
<tr>
<td></td>
<td>Cam: Equal percentage</td>
<td>Serial #: 102010</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pilot</th>
<th>Action:</th>
<th>Mfr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solenoid</td>
<td>Rating: None</td>
<td>Model: Serial #:</td>
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</table>

<table>
<thead>
<tr>
<th>I/P Converter</th>
<th>Input: 4-20 mA dc</th>
<th>Mfr: Taylor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Output: 3-15 psi</td>
<td>Model: 10-T-376-3</td>
</tr>
<tr>
<td></td>
<td>Action: Direct</td>
<td>Serial #: 1057-330</td>
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</table>

<table>
<thead>
<tr>
<th>Position Switch</th>
<th>Settings: Closed / Open 5 deg. rising</th>
<th>Mfr: National Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contacts: Close / Close</td>
<td>Model: 1049-67-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Serial #: 156 &amp;157</td>
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</table>

<table>
<thead>
<tr>
<th>Power Supply</th>
<th>Type: Pneumatic</th>
<th>Air Set Mfr: Air Products</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Potential: 40 psi</td>
<td>Model: 3210D</td>
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**ADJUSTMENTS**

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<thead>
<tr>
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<th>Date</th>
<th>VERIFICATION</th>
<th>Initial</th>
<th>Date</th>
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<tr>
<td>Air Set</td>
<td>JDS</td>
<td>Jun-06-92</td>
<td>Valve Action</td>
<td>JDS</td>
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<tr>
<td>Positioner</td>
<td>JDS</td>
<td>Jun-06-92</td>
<td>Installation</td>
<td>JDS</td>
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<tr>
<td>I/P Converter</td>
<td>JDS</td>
<td>Jun-07-92</td>
<td>Tube Connection</td>
<td>JDS</td>
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<tr>
<td>Actual Speed</td>
<td>JDS</td>
<td>Jun-07-92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS:** Valve was initially installed backwards.

*Observed to be correctly installed May-25-92*

*Valve Ready for Start-up*

*By: J.D. Sewell*

*Date: Jun-07-92*

*Tag No.: FCV-10-2-1*
### 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

   \[ Q(\text{MGD}) = 429 \times H^{2/3} \text{ (H = height in inches of water over weir)}. \]

   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

<table>
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<tr>
<th>( H(\text{measured}) )</th>
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<td>( Q(\text{LI on LP-521-1}) )</td>
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<td>( Q(\text{display by CCS}) )</td>
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### Forms/Sheets Verified

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<td>J.D. Sewell</td>
<td>May-18-92</td>
<td>By: J.D. Smith</td>
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<td>Instrument Calibration Sheet</td>
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<td>May-18-92</td>
<td>Date: Jun-6-92</td>
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<td>Jun-6-92</td>
<td>30-12</td>
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<td>Witnessed</td>
<td>B. DeGlanville</td>
<td>Jun-6-92</td>
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Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Instrumentation and Control Components

Revision History:

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<th>Description</th>
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Document Review & Approval:

Originator:
Dennis J. Thomas PE/I&C Lead

Design Verification Complete:
Roger W. Harte PE/I&C QC

Approved:
W. Laird Ellis, Jr. PE/Design Manager
Digitally signed by W. Laird Ellis, Jr.
Date: 2017.06.27 13:37:05 -06'00'
PART 1   GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 INSTALLATION

A. PIC will install individual instruments to maximize accessibility to plant operating personnel and to easily facilitate removal of instruments for maintenance and repair. Attention should be paid to orientation and placement of instruments with regard to accessibility.

1.03 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.
2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:
   1. For air or water service, unless otherwise noted.
   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.

B. Manifold, Three-Valve Equalizing:
   1. Type: For isolation and equalization of differential pressure transducers.
   3. Manufacturers and Products:
      b. Evans.

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.
      d. Acculite; Series 2000.

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.

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.

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.

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.

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.
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.
I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DA00-TSO-TKO.

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.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

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.

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.
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.

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.

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.
2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.

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.
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.

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.

U. Air Supply Sets:
   1. Parts: Integrally Mounted:
      a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
      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.

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.

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.
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.

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.

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.

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.

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.

6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   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.

7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   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.

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.

B. Relays:

1. General:
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.

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.

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.

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 falls 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.

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.
   d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
   e. Enclosure Mounted: Encapsulated in flame retardant epoxy.

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.
   b. 120V ac Lines: Emerson Edco HSP-121.
   c. Field Mounted at Two-Wire Instruments:
      1) Encapsulated in stainless steel pipe nipples.
      2) Emerson Edco SS64 series.
   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.

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.
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.

2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.

2.04 I&C COMPONENTS

A. Provide “SMART” Transmitters wherever possible.

B. A7 pH Element and Transmitter:

1. General.
   a. Function: Measure, indicate, and transmit pH of process fluid.
   b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.

2. Performance:
   a. Element:
      1) Range: 0 pH to 14 pH.
      2) Operating Temperature: 32 degrees F to 158 degrees F.
      3) Operating Pressure: 80 psig maximum at 149 degrees F.
   b. Analyzer/Transmitter:
      1) Range: 0 pH to 14 pH units.
      2) Accuracy: Plus or minus 0.02 pH units.
      3) Repeatability: Plus or minus 0.05 pH units.
      4) Stability: Plus or minus 0.01 pH units per month, noncumulative.
      5) Operating Temperature: Minus 4 degrees F to plus 104 degrees F.
      6) Operating Humidity: 5 percent to 95 percent; relative humidity, noncondensing.

3. Element:
   a. Process Connection: 1-inch MNPT.
   b. Body Style: Convertible with 1-inch NPT on both ends.
   c. Process Fluid: As noted.
   d. Wetted Materials: Compatible with process fluid.
   e. No field-replaceable parts, unless otherwise noted.
   f. Electrode Type: Flat glass or general purpose, unless otherwise noted.
   g. Integral Preamplifier: Required, unless otherwise noted.
   h. Mounting/Process Connections: As shown on Drawings or as noted from among the following:
1) Submersion:
   a) Sensor handrail assembly.
   b) Handrail mounting kit.
2) Flow-through:
   a) 3/4-inch NPT tee.
   b) 1-inch NPT tee.
   c) 1-1/2-inch NPT tee.
3) Insertion.
4) Hot-Tap Retractable:
   a) Suitable for 64-psig line pressure.
   b) 1-inch ball valve kit.
   c) Titanium Tube: 21 inches (12-inch insertion).
   i. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.
   1) Install in accordance with manufacturer’s instructions and applicable codes.
4. Analyzer/Transmitter:
   a. Display: Graphic LCD, with backlighting.
   b. Signal Interface:
      1) Analog Outputs: Two isolated 4 mA to 20 mA dc outputs (pH and temperature).
      2) Discrete Outputs:
         a) Process Alarms: Two SPSTs minimum, normally open.
         b) Sensor/Analyzer and Process Fault Alarm: SPDT.
         c) Contact Rating: 120 volts, 5 amps, resistive.
   c. Enclosure.
      1) Type: NEMA 4X.
      2) Suitable for panel, 2-inch pipe, or wall mounting.
   d. Power: 115V ac, 50/60-Hz, unless otherwise noted.
   e. Interconnecting Cable: Length as required.
   f. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.
5. Expendables (for each unit provided):
   a. Chemicals: 1 pint each of buffer solution for pH 4, pH 7, and pH 9.
6. Accessories:
   a. Junction Box: If noted.
      1) NEMA 4X box for cable extension.
7. Manufacturers and Products:
   a. Rosemount Analytical; Model 399 (water), Model 396P (wastewater), or Model 396R (retractable) sensor and Model 1056 pH analyzer.
   b. Hach; Digital Differential pH sensor and sc100 controller.
   c. Foxboro; 871A series pH sensor and Model 875 pH Intelligent Analyzer.
C. A32 Turbidity Element and Transmitter (Backwash):

1. General:
   a. Function: Measure, indicate, and transmit turbidity of backwash water.
   b. Type:
      1) Immersion (open-channel) or insertion (closed-pipe), as noted.
      2) Dual-beam infrared/scattered light photometer.
   c. Parts: Element, transmitter, interconnecting cable, junction box (if required), mounting hardware, and expendables.

2. Performance:
   a. Process Liquid: Filter Backwash Water, unless otherwise noted.
   b. Process Range: 0 to 20 NTU, unless otherwise noted.
   c. Accuracy: Plus or minus 1 percent of reading.
   d. Repeatability: Plus or minus 1 percent of reading.
   e. Detection Limit: 0.001 NTU.
   f. Initial response: Within 1 second.

3. Environmental and Process Conditions:
   a. Operating Temperature: 32 degrees F to 104 degrees F.
   b. Sample Temperature: 32 degrees F to 104 degrees F.
   c. Sample Pressure: 87 psig maximum.
   d. Flow Velocity: 9.8 fps, maximum.

4. Features:
   a. Signal Average Time: User selectable from 1 second to 300 seconds.

5. Element:
   a. Type: Insertion or immersion, as noted.
   b. Sensor body: Stainless steel, unless otherwise noted.
   c. Wiper (for self-cleaning of device):
      1) Required, unless otherwise noted.
      2) Material: Silicon.
   d. Dimensions:
      1) Insertion Type: 2.4 inches deep by 12.4 inches long.
      2) Immersion Type: 2.4 inches deep by 7.9 inches long.
   e. Process Connection (Insertion Type):
      1) Through pipe sidewall.
      2) Minimum Pipe Size: 4-inch diameter.
   f. Mounting Hardware:
      1) Immersion Type:
         a) Fixed Point Installation Kit: Required, unless otherwise noted.
         (1) Pipe and adaptor for sensor and cable.
         (2) Stand and sunshield for controller.
b) Handrail Mounting Kit: If noted.
   (1) Includes 1.5-inch deep by 7.5-foot long CPVC pipe and swivel/pivot/pipe clamp assembly.
   (2) Furnish sensor adapter, straight or elbow, as required.

2) Insertion Type:
   a) Insertion Mounting Kit: Stainless steel ball valve and extraction system.

6. Transmitter:
   a. Features:
      1) Display: Graphic dot matrix LCD with LED backlighting.
      2) Connected Sensors: One, unless otherwise noted.
      3) Memory Backup: User settings retained indefinitely in nonvolatile EEPROM memory.
      4) Built-in data logger that collects data up to 6 months.

7. Signal Interface:
   1) Number of Outputs: One, unless otherwise noted.
   2) Transmitter Range: 0 to 20 NTU, unless otherwise noted.
   3) Output: Isolated 4 mA to 20 mA dc for load impedance 0 ohm to 500 ohms minimum for 24V dc supply without load adjustments.
   4) Digital Communications: As noted.
   5) Contacts:
      a) Quantity: Three SPDT rated 5A resistive at 100 to 230V ac.
      b) User configurable for such parameters as low alarm, low alarm point deadband, high alarm, high alarm point deadband.

b. Enclosure:
   1) Type: NEMA 4X/IP66.
   2) Mounting:
      a) Suitable for surface, panel, and pipe (horizontal and vertical).
      b) Pipe mounting brackets.
   3) Dimensions: 6 inches high by 6 inches wide by 6 inches deep, nominal.

c. Power: 100 to 230V ac, 50/60 Hz.

8. Cable: Length as required to accommodate device locations.

9. Junction Box (weatherproof): Required, if distance between sensor and controller is greater than 33 feet.

10. Accessories:
   a. Calibration Kit:
      1) Includes calibration cylinder, two 500 ml, 800 NTU standard, and sensor bracket.
      2) Quantity: One total for lot of turbidimeters.
11. Expendables:
   a. Wiper blades: Five total for lot of turbidimeters.
      1) Manufacturer: Hach Company; SOLITAX sc Turbidity and Suspended Solids Analyzer.

D. 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:
          a) 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. ABB Automation MagMaster (includes Transmitter):
      1) 10D1475 Mini-Mag (size: 1/10 to 4 inches).
      2) MFE (size: 1/2 to 24 inches).
      3) Plus MFF (size: 8 to 84 inches).
   b. Emerson Process Management, Rosemount Division:
      1) Model 8705 (flanged) and Model 8711 (wafer) flow tubes.
      2) Model 8712 (surface) and Model 8732 (integral) transmitters.
   c. Endress & Hauser, Inc. Flow Measuring System:
      1) Promag 50/53H (size: 1/12 to 4 inches).
      2) Promag 50/53P (size: 1/2 to 24 inches).
      3) Promag 50/53W (size: 1 to 78 inches).
   d. Invensys Foxboro (includes IMT 25 Series Intelligent Magnetic Flow Transmitter):
1) 8000A Series Wafer Body (size: 1/16 to 16 inches).
2) 9100A Series Flanged Body Flow Tubes (size: 1 to 78 inches).
3) 9200A Series Flanged Body Flow Tubes (size: 8 to 48 inches).
4) 9300A Series Flanged Body Flow Tubes (size: 8 to 16 inches).
e. Krohne includes IFC 50/IFC 100 (integral) or IFC 50/IFC100 (remote) signal converter.
1) OptiFlux Flowmeter (size: 3/8 to 120 inches).
2) EnviroMag, IFS 4000 Flowmeter (size: 2 to 60 inches).

E. F16 Flow Element, Rotameter:

1. General:
   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.
   c. Maximum Operating Pressure: As noted.

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.
   b. Tube Size: As noted.
   c. Connection Material: Type 316 stainless steel, unless otherwise noted.
d. Connection Type: Threaded NPT, unless otherwise noted.
e. Connection Orientation: Vertical, unless otherwise noted.

6. Signal Interface: None, unless otherwise noted.

7. Manufacturers and Products:
a. ABB; Series 10A4500.
b. Emerson Process Management Brooks; Series 1100.

F. F20 Flow Element and Transmitter, Flume/Weir, Ultrasonic:

1. General:
a. Function: Measure indicate, and transmit a flow signal.
b. Type: Noncontact ultrasonic.
c. Parts: Element, transmitter, interconnecting cables, and mounting hardware.

2. Performance:
a. Range: As noted.
b. Accuracy:
   1) Sensor: Plus or minus 1 millimeter per meter.
   2) Flow Calculation: Less than 0.02 percent error.
c. Primary Element:
   1) Type: As noted.
   2) Dimensions: As noted.
d. Zero Reference: As noted.

3. Features:
a. Indicator: When noted or indicated by International Society of Automation (ISA) tag number. Scale range as noted.
b. Temperature Compensation: Ambient temperature sensor with thermocompensator circuitry.
c. Flow calibration using front mounted keypad to characterize level signal input based on the desired flow formula.

4. Power: 120V ac, 60-Hz, unless otherwise noted.

5. Element:
a. Features:
   1) Type: Noncontact ultrasonic sensor with polarized barium titanate crystal type and acoustic impedance matching face.
   2) Face Material: Hypalon, unless otherwise noted.
   3) Operating Temperature Range: Minus 20 to 65 degrees C.
   4) Beam Angle: 10 degrees or less.
   5) Mounting: As indicated, with mounting hardware.
   6) Enclosure: Kynar Flex body.
   7) Process Liquid: As noted.
   8) Temperature Sensor: internal to ultrasonic element.
   9) Approvals: FM, CSA
6. Transmitter:
   a. Features:
      1) Type: Microprocessor based flow computer.
      2) Relay: Three.
      3) Contact Output: Selectable for high or low alarm on head or flow, remote totalizer, or sampler input.
      4) Display: LCD, alphanumeric character.
      5) Flow Totalizer: When noted, unit digit value as noted.
      6) Memory: RAM with backup battery provided; unit to retain memory during battery replacement.
      7) Operating Temperature Range: Minus 20 to 50 degrees C.
      8) Enclosure:
         a) Type: NEMA 4X.
         b) Materials: Polycarbonate.
         c) Mounting: Wall, unless otherwise noted.
      9) Signal Interface:
         a) Input: Signals from ultrasonic transducer and temperature sensor.
         b) Output: Isolated 4 mA to 20 mA dc; 1,000 ohms maximum load.
         c) Contacts: Form C SPDT, rated 5A at 250V ac noninductive.

7. Cables:
   a. Type: As recommended by the manufacturer.
   b. Length: As required to accommodate device locations, potted into sensor at one end.

8. Manufacturers:
   a. Milltronics:
      1) Ultrasonic Element: Model XRS-5.
      2) Electronics/Transmitter: Model OCM III.
   b. Endress-Hauser:
      1) Ultrasonic Element: Model FDU-80.
      2) Electronics/Transmitter: Model FMU-861.

G. F23 Flow Element and Switch, Thermal:
   1. General:
      a. Function: Monitor process fluid flow and provide contact closure at setpoint.
      b. Type: Thermal dispersion flow switch using a heated active RTD and a reference RTD temperature sensor to detect rate of flow as a function of temperature difference between the two sensors.
   2. Service:
      b. Process Pressure: As noted.
      c. Process Temperature: As noted.
3. Performance:
   a. Setpoint: As noted.
      1) Factory Calibration: If noted.
   b. Accuracy: Greater of plus or minus 5.0 percent of reading or plus
      or minus 0.04 sfps (liquid) or plus or minus 2 sfps (gas).
   c. Repeatability: Plus or minus 0.5 percent of reading, at constant
      temperature and pressure.
   d. Temperature, Operating: Sensor Element: Minus 40 degrees F to
      plus 350 degrees F.
   e. Pressure, Operating: To 3,500 psig at 70 degrees F, to 2,350 psig
      at 500 degrees F.
4. Features:
   a. Wetted Surfaces Materials: Type 316 stainless steel, unless
      otherwise noted.
   b. Temperature Compensation: Via factory calibration.
5. Process Connections:
   a. Type: 3/4-inch MNPT, unless otherwise noted.
   b. Process Pipe Size: As noted.
   c. Connection Type: Insertion.
6. Conduit Connection: 1-inch FNPT.
7. Element Insertion Length: 2 inches from tip of probe to process
   connection, unless otherwise noted.
8. Electronics:
   a. Location: Integral, unless otherwise noted.
   b. Operating Temperature: Minus 40 degrees F to 140 degrees F.
   c. Calibration Circuit: Built in for field adjustment of setpoint.
9. Signal Interface Contact: Field selectable two SPDT or one DPDT, rated
   6 amps at 115V ac, 220V ac or 24V dc. SPDT with separate setpoints.
10. Enclosure:
    a. Type: NEMA 4X.
    b. Enclosure: Aluminum, unless otherwise noted.
    c. Approval: Hazardous locations, Class I and Class II, Division 1
       and Division 2, Groups B, C, D, E, F, and G.
11. Ancillaries:
    a. Furnish interconnecting cable if remote electronics specified.
       1) Cable Jacket: PVC, unless otherwise noted.
       2) Cable Length: 10 feet, unless otherwise noted.
12. Power:
    a. 120V ac, 60-Hz, unless otherwise noted.
    b. Field Selectable: 115V ac plus or minus 15V ac, 230V ac plus or
       minus 30V ac, 21V dc to 28V dc, 18V ac to 26V ac.
14. Manufacturer and Product: Fluid Components, Inc.; Model FLT93S.
H. 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.
      1) Face: PTFE, unless otherwise noted.
      2) Size: As noted.
   e. Process Connection:
      1) 1-inch NPT, unless otherwise noted.
      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.
   d. If no integral keypad, furnish one handheld programmer per lot of units furnished.

8. Manufacturers and Products:
   a. Pulsar; Blackbox Series 13X and Sensor.
   b. Siemens; SITRANS L, Model HydroRanger 200 and Sensor.
   c. Endress & Hauser; Model FMU90 and Sensor.

I. L007E Level Element and Transmitter, Radar, Type E:

1. General:
   a. Function: Continuous level measurement.
   b. Type: Radar, noncontacting.
   c. Loop powered.
   d. Parts: Element/integral transmitter and accessories as noted.

2. Service:
   a. Application: If and as noted.
   b. Operating Temperature Range:
      1) Ambient: Minus 40 degrees F to plus 176 degrees F.
      2) At Flange (Inside Vessel):
         a) Dependent on antenna type and O-ring materials.
         b) For PTFE rod with PVDF threaded connection, minus 40 degrees F to plus 176 degrees F.
      3) Pressure Rating:
         a) Dependent on antenna type and process temperature.
         b) For PTFE rod with PVDF threaded connection, minus 14 psig to plus 43.5 psig.

3. Performance:
   a. Process Range: As noted.
   b. Zero Reference: As noted.
   c. Frequency: C-band.
d. Accuracy (maximum measurement error):
   1) Up to 10 meters (23 feet), plus or minus 10 mm (0.39 inch).
   2) Over 10 meters (23 feet), plus or minus 0.1 percent of measuring range.

e. Resolution: 0.04 inch (1 mm.)

f. Transition Zone (not recommended for measurement): 2 inches from lower end of antenna.

g. Medium Suitability:
   1) Suitable for most liquids with measuring range decreasing for liquids with smaller dielectric constants.
   2) For conductive liquids, (for example, water) maximum possible measuring range is 65 feet.

4. Element/Integral Transmitter:
   a. Enclosure:
      1) Transmitter: NEMA 4X/IP65 watertight.
      2) Antenna: NEMA 6P/IP68.
   b. Display: Integral, unless otherwise noted.
   c. Antenna Type: Horn, unless otherwise noted.
      1) Available Antenna Types: Horn or rod.
   d. Horn Antenna Parameters:
      1) Size: 3 inches, unless otherwise noted.
      2) Material: Aluminum, unless otherwise noted.
      3) Seal: FKM, Viton, unless otherwise noted.
      4) Extension: If noted.
         a) Material: Type 316L stainless steel, unless otherwise noted.
         b) Length: 12 inches, unless otherwise noted.
   e. Rod Antenna Parameters:
      1) Inactive Length: 4 inches, unless otherwise noted.
      2) Inactive Length Material: PTFE, unless otherwise noted.
      3) Antistatic or Fully Insulated: Antistatic, unless otherwise noted.
   f. Process Connection:
      1) 4-inch ANSI 150 lb flange, unless otherwise noted.
      2) Material: Type 316L stainless steel.
   g. Approvals:
      1) FM Intrinsic Intrinsically Safe, Class I, Div 1, Group A-D: If noted.
      2) FM, Explosion-proof, Class I, Div 1, Group A-D: If noted.
      3) Others: As noted.
   h. Element Beam Angle:
      1) Antenna size dependent.
      2) For 6-, 8-, and 10-inch antennas, beam angles of 23, 19, and 15 degrees, respectively.
      3) Rod: 30 degrees.
5. Signal and Electrical Interface:
   a. Analog:
      1) 4 mA to 20 mA dc HART.
      2) Not furnished when digital interface is noted.
   b. Digital Interface:
      1) FOUNDATION Fieldbus or PROFIBUS PA: If and as noted.
   c. Conduit Type: 12-inch NPT, unless otherwise noted.

6. Other: As noted.

7. Accessories:
   a. Handheld Programmer:
      1) One per lot of level units provided: If noted.
      2) HART DXR375 Handheld Communicator.
   b. Software Configuration Package:
      1) One per lot of level units provided: If noted.
      2) Includes software and HART modem.
      3) Software: ToF Tool—Field Tool Package.
      4) Modem:
         a) Commubox FXA191/195.
         b) USB interface, unless otherwise noted.
   c. Remote Field Signal Indicator: If noted.
      1) Signal Interface: 4 mA to 20 mA dc.
      2) Enclosure: NEMA 4, IP65.
      3) Cable: 65 feet for HART, unless otherwise noted.
      4) Mounting Bracket: 1/2-inch pipe mount: If noted.
      5) Certification:
         a) FM Intrinsic Safety, Class I, Div 1, Group A-D: If noted.
   d. Others: As noted.


J. L18 Level Switch, Non-Mercury:

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type:
      1) Direct-acting, 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. Differential: 8 inches maximum.
   c. 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:
   a. Siemens Water Technologies; Model 9G-EF Direct Acting Float
      Switch (B100).
   b. Contegra; Model FS90.

K. L24 Level Element and Switch, Ultrasonic, Sludge Blanket:

1. General:
   a. Function: Operate contact based on sludge interface level.
   b. Type: infrared LED/Phototransistor
   c. Parts: Element, electronics, and swivel assembly.

2. Performance:
   a. Setpoint: As noted.
   b. Response Time: 10 seconds, minimum.

3. Features:
   a. Method: Sense suspended solids concentration in liquid by
      transmitting 64 infrared high intensity LEDs stacked vertically, which
      shine horizontally across a probe gap to 64 phototransistor
      detectors through liquid which shall detect infrared energy
attenuation due to suspended solids concentration. Activate SLUDGE indication when attenuation reaches preset level.

b. Infrared Signal Strength: Automatically Adjusted; suitable for concentration range specified.

4. Sensor:
   a. Transmission Path Length: 12 inches for solids concentrations 0.5 to 2.5 percent, 6 inches for 2 to 5 percent.
   b. Materials: Type 316 stainless steel.
   c. Process Connection: 3/4-inch NPT.
   d. Cable:
      1) Integral with sensor.
      2) Double coaxial with PVC sheath and two shielded termination plugs.
      3) Length as required to accommodate device locations.

5. Electronics:
   a. Status Lights: LIQUID/SLUDGE; on enclosure cover.
   b. Signal Interface Contact: DPDT, rated 10A continuous at 120V ac.
   c. Adjustable timer (0 to 30 minutes) with AUTO/OFF/MAN transfer switch.
   d. Enclosure:
      1) Type: NEMA 4, with hinged cover; suitable for outdoor service.
      2) Mounting: Surface.
   e. Power: 117V ac, 60 Hz, unless otherwise noted.

6. Swivel Assembly: Aluminum; locking type; for mounting extension pipe to handrail.

7. Manufacturer and Product: Markland Sludge Blanket Detector; Model 602.

L. L31 Level Switch, Integral Conductive Probe:

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type: Probe with integral conductance type switch.
   c. Parts: Probe; interconnecting cable; relay or indicating controller, as noted; accessories as noted.
   d. Coordinate installing applicable parts within panel furnished by PIC Supplier.

2. Service: Wastewater, unless otherwise noted.

3. Performance:
   a. Setpoint: As noted.
   b. Relay Operating Temperature Range: 14 degrees F to 140 degrees F.
   c. Indicating Controller Operating Temperature Range: 14 degrees F to 140 degrees F.
d. Intrinsically Safe Barrier Operating Temperature Range:
   14 degrees F to 140 degrees F.

4. Parts and Features:
   a. Probe:
      1) Quantity: As noted.
         a) One, three, or 10 available.
      2) Materials: uPVX molded housing with sensor made from
         Avesta 254SMO high-grade stainless steel alloy.
      3) Length: As noted.
      4) Switch Separation Distance: As noted.
   b. Cable Length: As noted.
   c. Relay: Furnish when one or three switches are noted.
      1) Quantity: One per switch.
      2) Adjustable Sensor Sensitivity: 1k, 4k, 20k, 80k.
      3) LED display lights.
      4) Nominal Dimensions: 3H by 2W by 5D, inches.
      5) DIN rail mounting.
      6) Power Requirement: 110V ac, unless otherwise noted.
   d. Indicating Controller: Furnish when 10 switches are noted.
      1) Sensor Inputs: 10.
      2) Adjustable Sensor Sensitivity: 1k, 4k, 20k, 80k.
      3) LED displays for 10 LED bargraph and power on.
      4) Dimensions: 4H by 4W by 5D, inches, nominal.
      5) Suitable for mounting inside a panel.
      6) Extruded aluminum enclosure.
      7) Power Requirement: 110V ac, unless otherwise noted.

5. Signal Interface:
   a. Relay: One set of contacts per relay.
   b. Indicating Controller: 10 sets of contacts.
   c. Common Characteristics:
      1) Contact Set: One NO and one NC.
      2) Contact Rating: 5 amps resistive at 250V ac.
      3) Adjustable output time delay ranging from 2.5 to
         160 seconds.
   d. Analog Output (Indicator Controller Only): 4 mA to 20 mA dc
      with rated load of 940 ohms.

6. Accessories:
   a. Probe Mounting Kit: Furnish, unless otherwise noted.
      1) Integral cleaning device.
      2) Stainless steel components.
      3) Extended Bracket: Furnish, unless otherwise noted.
         a) Provides up to about 11 inches of wall clearance.
b. Intrinsically Safe Barrier (ISB): If noted.
   1) If ISB is noted:
      a) Furnish one 5-channel ISB when one or three probes noted.
      b) Furnish one 10-channel ISB when 10 probes noted.
   2) Certified for use in circuits that extend into Class I Groups A, B, C, and D; Class II Groups E, F, and G; and Class III areas.
   3) Barrier Clamp Voltage: 22.8 volts.
   4) Suitable for interior panel mounting.
   5) Dimensions: 4H by 6W by 4D inches, nominal.

7. Manufacturer and Products:
   a. MultiTrode Probe and the following products:
      1) MTR Level Relay when one or three probes noted.
      2) MTIC Indicator Controller when 10 probes are noted.
      3) MTISB Intrinsically Safe Barrier: If noted, quantity as specified.

M. L42 Level Element/Transmitter, Submersible, Wastewater:

1. General:
   a. Function: Measure and transmit signal proportional to level.
   b. Type:
      1) Totally submersible pressure sensor (loop powered).
      2) Suitable for wastewater.
   c. Parts: Sensor, interconnecting cable, 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 percent and 80 percent of fixed factory range.
   b. Accuracy: 0.25 percent of full scale.
   c. Temperature, Operating: Minus 4 degrees F to plus 140 degrees F.
   d. Overpressure:
      1) Proof: At least 1.5 times full scale.
      2) Burst: At least 2.0 times full scale.

4. Features:
   a. Sensor:
      1) Silicon pressure-sensing element.
      2) External Diaphragm: Flush type, coated with fluoro-polymer.
      3) Titanium or Type 316 stainless steel pressure module assembly, unless otherwise noted.
a) For Titanium Sensors Only: 5-year corrosion warranty, replace sensor if it fails due to corrosion: If noted.

4) NEMA 6/IP 68 rating (submersible).
5) Temperature compensation.
6) Dimensions, Nominal:
   a) Diameter: 1.2 inches.
   b) Length: 5 inches.
7) Loop powered, 9-30V dc.

5. Interconnecting Cable:
   a. Length: As required.
   b. Polyurethane sheathed, unless otherwise noted.
   c. Kevlar strain relief cord.
   d. Integral vent tube.

6. Sensor Termination Enclosure: Required, unless otherwise noted.
   a. Enclosure: NEMA 4X.
   b. Houses such noted items as desiccant vent, filter, microfilter, aneroid bellows.
   c. 2-Inch Pipe Mounting Kit: If noted.

7. Accessories:
   a. Aneroid Bellows: If noted.
      1) Bellows shall be suitable for application.
      2) Desiccant Module: Required, unless otherwise noted.
      3) Spare Desiccant Modules: If noted.
         a) Quantity: As noted.
      4) Cable Hanger, Kellems Type Grip: Required, unless otherwise noted.
      5) Lightning Protection:
         a) Internal (protects against water lightning strike): If noted.
         b) External (protects 4 mA to 20 mA dc output): Required, unless otherwise noted.
      6) Anchor Assembly: If noted.
         a) Marine anchor, clamps, Type 316 stainless steel cable or chain, length as required, nominally 3 feet longer than interconnecting cable.

8. Signal Interface: 4 mA to 20 mA dc output, for load impedance of 0 ohm to 750 ohms, minimum for 24V dc supply without load adjustment.

9. Manufacturers (provided that they can furnish the noted options):
   a. Esterline; KPSI Series 705.
   b. GE Sensing; Druck PTX 1830.
   c. Viatran; Model 690.
N. L128 Level Switch, Float, Dry Well:

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type:
      1) Suitable for sensing water on a floor, such as in a wastewater pumping station dry pit.
      2) Assembly consisting of vertical pipe with switch on bottom and junction box on top.

2. Performance:
   a. Setpoint: As noted.
   c. Normally Closed Configuration: Closes on 1/4-inch rise, and re-opens when level lowers by 1/16 inch.
   d. Temperature: 32 degrees F (nonfreezing) to 167 degrees F.
   e. Suitable for monitoring water and other clear liquids.

3. Features:
   a. Vertical assembly with nominal dimensions of 26 inches high by 3 inches wide by 2 inches deep.
   b. Materials: Buna N, PBT, and PVC.
   c. Junction Box: NEMA 4X rated and located on top of assembly.
   d. Suitable for wall mounting.
   e. Vertical Pipe Connection: 1/2-inch slip fitting, unless otherwise noted.

4. Signal Interface:
   a. Switch Type: Magnetic reed.
   b. Switch Contacts:
      1) Isolated, rated at least 0.5 amp continuous at 120V ac and 24V dc.
      2) Contact Type: NO or NC, field selectable.

5. Manufacturers and Products:
   a. Contegra; Model FS202.
   b. Siemens Water Technologies; Model 101GX Dry Well Float (B100).

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.
P. P3 Pressure Differential Transmitter:

1. General:
   a. Function:
      1) Measure differential pressure.
      2) Transmit signal proportional to either differential pressure or square root of differential pressure, as applicable.
   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 0.10 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. Linear or square-root output, user-configurable.
   b. Factory preconfigure for square root output if transmitter tagged as “FT” or “FIT”.
   c. Adjustable damping.
   d. LCD indicator, unless otherwise noted.
      1) Display in either percent or engineering units, field configurable.
   e. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
      1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
   f. Wetted O-Rings: Glass-filled TFE, graphite-filled PTFE, or Viton, unless otherwise noted.
   g. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
   h. 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. 4-20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
   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. Three-valve manifold, unless otherwise noted.
      1) Includes one equalization and two isolation valves.
      2) Type 316 stainless steel.
8. Manufacturers and Products:
   a. Rosemount; Model 3051 CD.
   b. Foxboro; Model IDP10.
   c. SMAR; LD30XD Series.

Q. M30 Horn, Indoor/Outdoor:

1. General:
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.
   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.
R. M31 Warning Light, Indoor/Outdoor:

1. General:
   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:
   b. Dome Color: Amber, unless otherwise noted.
   c. Lamp Life: 200 hours.

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.


S. 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:
   a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
   c. WIKA, Type 2XX.34.

T. 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.

U. P7 Pressure Switch, Adjustable Dead Band:

1. General:
a. Function: Monitor pressure, activate switch at setpoint, and deactivate switch at reset point.
b. Type:
   1) Piston-actuated.
   2) Both setpoint and deadband (the differential between setpoint and reset point) adjustable.

2. Performance:
a. Setpoint:
   1) As noted.
   2) Repeatability: Plus or minus 1 percent of range.
b. Reset Point: As noted.
c. Range: The noted setpoint shall fall between 20 percent and 80 percent of the range.
d. Deadband: Adjustable within nominally 25 percent and 85 percent of range.
e. Overpressure Proof Pressure:
   1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
   2) Pressure Inches of Water Ranges: 20 psig.
   3) Compound Range: 250 psig.
   4) Vacuum Range: 250 psig.
f. Operating Temperature Range:
   1) Dependent on actuator seal materials.
   2) For Buna-N seal, 0 degree F to 150 degrees F.

3. Features:
a. Actuator Seal: Buna-N, unless otherwise noted.
b. Adjustable deadband.
c. Mounting: Surface, unless otherwise noted.
4. Process Connection:
   a. 1/4-inch NPT female connections, unless otherwise noted.
   b. Materials:
      1) Pressure psi Ranges: Type 316 stainless steel, unless otherwise noted.
      2) Pressure Inches of Water Ranges: Epoxy coated carbon steel, unless otherwise noted.

5. Enclosure: NEMA 4X, unless otherwise noted.

6. Signal Interface:
   a. Contact Type:
      1) SPDT.
      2) Rated for 10 amps minimum at 120V ac.
   b. Hermetically Sealed Switch: If noted.

7. Manufacturers and Products:
   a. Ashcroft; L or P Series.
   b. United Electric; J6 Series.
   c. If NEMA 7, explosion-proof enclosure specified; Ashcroft; P Series only.

V. 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 0.075 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. 4-20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
   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) Stainless Steel Manifold: If noted.

8. Manufacturers and Products:
   a. Gauge Pressure Units:
      1) Rosemount; Model 3051 TG.
      2) Foxboro; Model IGP20.
      3) SMAR; LD30XM Series.
   b. Absolute Pressure Units:
      1) Rosemount; Model 3051 TA.
      2) Foxboro; Model IAP20.
      3) SMAR; LD30XA Series.
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:
   b. Dover/OPW Engineered Systems; Iso-Ring.

X. S27 Indicator, Digital Panel:

1. General:
   b. Type: 3.5-digit LED display.

2. Performance:
   a. Accuracy: Plus or minus 0.05 percent of full scale plus or minus one count.
   b. Display Update Rate: 2.5 second minimum.
   c. Operating Temperature Range: 0 degree C to 60 degrees C.
   d. Relative Humidity: 0 percent to 90 percent noncondensing.

3. Features:
   a. Display:
      1) LED.
      2) At least 3.5-digits.
      3) 0.56-inch height.
   b. Overrange indication.
   c. Input Impedance: 100 ohms maximum.

4. Enclosure:
   a. 1/8 DIN, high impact plastic.
   b. Nominal Maximum Dimensions: 2.5 inches high by 4.7 inches wide by 4 inches deep.
   c. Nominal Cutout Dimensions: 1.8 inches high by 3.6 inches wide.
   d. Suitable for panel mounting.
   e. Maintains NEMA 4X Panel Rating: If noted.
      1) Furnish accessories as required.

5. Power: 115V ac, unless otherwise noted.

6. Signal Interfaces:
   a. Process Inputs:
      1) Field Selectable: 4 mA to 20 mA, 1 volt to 5 volts.
   b. Loop Power Supply: If noted.
      1) 24V dc, at least 25 mA.
   c. Dual Relay Output alarm contacts

7. Manufacturer and Products:
   b. Newport Electronics, Santa Ana, CA; Model 202A-P.
   c. Precision Digital, Natick, MA; Model Trident Model PD765.
Y. T5 Temperature Switch:

1. General:
   a. Function: Provide change in contacts as temperature rises or falls through noted setpoint.
   b. Type:
      1) Vapor pressure thermal bulb sensing element.
      2) Fixed differential, unless otherwise noted.
   c. Parts: Switch/element assembly and thermowell.

2. Performance:
   a. Setpoint: As noted.
   b. Range: Such that noted setpoint falls between 30 percent and 70 percent of range.
   c. Repeatability: Plus or minus 1 percent of span.

3. Switch:
   a. Type: Snap action, SPDT, sealed environment proof, unless otherwise noted.
   b. Rating: 125V ac 15A, unless otherwise noted.
   c. Reset: Automatic.
   d. Enclosure:
      1) Type: NEMA 4X, unless otherwise noted.
      2) Mounting:
         a) Direct mount, unless otherwise noted.
         b) If remote mounted, furnish capillary with length either as noted or as required.

4. Element:
   a. Type: Bulb.
   b. Stem mounted to thermowell.
   c. Length: Coordinate with thermowell insertion length.

5. Thermowell:
   b. Material: Type 316 stainless steel or Type 304 stainless steel.
   c. Insertion Length: 3-1/2-inch minimum immersion for liquids and 5-1/2-inch minimum immersion for gases, unless otherwise noted.

6. Electrical Connections:
   a. Conduit: 1/2-inch NPT(F).

7. Manufacturers:
   a. Ashcroft; B Series (Type 400 NEMA 4X, Type 700 NEMA 7 and NEMA 9).
   b. Barksdale; ML1H, MT1H.
Z. W210 Weight Scale, Element and Transmitter, 350 Gallon Tote

1. General:
   b. Type:
      1) Load cells on platform scale.
      2) Electronics package that displays and outputs analog signal.
   c. Parts: Platform scale with load cells, weight indicator and transmitter, interconnecting cable.

2. Performance:
   a. Range: 0 to 5,000 pounds.
   b. Accuracy:
      1) Platform Scale: 0.1 percent of full scale.
      2) Overall System Accuracy (including transmitter): 0.25 percent of full scale.

3. Platform Scale:
   a. Suitable to weigh 350-gallon tote.
   b. Welded steel construction.
   c. Coating:
      1) Minimum 80-mil thickness.
      2) Resistant to moisture, chemicals, abrasion, impact, and UV light.
   d. Four shear beam load cells.

4. Transmitter:
   a. Number of Channels: Two, unless otherwise noted.
   b. Features:
      1) Display:
         a) Displays in pounds, kilograms, gallons, liters.
         b) Displays in 0.1-pound increments when displayed in pounds.
         c) Dual line; 16 characters per line, alphanumeric.
         d) 4.5-digit LCD with 0.5-inch high characters.
      2) Zero/Tare Adjustment: Keypad.
      3) Ambient Operating Temperature: 32 degrees F to 122 degrees F.
   c. Enclosure:
      1) NEMA 4X, UL listed, structural foam molded.
      2) Mounting: Wall or surface.
   d. Signal Interface:
      1) Analog Output: 4 to 20 mA dc per channel.

5. Power Supply: 120V ac/240V ac.

6. Overall Nominal Dimensions:
   a. Platform Scale: Plan View: 54 inches by 54 inches.
   b. Transmitter: Approximately 8 inches high by 9 inches wide by 5 inches deep. Or manufacturer standard.
7. Accessories.
   a. Interconnecting Cable: Length as required.

8. Manufacturer and Product: Force Flow; Tote Bin Scale and Weighing
   System with the following major parts:
   b. Weight Indicating Transmitter:
      1) Solo G2, two-channel

AA. Y40 Uninterruptible Power Supply System:

1. General:
   a. Function: Provides isolated, regulated uninterrupted ac output
      power during a complete or partial interruption of incoming line
      power. For a minimum of 20 minutes
   b. Major Parts: Inverter, battery charger, sealed battery.

2. Performance:
   a. Capacity: UPS battery backup shall have enough capacity to
      energize the equipment for 20 minutes after a power failure. UPSs
      will not power field sensors or field equipment.
   b. Input Power:
      1) 120V ac single-phase, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer’s standard, unless otherwise
         noted.
   c. Output Power:
      1) 120V ac single-phase, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer’s standard, unless otherwise
         noted.
   d. On-line Efficiency: 85 percent minimum, unless otherwise noted.
   e. Backup Runtime:
      1) Full Load: 9 minutes minimum, unless otherwise noted.
      2) Half Load: 20 minutes minimum, unless otherwise noted.
   f. Continuous no-break power with no measurable transfer time.
   g. Sine-Wave Output Voltage Total Harmonic Distortion (THD):
      Plus or minus 6 percent or less.
   h. Input Voltage Range: Plus 15 percent, minus 20 percent.
   i. Output Voltage Regulation: Plus or minus 3 percent nominal.
   j. Operating Temperature: 0 degree to 40 degrees C (32 degrees to
      104 degrees F).
   k. Operating Relative Humidity: 5 percent to 95 percent without
      condensation.
   l. Lightning and Surge Protection:
      1) Pass lightning standard IEEE C62.41 Categories A and B
         tests.
      2) 2000 to 1 attenuation of input spike.
3. Features:
   a. Bypass Switches: As noted.
   b. Enclosure:
      1) Tower, unless otherwise noted.
      2) If rack-mount noted, unit to be suitable for mounting in a 19-inch rack.

4. Manufacturers and Products:
   a. Powerware; FERRUPS FE/Rackmount Uninterruptible Power System.
   b. Intellipower.
   c. APC.

PART 3 EXECUTION (NOT USED)

END OF SECTION
Digital Process Control Computers and Network Equipment
SECTION 40 94 13
DIGITAL PROCESS CONTROL COMPUTERS AND NETWORK EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for Digital Process Control Computers and Network Equipment and is in addition to requirements of Section 40 90 00, Instrumentation and Control for Process Systems.

B. SCADA local area network (LAN) within the OF200 WWTP. Reference Communication Block Diagram I941001-F-0002.

1. SCADA HMI, PLCs, will be incorporated into Plant SCADA network.
2. Digital Power Meters will be incorporated into a separate network.
3. One rack-mounted SCADA HMI Server and one rack-mounted Historian computer located within Administration (Operations) Building Server Room.

C. Plant SCADA local area network (LAN), point-to-point (star topology) from MTF Control Room to the Headworks Facility over a Fiber Optic Communication System. Reference Section 40 95 80, Fiber Optic Communication System, for additional requirements.

1. Contractor will purchase Networking and HMI hardware and deliver hardware to Owner for initial stating site configuration and set-up prior to installation at the project site.
2. Contractor will coordinate the following activities with OF200 personnel:
   a. Configuration, set-up, and Testing of network switches: IP addressing, configuration of operating system security and network software, quality of service, and field testing of network communications.
   b. Configuration, set-up, and Testing of HMI computers: IP addressing, configuration of operating system security and network software, and quality of service and field testing of network communications.

D. Scope of Work:

1. Provide completed design with Drawings and supplying required components (hardware and software) component assembly, cables, terminations, structures, cabinets, and power and grounding, documentation, testing, training, and coordination for complete digital process control computers and network equipment installation.
a. Treatment Building Control Room.
b. Headworks Electrical Building.
c. Main Treatment Facility Electrical room.

2. Action and Informational Submittals, furnishing of equipment, installing, testing, documenting, coordination, starting up, and Owner Training.

E. Major Products: Major products to be provided in support of delivering the scope of work include the following:

1. HMI Computers.
2. Works Station Computers.
3. SCADA Server.
4. PDMS Computer.
5. Historian Server.
6. All network switches as show on SCADA block diagram.
7. Equipment supports, cabinet environmental controls, power supplies, cables, connectors, programming software, and programming cables.

F. Contractor shall provide all ancillary hardware and software features required to make digital process computers and network equipment as specified herein totally operational.

G. PLC and HMI application software provided under Section 40 90 00, Instrumentation and Control for Process Systems.

H. Raceways and power conductors shall be provided under Division 26. Network copper cables shall be furnished and terminated under this section. Network fiber optic cables shall be furnished, terminated, and tested under Section 40 90 00, Instrumentation and Control for Process Systems, and Section 40 95 80, Fiber Optic Communication System.

I. Provide all work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or another testing agency acceptable to the AHJ, in order to provide a basis for approval under the NEC.

J. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories and or another AHJ Approved Testing Agency shall conform to those standards and shall have an applied listing mark or label.
1.02 REFERENCES

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

1. Institute of Electrical and Electronics Engineers (IEEE): 802.3, Local Area Networks: Carrier Sense Multiple Access with Collision Detection.

1.03 DEFINITIONS

A. Abbreviations:

1. CPU: Central Processing Unit.
2. DPM: Digital Power Meter.
4. LAN: Local Area Network.
5. OIU: Operator Interface Unit.
6. PLC: Programmable Logic Controller.

1.04 SUBMITTALS

A. Action Submittals:

1. Communication Block Diagram(s) with hardware descriptions and Network IP addressing Reference Section 40 90 00, Instrumentation and Control for Process Systems, for additional requirements.
2. Reference Section 40 95 80, Fiber Optic Communication System, for additional requirements.

B. Bill of Materials for Components: Component number, manufacturer, model number, component description, and quantity.

1. Room Layout Drawings: For show to scale enclosures, digital process computers and network equipment, and service area requirements.
2. Power Connection Diagram: For digital process computers and network equipment show interconnection from power sources through uninterruptible power supplies and power distribution panels, to computer and peripherals.
3. Grounding Diagram: For digital process computers and network equipment show grounding.
4. Interconnecting Wiring and Cabling Diagrams: For digital process computers and network equipment, identify terminal receptacles, cable
ID tags, actual cable lengths, and maximum distance limitations between cabinets or components.

5. Component Submittal:
   a. For each digital process computers and network equipment component identify:
      1) General data and description.
      2) Engineering Specifications and data sheets.
      3) Scaled drawings and mounting arrangements.
      4) Equipment weights.
      5) Power and grounding requirements.
      6) External electrical interconnection and interface definitions.

6. Shop Drawings for Specifically Manufactured digital process computers and network equipment:
   a. A complete connection diagram.
   b. Data sheets on each major item, annotated as necessary to describe specific items furnished.
   c. Scaled Layout and Fabrication Drawings:
      1) Cable access areas and cable routing.
      2) Power termination and ground lug location.
      3) Data cable termination points.
      4) Anchor bolt size and location.
   d. Installation and mounting detail drawings.
   e. Equipment weights.

7. Power Consumption and Heat Dissipation Summary for digital process computers and network equipment: Voltages, current, phase(s), and maximum heat dissipations in Btu/hr.

1.05 SOURCE QUALITY CONTROL

A. Quality Assurance: Reference Section 40 90 00 Instrumentation and Control for Process Systems.


1.06 SEQUENCE AND SCHEDULING:

A. Reference Section 40 90 00, Instrumentation and Control for Process Systems.

1.07 DELIVERY, STORAGE AND HANDLING

A. Reference Section 40 90 00, Instrumentation and Control for Process Systems.
1.08 MAINTENANCE

A. Reference Section 40 90 00, Instrumentation and Control for Process Systems.

B. Warranty:
   1. Three-year warranty on network switches and rack mounted power supplies.
   2. Three-year warranty for network ancillary hardware.
   3. Three-year warranty for non-network hardware (i.e. cameras).

C. Support: One-year onsite agreement with between City and Contractor.

1.09 EXTRA MATERIAL

A. Reference Section 40 90 00, Instrumentation and Control for Process Systems.
   1. Specialty Cables and Connectors: One of each type of assembly.
   2. Power Supplies: One of each type.
   3. Cabinet Locks, Racks, Fans, Surge Protection: One of each type.
   4. Wire Management: One of each type.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Latest Hardware and Software Products:
   1. Provide product hardware and software as available in January, 2015 from major manufactures. Products provided under this Contract shall:
      a. Include at a minimum the basic features specified and as coordinated with Owner.
      b. When delivered to Owner, have the same relative place in the market. For example, if a high performance computer is specified herein as having a processor speed of 2.4 GHz, and at the time that this processor is delivered the nominal processor speed for a high performance servers is 10 GHz, the computer shall provide with a 10 GHz processor.
      c. Allow the applications running on these computers to meet all the performance requirements established for these applications.
      d. Be the latest revision available from the manufacturer for commercial use.
   2. The product specifications give both functional and performance requirements. The following are some examples of how these requirements will be applied to proposed Products:
      a. Example 1: If a computer has a functional requirement for one hard drive, and a performance requirement for 50 Gigabytes, then:
1) The computer shall have at least one hard drive that has at least 50 Gigabytes.
2) Two 25 Gigabyte drives are not an acceptable substitution.
3) If the applications running on the computer require larger hard drives in order to operate, they shall be provided with larger drives.
4) If meeting overall system functional or performance requirements requires more or larger hard drives, they shall be provided.

b. Example 2: Where a software product is specified by name, for example, Windows 7, supply the current version of the Microsoft Windows operating system that is standard for high performance servers.

B. Like Product Items:

1. Use products of one manufacture 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 the same or similar manner to maintain consistency across the delivery.

2.02 HMI DESKTOP WORKSTATION

A. General: Desktop workstation for running SCADA Software Applications.

B. Manufacturer; Product:

1. Dell 7010 Mini Tower Workstation.
2. HP 8100 Elite Minitower.
3. No other “or-equal”.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL


3.02 TRAINING

A. Product and Management Training: Reference Section 40 90 00, Instrumentation and Control for Process Systems.
3.03 MANUFACTURER’S SERVICES

A. Manufacturer’s and Supplier’s Representative: As required by this section.

B. Specialty Equipment: For certain components or systems provided under this section, but not manufactured by PIC System Integrator, provide services of qualified manufacturer’s representative during installation, startup, demonstration testing, and training for the following:

1. HMI Desktop Workstation Computers.
2. Cabinets and Wire Management.

END OF SECTION
Specifying Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Instrument and Control Panels

Revision History:

<table>
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<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
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<td>Issue for Construction</td>
<td>June 27, 2017</td>
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Document Review & Approval:

Originator:

Dennis J. Thomas PE/I&C Lead

Design Verification Complete:

Roger W. Harte PE/I&C QC

Approved:

W. Laird Ellis, Jr. PE/Design Manager

Digitally signed by W. Laird Ellis, Jr.

Date: 2017.06.27 13:40:33 -06'00'
PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Detailed design, fabrication and installation of instrument and control panels; including instruments, control devices, power supplies and components. Panels shall include meters, switches, indicating lights, wireways, conductors, nameplates, and all other accessories and appurtenances required for complete panels.

1.02 SYSTEM DESCRIPTION

A. Structural Design:

1. Design connections and related details for seismic design criteria as specified in Section 01 88 14, Seismic Design Criteria.
2. For equipment with weight of 400 pounds or more provide calculations for:
   a. Determination of weight including panel internal components.
   b. Determination of seismic forces and overturning moments.
   c. Determination of shear and tension forces in connections.
   d. Design of connection details based on calculated shear and tension forces.

B. Equipment Units Weighing 50 pounds or More: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

1.03 SUBMITTALS

A. Shop Drawings:

1. Panel front view showing equipment arrangement and dimensional information.
2. Panel floor plan and side view showing dimensions, doors, and equipment layout inside the panel.
3. Drawings showing structural details of fabricated panels.
4. For Floor Mounted Free Standing Panels Weighing 400 Pounds or More: Submit calculations and other information to substantiate that panel, base, framing, and anchor bolts meet minimum design strength requirements and seismic design criteria specified in Contracting Requirements. Calculations shall be signed and stamped by a Professional Engineer registered in the State of California.

5. Internal interconnecting wiring diagrams showing terminal strips and all external devices connected to the panel shall be shown in the design submittal for loop and schematic diagrams.

6. Complete schematic and diagrams including terminal block and wire identification numbers and device location symbols consistent with the Contract Documents.

7. Panel bill of material with detailed description of components and equipment data sheets.

8. Field cable number/I.D. and terminations.


10. Load calculations both power and heat loss for ac and dc applications.

B. Panel Color: Submit color samples of paint to the Engineer for color selection ANSI.

C. Manufacturer’s installation instructions.

D. Cooling Calculations: Submit in accordance with requirements to maintain 90 degrees F within panel, calculations will not be returned.

1.04 QUALITY ASSURANCE

A. Factory witness tests.

B. Factory standard tests.

C. Field tests.

1.05 SEQUENCING AND SCHEDULING

A. Sequence and schedule in accordance with Contracting Requirements.

1.06 WARRANTY

A. Submit manufacturer’s standard warranty in accordance with the Section 01 61 00, Common Product Requirements.

B. Warrant to correct defective products for minimum 1 year.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. For PLC or Local Control Panels (LCP), Use one of the following or equal:

1. Rittal Corporation
   One Rittal Place
   Springfield, OH 45504
   Phone: (937) 399-0500
   Fax: (937) 390-5599
   Toll free: (800) 477-4000
   Website: www.rittal-corp.com

2. Hoffman
   2100 Hoffman Way
   Anoka, MN 55303
   Phone: (763) 421-2240
   Fax: (763) 422-2178.
   Website: www.hoffmanonline.com

2.02 PANEL ENCLOSURE

A. NEMA 12 indoor and NEMA 4X outdoor. Specific requirement as specified herein or as indicated on the Drawings.

B. Size panels in accordance with limitations indicated on the Drawings. Panel size is the specific requirement of the panel manufacturer. Minimum panel sizes and/or maximum panel sizes are indicated on the Drawings.

2.03 PANEL FABRICATION

A. The general fabrication requirements for the instrument and control panels including enclosures and sub-panels shall be as specified herein.

B. Pneumatic Tubing: Not less than 1/4-inch OD stainless steel with compression fittings. Run tubing in horizontal and vertical planes, rigidly supported to withstand handling and shipment. Use flexible tubing to connect devices mounted on hinged doors.

C. Provide compression type bulkhead fittings near the bottom or top of the panel, and compression nuts and sleeves for field connections. Provide plugged test connections and isolation shutoff valves for panels containing pneumatic instruments.

D. Pneumatic devices shall have separate air supply shutoff valves.

E. Interconnecting wiring and wiring to terminals for external connection shall be MTW or SIS 16 AWG, stranded copper wire, insulated for not less than
600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90 degrees C except for electronic circuits and special instrument interconnect wiring which shall be in accordance with manufacturer requirements.

F. 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: 600-volt, stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.

3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 16 AWG, minimum.

4. 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.
   c. Use 16 AWG for hot, switch, and DC (+) and (-).

5. Separate analog and other dc circuits at least 6 inches from any ac power and control wiring.

6. Enclose wiring in sheet metal raceways or plastic wiring ducts.

7. 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 equal.


H. Internal Panel Wiring Colors:

<table>
<thead>
<tr>
<th>Control Conductor</th>
<th>120V</th>
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<tbody>
<tr>
<td>Power (AC)</td>
<td>Black</td>
</tr>
<tr>
<td>Control (AC)</td>
<td>Red</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
</tr>
<tr>
<td>Neutral (foreign)</td>
<td>White/Yellow Tracer</td>
</tr>
<tr>
<td>Power/Switched (AC)</td>
<td>White/Red Tracer</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
</tr>
<tr>
<td>Foreign Voltage Hot (AC)</td>
<td>Yellow</td>
</tr>
</tbody>
</table>
I. Surge Protection Device for Power Entrances: Nominal 120V ac with a nominal clamping voltage of 200 volts; nonfaulting and noninterrupting design with a response time of not more than 5 nanoseconds.

J. Terminal Blocks for External Connections: Suitable for specified AWG wire, rated 30 amperes at not less than 600 volts; with marking strip, covers, pressure connectors, and labeled terminals, each conductor of external circuits plus one ground terminal for each shielded cable. Provide minimum 25 percent spare terminals.

K. Group cables, and firmly support wiring to the panel. Provide minimum 8 inches clearance between terminal strips and the base of vertical panels for conduit and wiring space. Individually fuse each control loop or system, and clearly label and locate fuses or circuit breakers for maintenance.

L. Furnish and install equipment grounding conductor in accordance with NEC 250. Provide power ground lugs. Provide signal insulated and isolated ground lugs.

M. Nameplates on Internal and External Instruments and Devices: Materials approximate dimensions with legends as indicated on the Drawings made of laminated phenolic material having engraved letters approximately 3/16-inch-high extending through the black face into the white layer; firmly secured to panels. Refer to Section 01 60 00.00, Product Requirements.

N. Fabricated Custom Panels: Thoroughly clean, sand, and apply minimum two coats of rust inhibiting primer both inside and out of panels. Apply minimum two coats of white enamel or lacquer on panel interior surfaces. Smooth exterior surfaces and apply minimum two coats of enamel, polyurethane, or lacquer finish. Furnish 2 quarts of finish color paint with the panels to cover future scratches.

O. Provide panels with an inside pocket to hold the panel drawings. Ship panels with one copy of accepted submittal drawings in a sealed plastic bag stored in the panel drawing pocket.

2.04 FREESTANDING VERTICAL PANELS

A. Panel Custom Fabrication: Dust tight, completely enclosed cubicle formed from steel structural members and steel plates. Form base of heavy channel iron, with flanges up, and with 1/2-inch holes drilled at 12-inch spacing so that the panel shall be bolted to floor. Grind smooth welds, seams, and edges on exposed surfaces. Provide lifting facilities for handling and shipment.
B. Panel Bracing: Suitably brace panel structure for sufficient strength to support equipment mounted on or within, to withstand handling and shipment, to maintain alignment, to be rigid and freestanding and resist seismic forces as specified in Contracting Requirements.

C. Fabricate tops, sides and rear from minimum 12 steel plates with stationary rear suitable for back-to-wall installation. Panels requiring rear access shall be designed with hinged rear doors. Rear doors shall be fabricated from US 14-gauge steel.

D. Front Doors: US 12-gauge steel plate, with turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging; of sufficient width to permit door opening without interference with rear projection of flush mounted instruments; essentially full height, with strong continuous piano type hinges.

E. Positive Latches: Acting from a common door handle which shall hold doors securely compressed at top, side, and bottom against gaskets.

F. Doors shall have padlock locking provisions. All panels key alike. Four keys.

G. Top and bottom with nominal 1 square foot per section removable access plates which shall be drilled to accommodate external wiring and conduit. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.

H. Arrange panel instruments and control devices in a logical configuration from an operator’s standpoint and as indicated on the Drawings. Center line of recorders shall fall within 36 inches and 69 inches above base of panel for convenient reading and chart replacement.

I. Locate control switches within 60 inches and 36 inches above the base of the panel. Local indicators within 36 inches and 60 inches above the base of the panels. Mount annunciators and clocks near the top of the panels.

J. Panels or panel sections shall be capable of passing through 36-inch doorways less stops.

K. Provide internal ceiling-mounted covered or guarded 100-watt incandescent fixture spaced at approximately 30 inches and located toward the rear for illumination of panel interiors with ON-OFF switches near end doors.

L. Provide duplex, grounded GFI receptacles for service and maintenance tools within the panel at spacings not greater than 5 feet throughout the length of a panel. Provide lighting and receptacle circuit from a separate power source and fuse separately from the instrumentation systems.
2.05 OUTDOOR PANELS

A. Panels: NEMA 4X rating, fabricated as described for vertical panels. An enclosure fabricated from US 12-gauge stainless steel plate shall provide a rigid and freestanding structure of sufficient strength to support equipment, withstand handling and shipment, and maintain alignment.

B. Grind smooth welds, seams, or edges. Edges shall be slightly rounded.

C. Latches and Other Hardware: Stainless steel.

D. Bases: Heavy channel, gasketed iron bases, flanges up, for anchoring to floor.

E. Completely shop assemble panels and ship as a complete unit. Access panels shall be fabricated from not less than US 14-gauge stainless steel. Provide doors and access panels with gaskets. Doors shall have padlock locking provisions.

F. Panel Mounted Instruments, Devices, and Control Switches: Suitable for outdoor service.

G. Conduits connections shall be waterproof sealed with suitable materials.

2.06 WALL-MOUNTED PANELS

A. Panels: NEMA 4X enclosures suitable for wall mounting, which contain the panel components as specified herein and as indicated on the Drawings. Fabricate the enclosures from not less than US 14-gauge steel complete with full size gasketed doors with stainless steel three point latch and hinges.

B. Construct instrument sub-panels from minimum 1/8-inch-thick steel, reinforced and braced as required to form a rigid assembly.

C. Mount components on easily removable steel sub-panels painted white.

2.07 FIBERGLASS TYPE 4X WALL-MOUNTED ENCLOSURES

A. Construction:

1. Fiberglass reinforcement with excellent temperature and chemical resistance qualities.
2. Seams are sealed with no holes or knockouts.
4. Fiberglass material can be easily punched, drilled, filed or sawed.
5. Hinges and quick release latches are made of fiberglass-reinforced polyester.
6. Padlocking hasp(s) shall be made of Type 316L stainless steel.
7. Backplane panel (metallic) and bracing to support mounting and weight of equipment.
8. Enclosure sized to safely dissipate heat from power equipment.
9. Data pocket made of high-impact thermoplastic.
10. Contains copper-flashed steel collar studs for mounting optional panels and terminal block kits.

B. Industry Standards:

1. Meets NEMA Type 4X Standards.
2. Meets UL 508A flammability rating.

2.08 EXISTING PANEL MODIFICATIONS

A. Provide labor and materials for complete modifications to existing panels as specified herein and indicated on the Drawings.

B. The existing panel face shall be field cut and refinished to original condition to accommodate installation of new instruments, removal of existing instruments and fitting of blanks to suit new layouts. New instrument supports shall be provided as required for complete installation.

2.09 AIR CONDITIONING

A. Manufacturers:

1. One of the following or equal:
   a. Rittal.
   b. Noren Products.
   c. Borg Warner.
   d. Hoffman.
   e. McLean Midwest.
   f. Or equal.

B. Provide cabinet coolers or solid-state air conditioning units on panels containing electronic components such as panel instruments, programmable logic controllers remote I/O.

C. Provide internal fans, coolers, or air conditioning units with thermostatic control as necessary for internal air circulation to maintain internal temperature ratings of 90 degrees F or below. Provide filters on intake and exhaust openings.

D. Enclosure’s required NEMA rating shall be retained after installation of air conditioning.
2.10 STRIP HEATERS

A. Provide electric strip heaters as indicated on the Drawings, as specified, and as required by the application.

B. Strip Heaters: Suitable for 120-volt, single-phase power supply, sized to prevent condensation within the enclosure and to ensure that equipment is maintained above its minimum operating temperature of 40 degrees F.

C. Locate strip heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.

D. Control strip heaters with adjustable thermostats having an adjustment range of 40 degrees F to 90 degrees F. Provide a circuit breaker or fused disconnect switch within the enclosure.

2.11 POWER SUPPLIES/FUSING

A. Design and arrange regulated 24 V dc power supplies for instrument loops so that loss of one loop does not affect more than one instrument loop or system. Provide power supplies suitable for an input voltage variation of plus or minus 10 percent. Fuse or short circuit protect the supply output.

B. Selectively fuse the power distribution from multi-loop supplies so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Label and locate fuses for easy access.

C. Output Voltage Regulation: As required by the instrument or control equipment being supplied.

D. Backup power supply units shall be provided to automatically supply the load upon failure of the primary supply. Design backup supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.

E. Oversize the multi-loop supply systems for an additional 15 percent future load. Indicate failure of a multi-loop supply on the respective instrument panel or enclosure.

F. Furnish and install signal repeaters for instrument loops that exceed the load impedance of the power supplies. Indicating fuses: Neon bulb type for 120V ac circuit and glass indicating fuse type for 24V dc circuits.

2.12 SOURCE QUALITY CONTROL

A. Functionally factory test instrument and control panel items electrically and pneumatically before shipment.
2.13 PANEL ACCESSORIES

A. Interface Modems/Converters:

1. Manufacturers:
   a. One of the following or equal:
      1) Phoenix Contact.
      2) Entrelec.
      3) RS-232-C.
      4) TTY.
      5) RS 422.
      6) RS 485.
      7) Optic fiber.
      8) Isolation.
      9) Amplifier.
     10) Multiplexer.
     11) Or equal.

B. Surge Protectors:

1. Manufacturers:
   a. One of the following or equal:
      1) Transector ACP-100 BW.
      2) Power Integrity Corporation ZTAS.
      3) Entrelec.
      4) Weidmuller.
      5) Phoenix Contact.
      6) Or equal.

C. Terminal Blocks:

1. Manufacturers:
   a. One of the following or equal:
      1) Weidmuller SAKS.
      2) Entrelec.
      3) Phoenix Contact.
      4) Wago.
     5) Or equal.

2. Nickel plated copper only; DIN rail; universal foot with the following as required for the application:
   a. Universal type.
   b. Feed through.
   c. Ground.
   d. Neutral disconnect.
   e. Intrinsically safe.
   f. Explosion-proof.
   g. Fuse.
h. Knife disconnect.
i. Ground fault indicator.
j. Bolt connecting.

3. Terminal Block Labeling: Each terminal and each conductor as previously specified with machine labels only.

D. Signal Interface Modules:

1. Manufacturers:
   a. One of the following or equal.
      1) Phoenix Contact.
      2) Entrelec.
      3) Hirschmann.
      4) Or equal.

2. Analog isolating converter.
3. Ground loop isolations.
4. Signal amplification.
5. Signal level matching.
6. 24V dc power supply (120V ac input).

2.14 SPECIAL ADDITIONAL REQUIREMENTS FOR SPECIFIC PANELS (DCS RELATED DCUS)

A. Distributed Control Unit (DCU) Panels:

1. Seismic/Zone and Applications: Enclosure model Rittal Seismic TS 8 with door stiffener, corner gussets, and diagonal brackets.
2. Climate Control:
   a. Built-in air conditioning (side wall or door or roof mount per drawings) cooling capacity shall be at least 4,780 Btu.
   b. Power Supply: 115V ac. Air conditioning shall be removable from DCU for installation due to limited space onsite.
3. System Lights: Rittal’s enclosure system lights (incandescent) operated by the motion sensor.
4. Dimensions of height, width, and depth as shown on panel drawing.
5. Marshalling (Field Wirings Termination):
   a. Seismic/Zone 4 applications: Enclose model Rittal Seismic TS 8 with door stiffener, corner gussets, and diagonal brackets.
   b. System lights: Rittal’s enclosure system lights (incandescent) operated by the motion sensor.
   c. Bottom mount module or wiring trough and wiring way for cable feed from bottom.

B. Marshalling (Field Wirings Termination) Panels:

1. Seismic/Zone 4 Applications: Enclosure model Rittal Seismic TS 8 with door stiffener, corner gussets, and diagonal brackets.
2. System Lights: Rittal’s enclosure system lights (incandescent) operated by the motion sensor.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install gasket and sealing material under panels with floor slab cutouts for conduit. Undercoat floor mounted panels.

B. Install conduit gasket, sealing material, and NEC Article 500 Seal-Off as specified in Division 26, Electrical.

C. Contractor shall install signal grounding conductor and grounding electrode as required by the panel manufacturer.

D. Connect panel equipment grounding (safety) terminal to the building or facility ground grid with 6 AWG green insulated conductor.

3.02 ADJUSTING

A. Adjust equipment in accordance with the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

3.03 CLEANING

A. Clean area during construction and after completion of construction by removing loose items such as plastic, short wires, short wire way covers, etc.

3.04 DEMONSTRATION

A. Demonstrate operation of equipment in accordance with the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

3.05 PROTECTION

A. Protect products until acceptance by Owner.

END OF SECTION
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:

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.
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):
   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):
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.


1.02 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.
B. AUI: Attachment Unit Interface.
C. dB: Decibel.
D. DNI: Desktop Network Interface.
E. EMB: Effective Modal Bandwidth.
F. ETL: Electrical Test Laboratories.
G. FDDI: Fiber Distributed Data Interface.
H. FIM: Facilities Information Management.
I. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

J. FOCS: Fiber Optic Communication System.

K. FOIRL: Fiber Optic Inter Repeater Link.

L. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

M. Hybrid Cable: Cable containing more than one type of fiber.

N. LAN: Local Area Network.

O. LIMS: Laboratory Information Management System.

P. m: Micrometer.

Q. Mbps: Megabits per Second.

R. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

S. Megahertz (MHz): One million cycles per second.

T. MHz: Megahertz.

U. micro: $x\ 10^{-6}$.

V. Micron: Micrometer or one millionth meter.

W. MIS: Management Information System.

X. n, nano: $x\ 10^{-9}$.

Y. N: Newton.

Z. nm: Nanometer—unit of measure equal to one billionth meter.

AA. OFL: Over-filled Launch.

BB. OFN: Nonconductive Optical Fiber Cable.

CC. OFNP: Nonconductive Optical Fiber Plenum Cable.

DD. OFNR: Nonconductive Optical Fiber Riser Cable.

EE. OLTS: Optical Loss Test Sets.
FF. OTDR: Optical Time Domain Reflectometer.

GG. OVD: Outside Vapor Deposit.

HH. PIC: Process Instrumentation and Control.

II. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

JJ. RLM: Restricted Mode Launch.

KK. ROL: Reverse Oscillation Lay.

LL. SPC: Super Physical Contact.

MM. UPC: Ultra Physical Contact.

NN. UPS: Uninterruptible Power Supply.

OO. V ac: Volts Alternating Current.

PP. 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:

1. In-Plant and Outside Plant Ethernet and EtherNet/IP Network.
2. In-Plant Fiber Installation: Multi-mode Fiber.

C. Network(s) will be used by Plant SCADA and Administration to distribute data and coordinate Engineer’s operations. Fiber will also be used to for fire, security and plant communications.

D. Install fiber between Headworks and MTF. Fiber to run from a Network Interface Panel with a fiber patch panel mounted inside (I941001-NIP-1) located near Headworks PLC cabinet I941001-LCP-100 located in the Headworks electrical room to a fiber patch panel (I941002-NIP-1) in the MTF control room. Site fiber will also terminate in I941002-FPP1 See I941001-F-0002 SCADA Network Block Diagram for more details.
1.04 SUBMITTALS

A. Action Submittals:

1. Site Layout Diagram Showing:
   a. Access holes, with identification.
   b. Above grade cable routings, with pole and cable identification.
   c. Below grade conduit routings between access holes and buildings, with conduit counts and identification.
   d. Below grade 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 planned 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 fiber systems and Design Build (DB) deliveries.
      1) Statement of Experience: List of at least five fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
         a) Engineer or other Design Build (DB) Engineer 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 Engineer or other Design Build (DB) Engineer. 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. Engineer acceptance of FOCS Subcontractor does not exempt FOCS Subcontractor or Subcontractor 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 Subcontractor generated in a previous project.
f. Testing and acceptance plan, prior to beginning of testing.
g. Fiber test results. Documentation covering fiber facility testing, 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, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
   3. Inside: 0 degree C to 40 degrees C.

B. Equipment:
   1. Outside, Aboveground: Minus 40 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.
   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.

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 Engineer.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

PART 2 PRODUCTS

2.01 SINGLE-MODE FIBER OPTIC CABLE

A. Single-Mode: 8.3/125-micron Class IVa dispersion-unshifted optical fibers for use in the backbone distribution subsystem shall meet or exceed requirements of TIA 568-C.3, including the following specifications:

1. Chromatic Dispersion:
   a. Zero-Dispersion Wavelength: Between 1,302 nm and 1,322 nm.
   b. Maximum value of dispersion slope at zero dispersion wavelength shall be no greater than 0.093 ps per km-nm².
2. Mode Field Diameter: Nominal 8.7 microns to 10 microns, with a tolerance of plus or minus 0.5 micron at 1,300 nm.
3. Maximum Attenuation:
   a. Outside and Indoor-Outdoor Optical Fiber Cable:
      1) 0.5 dB per km at 1,310 nm.
      2) 0.5 dB per km at 1,550 nm.
   b. Inside Optical Fiber Cable:
      1) 1 dB per km at 1,310 nm.
      2) 1 dB per km at 1,550 nm.
5. TIA 492 CAAB (OS2) low water peak and complies with ITU T G.652 (A to D). Distance Capacity per IEEE 802.3:
   a. 1 Gbit Ethernet, 1,300 nm Laser Minimum Distance: 5000 m.
   b. 10 Gbit Ethernet: 10 km at 850 nm and 40 km at 1,310 nm.

B. Type 8.3/250, Backbone for Underground Conduit Installation:

1. Individual Fibers: 8.3/125/250 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 and RDUP 7 CFR 1755.902 for backbone, feeder and distribution cables and RDUP 7 CFR 1755.903 for service entrance or drop cable with 12 strands or less used having a distance of 100 m or less (fiber-to-the-home applications).
3. NEC/UL Listing: None; not approved for general use within building, except when installed in metallic conduit.
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. Type 8.3/250, Backbone for Underground Conduit and Building Riser Installation:
   1. Individual Fibers: 8.3/125/250 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.

2.02 MULTIMODE FIBER OPTIC CABLE

A. 50/125-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. OM2-500 MHz•km minimum at 850 nm; TIA 492AAAB.
      b. 500 MHz•km minimum at 1,300 nm.
   3. Distance Capacity per IEEE 802.3:
      a. 100Mbit Ethernet: OM2 300m at 850 nm and 2000m at 1,310 nm.
      b. 1 Gbit Ethernet:
         1) OM2: 600m at 850 nm and 600 at 1310 nm.
      c. 10 Gbit Ethernet—10km at 850 nm and 40km at 1310 nm:
         1) OM2: 82m at 850 nm and 600 at 300 nm.
B. Type 50/250 OM2 Backbone for Underground Conduit Installation:

1. Individual Fibers: 50/125/250 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.
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. Type 50/250 OM2, Backbone for Underground Conduit and Building Riser Installation:

1. Individual Fibers: 50/125/250 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.

D. Type 50/900 OM2, Indoor/Outdoor Cable:

1. Individual Fibers: 50/125/250/900 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.
4. NEC/UL Listing: OFNR Low Smoke Zero Halogen.
5. Manufacturers and Products:
   a. Corning Cabling Systems; (MIC) cable.
   b. Mohawk; Distribution Riser cable.
2.03 MULTICELL CONDUIT SYSTEM

A. Nonmetallic, designed for fiber optic cabling and telecommunications.

B. Flexible Fiber Innerduct:
   1. Function: Install within conduit system provided under Division 26, Electrical to provide smooth, low friction path through conduit, with only one cable per path to facilitate changing individual cables.
   2. Features:
      a. Size and Count:
         1) 2-inch two-cell located within 2-inch diameter conduit unless otherwise noted.
         2) 3-inch three-cell located within 3-inch and greater diameter conduit unless otherwise noted.
      c. Color Code: Orange as coordinated with Engineer.
      d. Strength: Minimum 2500-pound tensile strength, with no more than 5 percent ovalization at 600-pound tension.
      e. Lubrication: Prelubricated.
      f. Preloaded pull string.
   3. Manufacturers:
      b. CableGuide Fabric Innerduct.

C. Corrugated Flexible Sleeves:
   1. Function: Exposed applications including cable trays, cabinets, and fiber routing between handholes and associated Network Interface Panels to provide smooth, low friction path through conduit, with only one cable per path to facilitate changing individual cables.
   2. Features:
      a. Size and Count: Two (2) 1-inch sleeves routed within outer conduits. 1-inch sleeves routed within cable trays to support quantity of fiber-optic cable runs.
      b. Type: Corrugated Flexible and Fire Resistant.
      c. Material: HDPE.
      d. Color Code: Orange, blue, green, brown, white, or grey as coordinated with the Authority.
      e. Strength: Minimum 600-pound tensile strength, with no more than 5 percent ovalization at 600-pound tension.
      f. Lubrication: Prelubricated.
   3. Manufacturers:
      a. Carlon Fire-Flex GP Duct.
      b. Carlon Fire-Flex Riser Duct.
      c. Future Path.
2.04 ETHERNET FIBER-TO-COPPER TRANSCEIVERS

A. Function: Convert half/full-duplex fiber optic Ethernet signal to copper Ethernet signal and vice versa.

B. Speed: Auto-negotiating 10/100/1000.

C. Features:

1. Support fiber optic type specified.
2. Fiber Optic Connectors: LC connectors preferred unless otherwise required for SC and ST ancillary devices.
3. Copper Connector: RJ45 unshielded.
4. Power:
   a. Powered by signal.
   b. 120V ac or 24V dc power source.
5. Mounting: Suitable for permanent mounting.
6. Fiber Signal Distance: 100 feet minimum.

D. Manufacturers:

1. Moxa; IMC Series Media Converters.
2. Black Box; LIC/LGC Series Industrial Media Converters.
3. OmniTron; Flexpoint Series Media Converters.

2.05 FIBER DISTRIBUTION FRAME

A. Function: Provides industry-standard rack mounting system for interface between fiber optic backbone and equipment cables.

B. Features:

1. Used in either cross-connect or interconnect configuration.
2. 23-inch (584-mm) rack for mounting 19-inch (483-mm) rack mount units.
   a. Accommodates up to 576 fiber terminations per frame.
   b. Accepts connector module housing and splice housing within same rack.
3. Fiber Optic Connectors: LC connectors preferred unless otherwise required for SC and ST ancillary devices.
4. Fiber/Wire Management System:
   a. Vertical: 75-mm by 100-mm supports on 200-mm centers vertically on four sides (front LHS, back LHS, front RHS, back RHS).
b. Horizontal: Supports on 100-mm centers horizontally above and below each termination frame front and back. Support may serve frames immediately above and below.

5. Mounting Hardware: Accepts standard 19-inch (483-mm) rack for integrated fiber optic system (for example, hubs, routers, patch panels).

6. Splice Trays with Coil Former: Former to wind slack cable around, provides controlled long radius bends.
   a. Doors: Pivot down lockable.
   b. Foot and End Caps: Included in final, assembled unit.
   c. Ancillaries: Jumper troughs and covers, cable tie brackets.


2.06 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 LC connectors preferred for entry and exit unless otherwise required for SC and STA ancillary devices.
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.
7. Doors: Separate doors for cable and jumper terminations.


2.07 HOUSINGS

A. Termination Housing:

1. Rack mountable connector housing.
2. Mountable in ECA 310-E compatible 465-mm or 592-mm rack.
3. Available in several sizes, including 1U, 2U, 3U, and 4U.
   a. One ECA rack space or panel height (denoted as U) is defined as being 44.45 mm in height.
4. In accordance with design requirements of TIA 568-C.3 and polymer compounds flammability requirements of UL 94.
5. Manufactured using 16-gauge aluminum or equivalent for structural integrity.
6. Finished with wrinkled black powder coat for durability.
7. Provide black installation fasteners.
8. Available sizes with their corresponding fiber capacities are noted below:

<table>
<thead>
<tr>
<th>Unit Size</th>
<th>Panel Capacity</th>
<th>Fiber Capacity with 6f Panels</th>
<th>Fiber Capacity with 12f Panels</th>
<th>Fiber Capacity with 24f Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1U</td>
<td>2</td>
<td>12</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>2U</td>
<td>4</td>
<td>24</td>
<td>48</td>
<td>96</td>
</tr>
<tr>
<td>3U</td>
<td>6</td>
<td>36</td>
<td>72</td>
<td>144</td>
</tr>
<tr>
<td>4U</td>
<td>12</td>
<td>72</td>
<td>144</td>
<td>288</td>
</tr>
</tbody>
</table>

B. Splice Housing (Outside Plant Single Mode Fiber Installation):

1. Mountable in ECA 310-E compatible 465-mm or 592-mm rack.
2. Available in two rack mount sizes of 3U and 5U.
   a. One ECA rack space or panel height (denoted as U) is defined as being 44.45 mm in height.
3. Provide individual tray access with minimal disturbance to neighboring trays and fibers.
4. In accordance with design requirements of TIA 568-C.3 and polymer compounds flammability requirements of UL 94.
5. Manufactured using 16-gauge aluminum or equivalent for structural integrity.
6. Finished with wrinkled black powder coat for durability.
7. Front and rear doors shall be lockable.
8. Brackets shall allow wall mounting of rack-mounted hardware.
9. Provide black installation fasteners.
10. Available sizes with their corresponding fiber capacities are noted below:

<table>
<thead>
<tr>
<th>Unit Size</th>
<th>Tray Height (inches)</th>
<th>Tray Capacity</th>
<th>Splice Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3U</td>
<td>0.2</td>
<td>12</td>
<td>144</td>
</tr>
<tr>
<td>3U</td>
<td>0.4</td>
<td>7</td>
<td>84</td>
</tr>
<tr>
<td>5U</td>
<td>0.2</td>
<td>22</td>
<td>264</td>
</tr>
<tr>
<td>5U</td>
<td>0.4</td>
<td>14</td>
<td>168</td>
</tr>
</tbody>
</table>
C. Combination Termination/Splice Housings:

1. In accordance with design requirements listed in TIA 568-C.3, TIA/EIA-942, and polymer compounds flammability requirements of UL 94.
2. Mountable in ECA 310-E compatible 465-mm rack or 592-mm rack.
3. Available in 1U and 4U sizes.
   a. One ECA rack space or panel height (denoted as U) is defined as being 44.45 mm in height.
   b. 1U shall have removable top lid.
   c. 4U shall have integrated jumper routing guides.
5. Manufactured using 16-gauge aluminum or equivalent for structural integrity.
6. Finished with rustic gun-metal grey powder coat for durability.
7. Joints shall be welded and finished in a workman-like manner.
8. Provide installation fasteners that match housing color.
9. Provide clamshell-type cable clamping mechanism to provide cable strain relief.
10. Front and rear doors shall be lockable.
11. Connector housings shall have a labeling scheme that complies with TIA-606.
13. Able to accommodate fusion splicing with additional hardware.


2.08 PANELS

A. Closet Connector Housing Panel:

1. Manufactured from 16-gauge cold rolled steel or injection-molded polycarbonate for structural integrity.
2. Designed to accommodate applications requiring specified labeling.
3. Offered in 8-fiber, 12-fiber, 16-fiber, and 24-fiber versions.
4. 8-fiber and 12-fiber versions shall include LC connectors preferred for otherwise required for SC and STA ancillary devices.
   a. For high-density applications, LC duplex panels and MT-RJ shall be available in 16-fiber and 24-fiber versions.
      1) When MT-RJ adapters are used, adapter shall be a style that has a polarity adjustment knock-out keyway tab that shall be oriented on inside of panel so that it is not accessible to user once system is installed.
5. Capable of being used with field-installable connectors or in applications where pre-connectorized cables are routed directly from equipment to interconnect hardware.

6. Capable of accepting interchangeable connector panel.

7. Panel shall be attached with two push-pull latches to allow quick installation and removal.

8. Blank Connector Panel:
   a. Available to fill unused space within housing.
   b. Attached with at least two push-pull latches to allow quick installation and removal.
   c. Manufactured from injection-molded polycarbonate.

B. Pigtailed Adapter Panels:
   1. Manufactured from 16-gauge cold rolled steel or injection-molded polycarbonate for structural integrity.
   2. Attached with two push-pull latches to allow quick installation and removal.
   3. Use for splicing pre-terminated pigtails to field cables.
      a. Pigtails shall be bundled in a MIC or Ribbon style subunit.
      b. Pigtail Length: 3 meters.
   4. Offered in 6-fiber, 8-fiber, 12-fiber, 16-fiber, and 24-fiber versions.
      a. 6-fiber panels shall be offered in ST compatible, FC, SC simplex.
      b. 8-fiber and 12-fiber versions shall include ST compatible connector, LC duplex, SC duplex and simplex and MT-RJ multi-fiber connectors.
      c. For high-density applications, LC duplex and MT-RJ panels shall be available in 16-fiber and 24-fiber versions.
         1) When MT-RJ adapters are used, adapter shall be a style that has a polarity adjustment knock-out keyway tab that shall be oriented on inside of panel so that it is not accessible to user once system is installed.
      d. Each individual fiber shall be color coded in accordance with TIA 598.


2.09 SPLICE TRAY

A. General:
   1. Compatible with hardware connector/splice housings.
   2. Securely organize and provide physical protection without stress on fibers for both single-mode and multimode individual and ribbonized fiber splices.
3. Splice enclosures to include various lengths and depths for a variety of splicing methods.

B. Features:

1. Shall not induce attenuation of signal at operational wavelengths up to 1,550 nm.
2. Consist of rugged aluminum base and aluminum cover with crimpable metal tabs that provide buffer tube strain-relief on both ends of tray.
3. Hold up to 24 single-fiber splices and up to six mass fusion splices.
4. Splice Organizer:
   a. Accommodate fusion splice, fusion splice with heat-shrink sleeve or mechanical sleeve, and mechanical splice part.
   b. High-precision molded construction that holds and protects actual splice thus eliminating need for extra splice protection parts.
   c. Provide positive holding action for maximum splice protection during installation and operation.
5. Strain-relief Points: Tie-wrap buffer tubes or pigtails to metal tray.
6. Finish: Black powder coating for ease of fiber identification and protection.

2.10 SPlice ClosURES UNDERGROUND

A. Function: Enclose branch and inline splices in underground Outside-Plant applications.

B. Available in canister (butt) and in-line styles to fit most applications.

C. Sizes:

1. Small: Accommodate up to 72 single-fiber splices.

D. Housing:

1. Nonmetallic, resistant to solvents, stress cracking, and creep.
2. Material shall be compatible with chemicals and other materials to which they might be exposed in normal applications.

E. End Caps:

1. Feature two express ports for uncut feeder cables.
2. Capable of accepting additional cables without removal of sheath retention or strength-member-clamping hardware on previously installed cables or disturbing existing splices.

F. Quick-seal mechanical seal drop ports.
G. Optical Fiber Closure:
   1. Capable of accepting optical fiber cable commonly used in interoffice, outside plant, and building entrance facilities.
   2. Provide clamping mechanism to prevent pistoning of central member or strength members, and to prevent cable sheath slip or pullout.
   3. Ability to double cable capacity of installed canister splice closure by use of a kit. Such a conversion shall not disturb existing cables or splices.

H. Encapsulati on shall not be required to resist water penetration.

I. Re-enterable.

J. Bonding:
   1. Provide hardware to facilitate bonding and grounding of metal components in closure and armored cable sheath.
   2. Cable bonding hardware shall be able to accommodate a copper conductor equal to or larger than 6 AWG.

K. Installation shall not require specialized tools or equipment other than those normally carried by installation crews.

L. Manufacturer and Products:
   1. 3M; Fiber Splice Enclosure 2178-L/S, or as required.
   2. 3M; Fiber Splice Tray 2170, or as required.
   3. 3M; Fiber Optic Splice Closure 2178-XSB Butt Splice Configuration with all fiber cables enter splice enclosure from one end only (smaller communications access handhole-manhole applications) and supporting 24 single fusion splice capacity. Dimensions: 14.6-inch L by 10.1-inch W by 4.6-inch H.
   4. Corning Optical Communications; Splice Closure Fiber (SCF).
   5. Coyote; Fiber Optic Closures.

2.11 CONNECTORS

A. General:
   2. LC connectors preferred unless otherwise required for SC and ST ancillary devices.
   3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   b. Polarizing key on duplex connector systems.

5. Attenuation:
   a. In accordance with TIA 568-C.3.
   b. Maximum of 0.75 dB per connector pair.

6. Manufacturer:
   a. Corning Cable Systems; Unicam.
   b. Leviton; FastCAM.
   c. Black Box.

2.12 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:
   a. Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).
10. Manufacturer:
    a. Corning Cable Systems.
    b. Black Box.
2.13 COMMUNICATIONS MANAGEMENT OUTLETS

A. General:
   1. In accordance with TIA 568-C.3.
   2. Function: Provide organized system for connecting workstations into precabled communications.

B. Cover Plates:
   1. Flush and extension mount, as required to provide bend radius and space for coiled cable.
   3. Color: White, unless otherwise indicated.

C. Connectors:
   1. Type: LC connectors preferred unless otherwise required for SC and ST ancillary devices.
   2. Mounting: Face flush mount and Side, for low-profile applications.

D. Manufacturers and Product:
   1. Leviton; QuickPort wiring systems.
   2. Panduit; CJ6X88 series wiring systems.
   3. Hubbell; Premise wiring systems.

2.14 CONDUIT

A. In accordance with Division 26, Electrical.

2.15 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 and Innerducts: 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:
   a. No cables shall be pulled into spare conduit.
   b. 100 percent spare conduit capacity required for buried conduit only. For example, for every conduit with one or more cables in it, there shall be one spare equal-size conduit with no cables.

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.

B. Innerduct:
   1. In accordance with manufacturer’s recommendations.
   2. In all fiber optic conduits.
   3. Install no more than one innerduct of each color in single conduit.
   4. Terminate innerducts in conduit with fabricated termination kits.
   5. Identify innerducts at both ends by methods such as color-coding or waterproof tags wired through innerduct wall.

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: One cable maximum 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:
   a. Install In-Plant fiber optic cables in un-spliced lengths between network interface panels (NIPs).
   b. Install Outside-Plant fiber optic cables in outside splices in access holes, protected by splice closures.
   c. Fusion splice fibers using apparatus applicable to type and size of fiber being spliced. Insert loss of splicing unit shall not exceed 0.2 dB on single-mode fibers and 0.25 dB on multimode fibers.

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 minimum 30 inch centers along sides.
    b. Provide 30 feet additional fiber (looped) for runs through and within handholes.
    c. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Fiber Center, Fiber Distribution Frame, Housing, Panel, and Splice Tray:
    Install securely in field panels or enclosures as shown on Drawings.

C. 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.
D. Ethernet Fiber-to-Copper Transceivers:

1. Install transceivers in accordance with manufacturer’s instructions.
2. Location: Install transceivers securely in field panels, close to network nodes and fiber centers.
3. Power: Energize each transceiver from its field panel’s UPS, if applicable.
4. Connections:
   a. Connect transceiver to fiber optics and network node.
   b. Lace fiber optics neatly in place, routed through wireways.

E. Conduit: Install in accordance with Division 26, Electrical.

3.03 LABELING CONVENTIONS

A. Conform to TIA 606 or to requirements specified by Engineer or Engineer’s representative.

B. Backbone (Riser) Cables:

1. Multi-conductor 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.
   c. Note: Project include Network Interface Panels (NIP) supporting both main and intermediate distribution of fiber and copper cables. Fiber cable route between NIPs. Fiber and copper cable route between NIPs and Plant SCADA PLC and Package Control System PLC local control panels (LCP).

Where:

<table>
<thead>
<tr>
<th>IDF</th>
<th>Is the 3-5 position IDF/wiring closet/building code</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDF</td>
<td>Is the 3-5 position MDF (or IDF) code</td>
</tr>
<tr>
<td>F</td>
<td>Fiber</td>
</tr>
<tr>
<td>PPP</td>
<td>Is pair count of a copper cable</td>
</tr>
<tr>
<td>MMM</td>
<td>Is multimode strand count</td>
</tr>
<tr>
<td>SSS</td>
<td>Is single-mode strand count</td>
</tr>
<tr>
<td>N</td>
<td>Is a sequential number</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>IDF</th>
<th>Is the 3-5 position IDF/wiring closet/building code</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Data cable (green)</td>
</tr>
<tr>
<td>V</td>
<td>Voice cable (gray)</td>
</tr>
<tr>
<td>NNN</td>
<td>Is the sequence number</td>
</tr>
<tr>
<td>A/B</td>
<td>Indicates left or right port in faceplate</td>
</tr>
</tbody>
</table>

3.04 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.
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.
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.

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.

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. 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.
   g. Manufacturer: Fluke Networks.

4. Fiber Microscope:
   a. Magnification: 250X or 400X for end-face inspection.
   b. Manufacturer: Fluke Networks.
5. Integrated OLTS, OTDR, and Fiber Microscope:
   a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
   b. Manufacturer: Fluke Networks.

C. Conduit Test:

1. Test and seal spare conduits.
2. 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/EIA 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:

<table>
<thead>
<tr>
<th>Type of Optical Fiber</th>
<th>Wavelength (nm)</th>
<th>Attenuation Coefficient (dB/km)</th>
<th>Wavelength (nm)</th>
<th>Attenuation Coefficient (dB/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimode 50/125 μm</td>
<td>850</td>
<td>3.5</td>
<td>1300</td>
<td>1.5</td>
</tr>
</tbody>
</table>

b. OTDR Testing:
   1) Reflective Events: Maximum 0.75 dB.
   2) Nonreflective Events: Maximum 0.3 dB.

c. Magnified Endface Inspection:
   1) Visually inspect fiber connections for end-face quality.
   2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

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 Subcontract Agreement and satisfaction of Engineer.

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 multi-fiber 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 Engineer or Engineer’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
Engineer 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 TRAINING

A. Train Owner’s staff in the following skills:
   1. Connectorizing fibers.
   2. Splicing optical fiber cables, including fiber splices.
   3. Testing quality of connectors, splices and fibers.

B. Materials: Provide hardware for training, including fibers, connectors, and splice kits.

3.06 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/Innerduct Installation Form.

END OF SECTION
PROJECT: OF200 Mercury Treatment Facility

Subcontractor: ____________________________________________________________

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

*Subcontractor to provide actual length installed, within ±0.1 km.

<table>
<thead>
<tr>
<th>Fiber ID</th>
<th>Use/Spare</th>
<th>Measured Attenuation (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hub-to-Node</td>
</tr>
<tr>
<td></td>
<td></td>
<td>850 nm</td>
</tr>
<tr>
<td></td>
<td></td>
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</tbody>
</table>
Single-mode Fibers

<table>
<thead>
<tr>
<th>Cable length*</th>
<th>1310 nm: 1.0 or 0.5 dB/km x km + 1.5 dB = dB</th>
<th>1550 nm: 1.0 or 0.5 dB/km x km + 1.5 dB = dB</th>
</tr>
</thead>
</table>

*Subcontractor to provide actual length installed, within ±0.1 km.

<table>
<thead>
<tr>
<th>Fiber ID</th>
<th>Use/Spare</th>
<th>Measured Attenuation (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hub-to-Node 1,310 nm 1,550 nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PROJECT: OF200 Mercury Treatment Facility

Subcontractor: 

Signed by: 

AS-BUILT CONDUIT/INNERDUCT 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:

<table>
<thead>
<tr>
<th>Conduit ID*</th>
<th>Innerduct ID</th>
<th>Cable ID / Spare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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</tbody>
</table>

(Continued overleaf delete if not applicable)

*Provide conduit ID if required to identify innerduct uniquely in the access hole, if for example, color-coded innerduct is used in more than one conduit. If innerducts are tagged uniquely, leave this column blank.

END OF SUPPLEMENT
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Applications Software

Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 27, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

Document Review & Approval:

**Originator:**

Dennis J. Thomas PE/I&C Lead

**Design Verification Complete:**

Roger W. Harte PE/I&C QC

**Approved:**

W. Laird Ellis, Jr. PE/Design Manager

Digitally signed by W. Laird Ellis, Jr.

Date: 2017.06.27 14:05:47 -06'00'
SECTION 40 96 01
APPLICATIONS SOFTWARE

PART 1  GENERAL

1.01 WORK INCLUDED

A. General: Work includes design, furnishing, testing, documenting, training and
starting up the Process Instrumentation and Control (PIC) Applications
software, complete.

B. Major applications software work items include:
   1. Work sequence and schedule.
   2. Applications software workshops.
   3. Applications software submittals.
   4. Applications software development.
   5. Software testing.
   7. O&M development.
   8. Owner training.
   9. Startup.

1.02 DIVISION OF WORK

A. Software Supplier: By Engineer.

B. PLC and HMI Software purchased by Contractor, licensed to client.

1.03 DEFINITIONS

A. Abbreviations:
   1. I&C: Instrumentation and Control.
   2. I/O: Inputs and Outputs.
   4. ORT: Operational Readiness Test.
   6. PC: Personal Computer.
   8. PLC: Programmable Logic Controller.
  10. PT: Performance Testing.
  11. SCS: Supervisory Control System.
  12. SDT: Software Demonstration Test.
  13. SLC: Single Loop Controller.
B. Instructor Day: 8 hours of actual instruction time.

C. Loop Narratives: Lists and descriptions in Article Supplements, giving additional requirements for individual control loops.

D. Software:
   1. Programming of digital devices using all types of programming language.
   2. Configuring of digital devices using all types of configuring process.
   3. Programs or configuration data stored in read only memory, programmable read only memory, read/write memory, disk, tape, or other storage device.

E. Types of Software:
   1. Standard Software: Software packages that are independent of project on which they are used. Standard software includes system software and process monitoring and control software.
      a. System Software: Application independent software developed by Microsoft. Includes, but is not limited to, Microsoft’s NT operating system; file management utilities; text editors; debugging aids; and diagnostics.
      b. Process Monitoring and Control Software (PMCS): Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing capability for, data acquisition, monitoring, alarming, man-machine interface, data collection, data retrieval, trending, report generation, control, and diagnostics.
   2. Application Software:
      a. Software to provide functions unique to this Project and that are not provided by standard software alone.
      b. Configuring databases, tables, displays, reports, parameter lists, ladder logic, and control strategies required to implement functions unique to this Project.

1.04 WORK SEQUENCE AND SCHEDULE

A. General: All work provided under this section shall be in accordance with a Milestone Breakdown and System Delivery Plan.

B. Milestone Breakdown (MB): Summarize the major milestones for work.

C. System Delivery Plan (SDP):
   1. The intent of the SDP is to:
      a. Coordinate and communicate applications software design and testing activities.
b. Coordinate interactions with the Owner regarding workshops, submittal reviews, contractor(s) progress, test witnessing, training, etc.

c. Communicate and clarify required work sequences and major milestone.

2. Minimum Content:
   a. Work sequence and schedule.
   b. Applications software workshops.
   c. Applications software submittals.
   d. Applications software development.
   e. Software testing.
   f. Software installation.
   g. O&M development.
   h. Owner training.
   i. Startup.

1.05 SOFTWARE DESIGN WORKSHOPS

A. Location: Owner’s facility during the course of the Project.

B. Objective: To provide a vehicle for the Owner to oversee the applications software development.

C. Documentation: Software Supplier summarize resolutions reached in each workshop, including cost and schedule impacts and distribute copies to Owner and Engineer.

D. Order and minimum topics to be covered in each Software Design Workshop.

1. Applications Software Design Workshop (kick off) that establishes project processes, including:
   a. Software Supplier and Contractor organization and reporting procedures.
   b. Workshop objectives.
   c. Submittal process.
   d. Review work sequence and schedule.

2. Loop Narratives, P&ID Review Workshop:
   a. Software Supplier use P&IDs and Loop Narratives to present how the proposed control system design and Applications Software will meet the functional requirements specified herein.
   b. At the completion of workshop Applications Software Supplier updates Loop Narratives with changes, additions and clarifications, using revision mode, that document the changes.
   c. Submit finalized Loop Narratives along with an outline of any application software cost and schedule impacts.
3. PLC Software Standards Submittal Workshop: PLC Software Standards shall be developed in a Software Standards Workshop. Ladder diagram standards for commonly used functions, including the following:
   a. Objective: Develop PLC Software Standards.
   b. Ladder diagram standards for commonly used functions, including the following:
      1) High and low process variable alarm checking.
      2) Instrument failure alarm detection.
      3) Equipment control.
      4) On/Off pump control.
      5) Start/Stop pump control.
      6) Valve control.
      7) Gate control.
      8) Equipment failure detection.
      9) Equipment run time.
     10) Signal filtering.
     11) Flow totalization.
     12) Setpoint ramping.
     13) Annunciator routine.
     14) Interface with SCS.
     15) Memory mapping.

4. SCS Standards Workshop:
   a. Objective: To review and develop SCS standards in a participative workshop with Owner.
   b. Design products and topics to be finalized:
      1) SCS integration.
      2) Tag Group naming convention.
      3) SCS Tag naming conventions.
      4) Overview display design.
      5) Process graphics.
      6) Display paging and navigation.
      7) Dynamic Objects: Pumps, valves, gates, compressors, etc.
      8) Equipment control through pop up windows.
      9) Loop control through pop up windows.
     10) Display philosophy, organization and operation.
     11) General data entry through the SCS.
     12) Use of tool tips.
     13) Color graphic standards, symbol standards, etc.
     14) Dynamic Objects: Pumps, compressors, valves, gates, controller faceplates, process indicators, indicators with alarms, data entry, controller face plate, dampers, aerator, chemical feed pump, mixers.
     16) Alarm Management: Operation of the alarms, alarm areas, alarm filtering.
     17) Trending.
     18) Historical data storage and retrieval.
19) Variable naming conventions.
20) Scripting.
21) Tag Group file naming convention.
22) Display file naming convention.

5. Plant Process Reporting Workshop:
   a. Objective: Developed and document number and types of reports.
   b. Identify and define each type of Process report including:
      1) Daily flow and energy totals.
      2) Weekly flow and energy totals.
      3) Monthly flow and energy totals.
      4) Yearly flow and energy totals.

6. Presoftware Development Workshops:
   a. Objective: To present to Engineer and Owner how Applications Software Supplier will implement functional requirements of this Section.
   b. Present information on:
      1) Program Flow Diagram(s) showing all software sections, sub sections, function blocks, subprograms, and their interrelationships.
      2) SCS/PLC I/O Database listing.
      3) SCS Screen sketches that illustrate dynamic objects, how control functions are controlled and monitored, how equipment is controlled and SCS screen navigation.

1.06 SUBMITTALS

A. Action Submittals:

1. Loop Specification and P&ID Submittals:
   a. Timing: Following P&ID and Loop Description Workshop.
   b. Content: Updated version of Loop Narratives.

2. Process Reports Submittal:
   b. Content: Document and submit reporting criteria and functional requirements.

3. PLC Software Standards Submittals: Developed in a Software Workshop, Documented and Submitted as PLC software standards.

4. SCS Standards Submittal:
   a. Review and develop SCS standards in a participative workshop with the Owner.
   b. Documented and submitted as SCS software standards.


6. Software Design Submittal: Detailed description of SCS Configuration and PLC program on a Unit Operation Basis. Submit this during program development stage.
a. An updated version of all information presented in Presoftware Development Submittal.
b. Documented PLC Program.
c. Print out of SCS screens.

B. Informational Submittals:

1. Applications Software Schedule of Values and Progress Schedule:
   a. Submit within 30 days after first Preconstruction Conference.
   b. Upon acceptance by Engineer, shall form basis and schedule of Submittal reviews, test witnessing, and partial payments.
   c. Prior to this acceptance, Engineer will not review Submittals, witness tests, or consider requests for partial payment.

2. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers’ Field Services.

3. Testing Related Submittals:
   a. Test Forms:
      1) Proposed test procedures, forms, and check lists:
         a) Software Demonstration Tests (SDT).
         b) Operational Readiness Test (ORT).
         c) Performance Acceptance Test (PAT).
   b. Test Procedures: Conduct tests using Engineer accepted test procedures, forms, and checklists.
   c. Test Documentation: Copy of signed of test procedures when tests are completed.

4. Operations and Maintenance Manuals:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data, unless otherwise specified in this section.
      1) User’s manuals for Standard Software packages.
      2) Licensed copies of Standard Software packages.
      3) Updated versions of material provided under Shop Drawing Submittals for Applications Software Design and Development.
      4) Applications software source files.

PART 2 PRODUCTS

2.01 PLC APPLICATION SOFTWARE DESIGN CRITERIA

A. PLC Program Design:

1. The programmable logic controller system (PLC) shall be used to provide facility automatic control, alarm functions (annunciator), and continuous loop control. Specific PLC functional requirements are described in the Loop Narratives.

2. No control routines, control algorithms, or control logic shall be implemented in the SCS.
3. Break PLC applications software into:
   a. Sections:
      1) Contains all logic for a specific unit operation.
      2) Each section consists of a general logic sub sections and,
         followed by unit operation sub sections.
   b. Subsections: Contains logic for specific equipment such as a
      pump, valve or loop.
   c. Functional Blocks:
      1) Building block for pumps, valves, loop control, analog
         processing, alarm switches.
      2) Requirements for standard SCS/PLC function blocks to be
         provided are specified herein.

4. Program Documentation:
   a. Note and describe start of a new program section.
   b. Briefly describe control objectives.
   c. Identifies subsections.
   d. Subsection documentation includes brief description of control
      objective followed by a description and tag of the equipment
      being controlled.

5. The PLC applications software provides an PLC coil index for each
   subsection that can be used to quickly search and locate a specific
   section.
   a. Influent flow monitoring.
   b. Temperature control.
   c. pH control.
   d. Chemical flow pacing.
   e. Reactor feed control and monitoring.
   f. Recirculation flow control.
   g. Sludge tank.

B. PLC Program Documentation:

1. Ladder Diagram Description:
   a. Written overview description of each ladder logic program.
   b. Lead user through sections, subsections and function block of
      programs.
   c. Generally describe functions being implemented including
      software block used to implement functional requirements of this
      Specification.

2. Ladder Diagram Logic Listings:
   a. Include a description for each element (input, output, or special
      function block).
   b. Comments that describes function of ladder rungs. Average of one
      60-character comment line per ladder rung.
   c. Complete ladder diagram logic listings.
   d. Provide following additional information integral to ladder listings
      to document PLC programs: Note: Documentation will be limited
to what Square “D” Modicon PLC documentation system provides:

1) I/O Point Cross Reference List: Each input and output, alphanumeric functional identification (up to 15 characters) printed above respective input or output in program listing. For each I/O point, the cross reference indicates each rung number where the point is used.

2) Internal Coil Cross Reference List: For each coil a 15-character alphanumeric function identification printed above respective coil and all of its contacts in program listing. For each coil, cross reference indicates each rung number where respective coil or contact is used.

3) Data Register Cross Reference List: For each registers locations in program where register is used.

4) Listing of all programmed PID loops by numbers. Function descriptions for all memory locations and status registers used and generated in the loop, as well as loop tuning values, shall also be shown in the PID loop printout. Programmed values of all pertinent memory locations used shall be shown.

5) Timers, counters, integer add and subtract, move, master control relay, and jump functions shall show all memory locations used and their programmed values.

2.02 SCS APPLICATION SOFTWARE DESIGN REQUIREMENTS

A. General:

1. The Applications Software Supplier shall develop the SCS design to convey accurate information to the plant operations staff so they can make informed process control decisions and provide the platform to execute the control decisions.

2. The following outlines key objectives in designing the SCS graphics displays:
   a. Easily navigated menus.
   b. Provide no more than three mouse actions to navigate to any control display.
   c. Maintain consistency in graphic display and controls design. (Consistency reduces the chances of misunderstanding, significantly reduces learning time, anxiety and stress.)
   d. Maintain consistent and predictable window operations.
   e. Accurate representation of the plant and its operations.
   f. Represent control options in an easily understood fashion.
   g. Develop help screens to provide additional information to help the operations staff understand the control options where complex operations are required.
h. A pleasant and engaging interface that conforms to the operators “Mental Model”.

i. Where possible, design overview displays similar to the physical layout of the facility. The perspective to the physical layout should be from the local main control room.

j. Provide operator access to process and alarm setpoints, including the following:
   1) Process alarms (High-High, High, Low, and Low-Low).
   2) Pump and equipment control setpoints.
   3) Process timer setpoints.
   4) Sequence setpoints for volume, level, time etc.

B. General Display Organizational Philosophy:

1. As shown, the process and control graphic display hierarchy consists of four levels of displays. The following briefly describes the intent of each of the four levels of displays:
   a. Level 1—Plant Overview(s):
      1) The Plant Overview(s) show major processes such as Primary, Secondary, Anaerobic Treatment etc. These overview displays show the most important (essential) process data and major equipment status on a plant wide basis, but provide no equipment or system control.
      2) The Plant Overview(s) display provide the means to page (i.e., go to) to other Plant Overviews or Unit Process overviews, or in some cases directly to Control Displays.
      3) As a general rule, the Plant overviews show the most critical status and system data that give the operations staff a good general feel on how the plant, is currently operating. A Plant Overview is going to be the opening display whenever the SCS is started.
   b. Level 2—Unit Process Overviews:
      1) Unit Process Overviews are full sized screens.
      2) The Unit Process Overviews show primary process data on unit processes, unit operations, equipment status, or system status, etc. As a general rule no control strategies are implemented through the Unit Operations Overviews. The unit operations overview provides the means to page to Control Displays.
      3) The general rule is to show enough status and system data information that gives operations staff a good general feel on how the individual processes are currently operating. It also provides a launching pad to access control information associated with the individual processes.
      4) Examples of Unit Process Overviews are Base and Storm Influent Pump Station, Equalization Tank and associated Pumps, and Gravity Filters.
c. Level 3—Control Displays:
   1) Control Displays can be Full screen or popup windows.
   2) Control Displays provide the means to monitor and provide
      Supervisory Control of specific process operations such as
      pump stations, specific pumps, pH control, chemical
      systems, etc. Depending on the complexity of the specific
      process there may be several levels of displays. For
      example, some unit operations will have a special display
      for each phase of a startup sequence. Control of each piece
      of equipment on individual unit operation control displays is
      possible. The following figure illustrates a typical control
      Display.
         a) The Level display provides the capability to control
            specific equipment, system and to navigate directly to
            related displays.
   3) Supervisory Control:
      a) The objective of the SCS design approach is to
         implement all Supervisory Control of the plant and
         its process and control strategies from the control
         displays. The control strategies include the following
         functions:
            (1) System level control, such as control loops, and
                sequences, etc.
            (2) Equipment level control, such as a pump
                start/stop control.
            (3) Detailed monitoring of sequence steps and
                general information messages for status.
            (4) Important alarm messages.
            (5) Paging between related displays.
            (6) Paging between related processes.
   4) Pop-Up Windows:
      a) Pop-up windows provide the capability to control
         systems and equipment without cluttering the
         overview or control display.
      b) The typical pop-up window provides the following
         functions:
            (1) Status monitoring of equipment being
                controlled.
            (2) Operating mode.
            (3) Manual mode selection.
            (4) Start/Stop Control in Manual.
            (5) Auto mode selection.
            (6) Failure Reset.
            (7) Equipment description.
            (8) Control for displaying the equipment number.
d. Level 4—Data Entry and Trend Displays: Data Entry displays are designed especially for data entry purpose. Operators enter process setpoints, equipment control setpoints (such as lead-lag pump start/stop setpoints), alarm setpoints, etc.

e. Display Navigation: To provide fast and effective screen navigation shall be provided. The following outlines the type of screen navigation functionality to be provided. The final display navigation process shall be developed in the software workshops.

f. Main Directory:
   1) A Main Directory can be a list of Displays that shows the hierarchy of Plant Overviews, Unit Process Overviews, Control Displays and Data Entry Displays.
   2) The Main Directory provides a way to catalog and access all displays, however, is does not provide an effective navigation tool for plant operations.
   3) The Plant Overview Display is another type of Main Directory Display that has active areas (poke points) to call up Unit Process Displays based on physical location in the plant.
      a) The Main Directory Display lends itself to fast navigation from display to display.

g. Main Navigation Menu Bar: The Main Navigation Menu Bar is a series of buttons on the bottom of each display that provides the user with the capability to go to (navigate to) any unit operation.
   1) The Main Navigation Menu Bar takes up graphic screen area on each full size screen but does provide a consistent, fast way to navigate between unit operation screens.

h. Previous and Next Display Controls:
   1) Previous and Next display configurations shall be provided.
   2) The Next and Previous displays will be configured to operate within the same level. For example, if an operator is on a Level 2 unit process overview, the previous and next displays configuration will be set up to cycle between all the Level 2 unit process overview displays.
   3) If the user was in the Level 3 displays for a specific unit process the next and previous displays will be configured to cycle between all the Level 3 and Level 4 displays associated with the unit process overview.

i. System/Control Displays:
   1) Each Unit Process Display will have softkeys that call up System/Control displays. If possible, develop softkeys that call up system/control displays that use a transparent button over the unit. For example on the Thickening overview a transparent button over a specific gravity belt will call up the respective gravity belt control display.
   2) A transparent button is a control that has an outline of a button but is transparent. When placed over an object on a
display, the object is still visible by clearly identifies navigation to another display or access to a pop-up window.

C. Alarm Group Display: The alarm group window gives operators a first-level indication of an alarm occurrence by group and allows operators to filter the alarm list. It indicates by solid color that an active (acknowledged) alarm exists in the alarm group and by blinking that an unacknowledged alarm exists in the alarm group.

D. Alarm Summary (Filtered): The Filtered Alarm summary window is dedicated to the presentation and acknowledgment of alarms. It provides alarm details, such as date and time of alarm, recurring alarm signal, alarm group, description of the alarm, alarm priority, current value, engineering unit, etc. for all alarms, acknowledged or unacknowledged. Once the alarms occur, they can be taken off the alarm list only if they have been acknowledged and the alarm conditions are no longer true.

2.03 SCS/PLC I/O DATABASE

A. SCS/PLC I/O Database: The Software Supplier shall provide a Database tool that has the following functions:

1. Coordinate, manage and document all points SCS database points including those communicated between the PLCs and SCS.
2. The database shall contain all the field necessary to configure the various points including the following per point type:
   a. Discrete Point configuration: The Software Supplier shall provide a SCS/PLC Discrete Input/Output (I/O) database of all the analog and discrete points that are communicated to and from the SCS. The list shall be configured on a Microsoft Excel or Access database. The I/O list includes the following fields.
      1) Loop Number.
      2) FIX Block Tag Number.
      3) FIX Block type.
      4) FIX SCADA node the point is assigned to.
      5) Attribute: further definition of the function of the point. The follow list the definitions:
         a) A(X): SCS alarm read, where X designates the alarm priority: 1,2,3.
         b) W: SCS write to PLC register.
         c) R: SCS read a PLC register.
         d) RW: SCC read and write to PLC register.
      6) Point description.
      7) Alarm Description 1.
      8) Alarm Description 2.
9) Closed Condition (INPUT): Description of the state of the input parameter of device when the field or internal PLC contacts are in the CLOSED position.

10) Open Condition.

11) Closed Condition (OUTPUT): Description of the output signal in the energized position.

12) Alarm area.

13) PLC NO: PLC number.

14) PLC I/O: PLC I/O address.

15) PLC coil number: The PLC register that the SCS reads or writes to.

b. Analog Point Configuration: The Software Supplier shall provide a SCS/PLC Input/Output (I/O) Database of all analog points that are communicated to and from the SCS. The list shall be configured on a Microsoft Excel or Access database. The Analog I/O database includes the following fields:

1) Loop Number.
2) FIX Block Tag Number.
3) FIX Block Type.
4) FIX SCADA node the point is assigned to.
5) Attribute that further defines of the function of the point. The following list the definitions: Note the attributes will be used of sorting and development of the I/O driver configuration. New classification will be develop to meet the software needs.
   a) SPR: Setpoint read from PLC (floating point).
   b) SPW: Setpoint write to PLC (floating point).
   c) MNR: Output read from PLC (floating point).
   d) MNW: Output write to PLC (floating point).
   e) PVR: Process variable read from PLC (floating point).
   f) FPR: Floating Point Read (floating point).
   g) FPW: Floating Point Write (floating point).
   h) FQR: Flow totalizer read (Integer).
   i) KTR: Equipment run time read (Integer).
   j) IPR: Integer read (Integer).
   k) IRW: Integer write (Integer).

6) Point description.

7) Alarm Description 1.

8) Alarm Description 2.

9) Engineering units.

10) Scale range.

11) Alarms functions to be configured in FIX analog block configuration.
   a) High-High.
   b) High.
   c) Low.
   d) Low-Low.
e) Signal fail.
f) Other.

12) PLC NO: PLC number.
13) PLC I/O: PLC I/O address.
14) PLC register number: The PLC register that the SCS reads or writes to.

c. SCS Database: The Software Supplier shall provide a database of all SCS database points that are not included in the analog or discrete I/O Databases in the that are communicated to and from the SCS. The database shall be configured in a Microsoft EXCEL or ACCESS database. SCS database includes the following fields:
1) Loop number.
2) FIX block tag number.
3) FIX block type.
4) FIX SCADA node the point is assigned to.
5) Point description.
6) Alarm Description 1.
7) Alarm Description 2.
8) Engineering units.
9) Scale range.
10) Alarms functions to be configured in FIX block configuration:
  a) High-High.
  b) High.
  c) Low.
  d) Low-Low.
  e) Signal fail.
  f) Other.

2.04 STANDARD PLC/SCS FUNCTIONS BLOCKS

A. General: The follow Standard functions blocks specify the standard PLC/SCS functions block to be developed and used to implement the PLC/SCS requirements specified in the Loop Narratives.

B. Discrete SCS/PLC Mode Command And Feed Back Status: When the SCS commands the PLC to specific mode such as Auto or Manual, the SCS shall be configured with an Auto write command database point and a in Auto mode database status.

C. Analog SCS/PLC Read-Write Process: When an analog value such as setpoint or controller output is specified to be accessible to the operator, the SCS 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. Discrete Equipment Control:

1. Controlled equipment to have HAND-OFF-AUTO (HOA) switch or a LOR (LOCAL- OFF-REMOTE) switch input to the PLC. The Controlled equipment shall include ON running status. PLC outputs include a RUN signal (or separate START and STOP signals) to start the equipment. The Applications Software shall prevent Start/Stop control of equipment by the PLC unless the HOA switch is in the AUTO position.

2. When the controlled Equipment is in REMOTE or AUTO the SCS and PLC shall be enabled to set the Equipment mode to SCS AUTO or SCS MANUAL. When the controlled Equipment is in SCS Manual the SCS and PLC shall be configured to Start and Stop the Equipment from the SCS. When the Controlled Equipment is in SCS Auto the automatic PLC routine shall control the ON/OFF status of the Equipment.

3. Monitor the ON status of equipment in the AUTO mode. If the PLC calls for the equipment to RUN and does not receive an ON signal after a suitable time delay, lock out the equipment in the PLC and generate an alarm to the SCS.

4. If the equipment is not in AUTO mode the logic shall set the mode Manual.

5. Equipment Available Statues: Provide equipment available status that is logically true when equipment is in AUTO or REMOTE, SCS AUTO and not FAILED.

6. If the PLC calls for the equipment not to RUN (STOP) and the ON signal is true after a suitable time delay, lock out the equipment in the PLC and generate equipment failure alarm to the SCS.

7. The equipment failure alarm condition and the equipment lock out shall be cleared by the loss of the REMOTE signal or SCS initiated Reset.

8. Provide a test input that to be used for system testing. When the TEST input is true the RUN (or START/STOP) output shall be prohibited from energizing. When in this mode, the ON status points read by the SCS and used by the PLC logic will follow the command to run, instead of the field ON inputs.

9. Provide a bumpless transfer from LOCAL to REMOTE or AUTO mode. If the Pump is running in the LOCAL mode it shall continue running when transferred to AUTO.

E. Lead/Standby Pump Control:

1. The lead/standby provides control over two redundant pumps.

2. The lead pump can run continuously or when called to run.

3. The lag pump runs when the lead pump is not available or is not ON.

4. Provide a FAIL output that goes true if there is no sequence selected or no pumps are available.

5. Provide a 1-2 and 2-1 lead/lag sequence selection from the SCS.
F.  Discrete Valve (or Gate) Control:

1. Controlled valves have HAND-OFF-AUTO (HOA) switches with OPEN, CLOSED and REMOTE inputs to the PLC. PLC outputs include an OPEN signal (or separate OPEN and CLOSE signals) to open the valve. The applications software shall prevent control of valve by the PLC unless the OCR switch is in the REMOTE (COMPUTER) position.

2. Equipment Available Statues: Provide equipment available status that is logically true when equipment is in AUTO, SCS AUTO and not FAILED.

3. When the controlled valve is in AUTO the SCS and PLC shall be configured to set the valve mode to SCS AUTO or SCS MANUAL. When the controlled valve is in SCS Manual the SCS and PLC shall be configured to Open and Close the valve from the SCS. When the Controlled valve is in SCS Auto the automatic PLC routine shall control the Open/Close position of the valve.

4. Monitor the OPEN/CLOSED status of valve in the REMOTE position. If the SCS/PLC calls for the valve to OPEN and does not receive an OPEN signal after a suitable time delay, lock out the valve in the PLC and generate an alarm to the SCS.

5. If the PLC calls for the valve to CLOSE and continues to receive an OPEN signal or does not receive a CLOSED signal after a suitable time delay. Generate a valve failed alarm to the SCS.

6. The alarm condition and the valve shall be cleared when the valve is noted to be in the correct position.

7. 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 SCS and used by the PLC logic will follow the command to OPEN/CLOSE, instead of the field OPEN/CLOSE inputs.

G. 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. Use the PLCs built-in lag filter and set the time constants to no greater than four times the input sample time.

3. All analog inputs shall be configured into a floating point variable and scaled in engineering units.

4. Provide analog switches on each analog input. Analog switches to provide High and Low alarms, or as shown or as described in the loop Narratives. The setpoints for the analog switches shall be accessible and changeable through the SCS.

5. Monitor signal failure (out of normal range) on all analog inputs and alarm on the SCS.
H. Analog Switches:

1. All analog switches used for Process alarms, to START and STOP pumps, sequences, etc. shall be configured through analog switches. Two types of analog switches shall be provided one for rising signal and one for falling signal. Each analog switch shall be configured with a 1% dead band to prevent nuisance tripping. Provide operator access through the SCS to the analog switch setpoints.

2. Each analog alarm shall be configured with four inputs and one output.
   a. Inputs:
      1) Process variable scaled in engineering units.
      2) Setpoint.
      3) Minimum and Maximum engineering units.
   b. Outputs: Discrete output that switches when the process variable is above or below the setpoint.

I. Analog Control:

1. Unless otherwise noted, controllers shall be configured as Proportional-Integral (PI) type. Unless specifically noted do not use derivative mode.
2. Provide access through the SCS for discrete mode changes, Setpoint and controller output when the controller is in manual.
3. Controller gain and integral time constant shall be adjusted to provide stable operation normal operating conditions.
4. Use the position from of the PI equation unless otherwise noted.
5. Freeze the controller bias to prevent reset wind up, if the output is out of range.
6. Controller sample times shall be no slower than once every 2 seconds.
7. Provide bumpless transfer between operating modes, Auto to manual, and manual to auto.
8. Provide a SCS Controller tuning display for each loop. The tuning display shall have a trend that trends the Process Variable, Setpoint and Output.
9. Provide a setpoint initialization routine that initializes the setpoint to the value of process variable when the loop is set to Automatic.
10. Unless otherwise noted, the Analog control shall be one shot into Manual when signal failure is detected on the Process variable. Provide a SCS alarm that indicates that the loop was set to MANUAL.
11. Each Controller shall be configured with a Manual Loading Station that has the follow functions:
   a. The Output of the Manual Loading Station to the Manipulated Device is input back to the PLC.
   b. The Manual Loading Station also has a Remote Status that is input into the PLC.
12. When the Manual Loading Station in Not in Remote, the Loop Controller shall be forced into manual and the manual output shall track the input from the Manual Loading Station.

13. Indicate the Manual Loading Station Local/Remote Status on the SCS.

J. Alarm Processing:

1. Provide alarms as noted or shown.
2. All alarms shall be configured into Alarm Areas as specified by the Owner in the Workshops.
3. Discrete type alarms shall be provided with an adjustable delay timer so that they do not become nuisance alarms.

K. Feed Forward Flow Pacing:

1. The Feed Forward Flow.
2. The Flow Ratio control routine shall be configured to calculate the chemical flow demand in GPM, based on a SCS entered Flow ratio in PPM and the flow that the chemical is to be ratioed to.
3. The flow demand is passed to a scaling routine that calculates the desired pump flow based on the flow demand and operator entered calibration constant. The desired pump flow is scaled to 0 to 100 percent pump speed.
4. The pump calibration constant is entered into the SCS and constitutes the pump flow at maximum flow.
5. Totalize the flow based on the calculated flow demand when the pump ON status shows the pump is on. Display the flow total on the SCS.

L. Manual Equipment Control from the PLC:

1. Provide a SCS AUTO/MANUAL mode for PLC-controlled devices. In the SCS AUTO mode, the device shall operate as described in the Loop Narratives. In the SCS MANUAL mode, the operator shall control the device through Start/Stop or Open/Close commands from the SCS.
2. The software AUTO/MANUAL selection shall be allowed only when the device’s panel switch is in the AUTO 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 SCS 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.
M. Run-Time Counters:

1. Provide a run-time counter for all motorized equipment that has an ON signal to the PLC.
2. Accumulate run times in hours with a minimum resolution of 0.1 hour. Counters shall roll over automatically when the accumulator is full.
3. Provide for a contact from the SCS to reset all run-time counters, on demand or by reaching a preset of 30,000 hours.
4. Store all run-time counters in a linear block of PLC memory for transmission to the SCS.

N. 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 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. 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.
   c. If in any sequence step, 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 SCS 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.
   d. Each sequence shall transmit bit variable indicating the active step to the SCS.

O. Totalization: All Flow, weight, and power signals shall be totalized in the PLC and the flow totals communicated to the SCS. All totalizers shall be calculated at least every 3 seconds. PLC special function programs shall be configured to scale the process variable to be totalized into gallons, pounds, or KWH in three seconds. These scaled variables shall be accumulated every 3 seconds until an accumulated value is greater than the a unit digit value. When the accumulated value is greater than the unit digit value, a totalizing counter shall incremented by one and the accumulated value subtracted from the unit digit value, and the accumulated value set equal to the result. 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. Each totalizer shall reset to 0 at 30,000 counts or from a single reset coil shall reset all PLC totalizer counters. The reset coil shall be controlled by the SCS.
P. Sampler:

1. Sampler Function:
   a. Receive at the PLC a contact closure denoting trouble (TRBL) with the sampler. Store this contact state for use in the PLC and transmission to the SCS.
   b. When the sampler is required to start transmit a RUN contact closure from the PLC to panel. Store this contact state for use in PLC and transmission to the SCS.
   c. Provide Manual/Auto control of the sampler from the SCS. When the control is in the manual mode the sampler sequence shall be controlled through a start control. When the control is in the AUTO mode the sampler shall be controlled by either flow or time. In the Time mode the sampler shall be controlled by repeat cycle timer that is controlled and monitored through the SCS. In the flow mode the sampler shall be controlled by a flow totalizer. The flow totalizer shall be monitored and controlled through the SCS.

Q. Process Control Functions Timing:

1. The objective of the process control function timing function is to reduce processor loading on any one scan by distributing over four time slots.
2. Provide a timing sequence that is designed to distribute processing of functions in one of four time slots. The duration of each time slot shall be controlled to one scan, approximately 0.25 second.

PART 3 EXECUTION

3.01 TESTING

A. General:

1. Test software to demonstrate that the applications software satisfies requirements outlined in the Loop Narratives, and described in submittals, and workshops.
2. Test Format: Cause and Effect:
   a. Person conducting test initiates input (cause).
   b. Specific test requirement is satisfied if correct result (effect), occurs.
3. Procedures, Forms, and Checklists:
   a. The Test will be completed on a unit operation and loop basis that is design to coordinate with the PIC testing and startup.
   b. The Software Supplier shall generate testing forms, and checklists from the SCS/PLC database.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
B. Software Demonstration Tests (SDT):

1. Scope: Test entire PLC and SCS to demonstrate that it is operational. The SDT shall be successfully completed to the satisfaction of the Engineer before the software is loaded on to the Plant SCS and PLC.

2. Location: Software Suppliers facility.

3. SCS Display Tests: The Object of the test is to verify all SCS database points and points communicated between the SCS and PLC and not the operation of the PLC software. Each SCS display and dynamic object on that display and control will be tested and verified. The Applications Software Supplier shall provide a test form for each display that lists all of dynamic objects, controls, pop-up windows and their associated database tags and corresponding PLC address. The test form shall provide a place for a sign off for the Software Supplier and Engineer.

4. SCS Display Navigation Test: The Objective of the test is to verify all the display navigation controls.

5. Loop-Specific Functions: Demonstrate functions shown on P&IDs, specified in the Loop Narratives, described in submittals, and workshops. This test shall not be started until the Display and Display navigation tests have been successfully completed. This test shall verify all SCS and PLC functions through indications on the SCS and the PLC programming software. The Applications Software Supplier shall develop a test form on an unit Operation and loop basis. The form shall list all controlled equipment, control routines, alarm points, status points, setpoints, controllers, sequences that are specified in the Loop Narratives. The test shall demonstrate all manual and automatic functions are operating as specified and verify that the outputs and inputs are configured to the correct PLC I/O point.

6. Make following documentation available to Owner at Test Site both before and during SDT:
   a. Loop Narratives.
   b. Pre-software design submittal.
   c. Software design submittal.
   d. O&M material.
   e. Master copy of SDT sign off sheets.
   f. Applications software documentation.

C. Phase 1 Operational Readiness Test Provided by the Contractor: Prior to Phase 2 ORT, startup test period and PAT, inspect, test, and document that entire PIC is ready for operation. Performed by PIC Contractor to test and document that PIC, excluding Software Supplier provided PLC and SCS applications software.
D. Phase 2 Operational Readiness:

1. Phase 2 ORT: Combined effort between Contractor and Software Supplier to confirm that PIC, including applications software, is ready for operation.
   a. Prerequisite: Completion of Phase 1 ORT.
   b. Joint test with Software Supplier. Repeat of Software Supplier’s SDT, except using real field sensors and equipment. Plant interlocking and communications with PLCs and SCS shall be tested on loop-by-loop basis.

E. Performance Acceptance Tests (PAT): These are the activities the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan refers to as performance testing.

1. Once ORT Phase 1 and Phase 2 has been completed and facility has been started up, perform a witnessed PAT on complete PIC and software to demonstrate that it is operating as required by the Contract Documents and software loop descriptions. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop basis.
2. Loop-specific and non-loop-specific tests same as required for SDT except that entire installed PIC tested using actual process variables and all 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 PAT available to Owner at Site, both before and during tests.
6. Make one copy of all software O&M manuals available to the Owner at the Site both before and during testing.

3.02 OWNER 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 all working shift(s) as needed to accommodate the Owner’s personnel schedule.
5. Owner reserves the right to make and reuse videotapes of all training sessions.

B. Management Seminar:

1. Length: 1 day.
2. Location: Owner’s facility.
3. Objective: Provide an overview for non-operations and maintenance personnel for understanding the applications software.
4. Attended by management, engineering, and other non-operations and nonmaintenance personnel.
5. Primary Topics:
   a. Applications software overview: How software is used for operation and control of facilities.
   b. Block Diagram Presentation of PLC and SCS: How and what information flows within system and what is done by each functional unit.
   c. Process/Operator Interface: Explanation and demonstration of how to use an operator’s CRT to access displays, reports, and controls.
   d. Management-oriented explanation of data management displays and printouts.
   e. Walk-through of installed systems.

C. Operations:

1. Provide a minimum of 10 days of training at the Site indicated by the Owner for Owner’s personnel in the operation of the PLC. Training shall include:
   a. Standard operational features of PLC equipment provided.
   b. Specific features provided for this project including:
      1) General Loop functions.
      2) Operation of Each Loop: For example, AUTO/MANUAL control, control setpoint settings, control mode selection, alarm acknowledgment.
      3) Operation of Each SCS display, dynamic objects, and controls on that display.
         a) The information shall be presented in an electronic format similar to the following Microsoft Power Point slide that illustrates the function of a compound mode in a chlorination control routine.
   2. Operations Startup Suggestions:
   a. Suggested unit operations startup suggestions shall be developed and presented to the operations staff. The suggested unit operation shall consist of two sections, field setup and Startup through the SCS.
a) The Field Set up shall list the field devices such as pumps, valves, chemical feeders, etc. and the position of their local control switches to transfer control to the SCS.

b) The Startup Sequence through the SCS shall list each equipment control, its display where located and the control action to be taken and the expected response to be seen on the SCS.

b. The following is a list of Unit Operations to be developed:
   1) Influent cooling.
   2) Reactors and associated chemical systems.

3. Alarm Summary:
   a. Describe each SCS alarm, including SCS tag name, detailed description of the alarm, probable cause, suggested operator action(s).
   b. The Alarm summary shall be configured in Microsoft Excel.

D. Software Maintenance:
   1. Provide a minimum of 5 days of training at the Site indicated by the Owners for personnel in the maintenance of the PLC and SCS software.
   2. Software functional Block diagrams.
   3. Documented ladder diagrams.
   4. SCS/PLC I/O Database.

3.03 O&M MANUALS

A. General: Provide the following:
   1. Suggested startup procedures.
   2. Training material.
   3. Alarm summaries.

B. Software: Provide the following:
   1. Finalized Loop Narratives.
   2. Program flow diagrams.
   3. Documented ladder programs.
   4. PLC/SCS I/O database, forms, queries, and reports.

3.04 SUPPLEMENTS

A. Supplements listed below, following “End of Section” are part of this Specification.
   1. Loop Narratives (LN).

END OF SECTION
LOOP NARRATIVES (LN)

Outfall 200 Mercury Treatment Facility (WPCP)

Overview
The following process narratives describe the control system functions required for operation of the Mercury Treatment Facility (MTF). These process narratives are intended to document and convey the intended control functions for the various processes to be included in the project. The project loop descriptions, which will ultimately be included in the Specifications to fully define the plant control systems, will build on these process narratives.

In general, automatic controls will originate from SCADA, with the exception of local package control panels included with certain equipment systems (e.g., Plate and Frame Filter Presses). Manual operation for all equipment will be possible from SCADA and/or the local packaged control panels, and also using locally mounted hand switches.

List of Sections
1. Headworks, Degritting and Equalization
2. Precipitation and Clarification
3. Filtration
4. Chemical Storage Facility
5. Miscellaneous Systems

Plant SCADA
Plant SCADA will incorporate HMI software (TBD) and PLCs (TBD) Architectures. Plant HMI and PLC are to be programmed to provide automated control and monitoring of the liquid and solids systems. The PLC network will consist of:

- PLC-1: Headworks Electric Room
- PLC-2: Treatment Building Plant Floor
- PLC-3: Treatment Building Plant Filters

Abbreviations
- BFPS Base Flow Pumping Station
- SFPS Storm Flow Pumping Station
INFLUENT FLOW CONTROL (P&IDS I941001-F-0003 AND -0004)

PHILOSOPHY OF CONTROL

The flow control system operates in one of three stages, depending on the stream flow at the time. The system operates automatically, moving from one stage to another without operator intervention. The system controls the flow to both the base and storm sides of the Headworks Facility, as well as the bypass in the stream in excess of the headworks capacity. Under certain conditions, the control scheme is altered to accommodate system operating conditions.

Stage 1 3,000 gpm

Base Flow only, as indicated by HDWK-FIT-100. Creek flow is low, HDWK-G-200 is closed, HDWK-G-100 is fully open, all flow is into Base Flow Pumping station. If needed HDWK-G-200 modulates to maintain 3,000 gpm base flow.

BASE_FLOW_SPG200=3000 GPM

Stage 2 3,000 to 39,000 gpm

BASE_FLOW_SPG200=3000 GPM

(BASE_FLOW_SPG200=2700 GPM, 2430 based on high turbidity)

BASE_FLOW_SPG100=3500 GPM

STORM_FLOW_SPG200=39,000 GPM

Storm Channel Control Gate HDWK-G-200 is engaged to limit base Flow to 3,000 by diverting excess to the Storm Pumping Station.

While HDWK-G-200 is maintaining base flow of 3,000 gpm, HDWK-G-100 will act to provide an upper limit of 3,500 gpm base flow in case HDWK-G-200 malfunctions or during a sudden surge in creek flow. HDWK-G-200 will also act to limit Storm Flow to 39,000 gpm for a combined total of 42,500 gpm.

NOTE: High turbidity as indicated at the Clarifier Effluent FLTR-AIT-600-A, and -600B. [TBD] will lower the Base Flow SP by 10 percent to 2700 gpm for 1 hour. If high turbidity is still present after another hour, the SP is reduced by another 10 percent to 2430 gpm.

Stage 3 > 42,500 gpm (initially) water in excess is turned back into Polar Creek

The system transitions from Stage 2 to Stage 3 when HDWK-LIT-100 at the bypass weir senses water is at the top of the weir. The system transitions from Stage 3 to Stage 2 as water level drops 6” below the Bypass weir. When water level reaches the top of the Bypass Weir (plus a small time delay), Base Flow Set-point will be reduced to 3,000 gpm for HDWK-G-100 and 37,500 gpm for HDWK-G-200 for a combined total of 40,500 gpm

BASE_FLOW_SPG100=3000 gpm

STORM_FLOW_SPG200=37,500 gpm

Stormwater Storage Tank Override

If, at any time, the Stormwater Storage Tank (T-300) becomes full and reaches a high level set-point, the storm flow gate HDWK-G-200 will rise to its rest position, shutting off storm flow, and the Storm Flow Pumping Station (SFPS) will shut down. This level set-point will include a deadband so that it doesn’t cycle the gate and pump station on and off unnecessarily. The Storm water tank is monitored by redundant level transmitters HDWK-PIT-250-A and HDWK-PIT-250-B. Add Deviation Alarm (6-inch) between transmitters, use Hi Select to choose highest reading transmitter.

Base Flow Pumping System Shutdown Override

If for any reason the BFPS is shutdown i.e. Base Flow Pumps unavailable. In this mode, base flow will be diverted from the base Wetwell through the Storm Flow Gate, the gate will operate to control the water level at the bypass weir wall to a setpoint at 6 inches (adjustable) below the wall. The Storm Flow Pumping System will also operate in response to wet well level, sending the diverted water to the Stormwater Storage Tank. When the situation is resolved and the BFPS returned to service, the control system will revert to Stage 1 or 2 control, and stormwater
will be returned from the Stormwater Storage Tank to the Base Flow Wetwell using HDWK-FCV-251 as described under Stormwater Storage Tank Return Flow.

**BASE FLOW PUMPS CONTROL (P&ID I941001-F-0003)**

**AUTOMATIC CONTROL**

Base Flow Pumps HDWK-P-100-A, B, C will operate in a Lead, Lag, Stby arrangement depending on plant conditions. Each is VFD driven. The operator selects the Lead, Lag, and Stby pumps from the Plant SCADA screen. The Process Variable for the following Level Control loop is HDWK-LIT-101

The operator selects a Level Control Set-Point from the Plant SCADA screen (initially set at 3 feet above Low Level).

**INCREASING FLOW**

The Lead pump speed will vary in an effort to maintain this set-point. If the Lead VFD reaches 100 percent for a pre-determined time, the Lag pump will start, and both pumps will be set to 50 percent speed [nominal value], both pumps will then vary speed in unison in an attempt to maintain LCSP. If both pumps reach 100 percent for pre-determined time, the Standby Pump will start and all three pumps will be set at 50 percent speed. All three pumps will then vary speed in unison in effort to maintain LCSP.

**DECREASING FLOW**

On decreasing flow, the VFDs will tend to slow down in order to maintain the Level Control Set-point LCSP. Force Discharge Main Pressure as measured by HDWK-PIT-101 will help determine the minimum required speed for the different pump configurations as shown below. This minimum speed will always be in effect.

- 3 pumps to 2 pumps (Stage 3 to Stage 2): Min Speed = 0.92*P + 60.6
- 2 pumps to 1 pump (Stage 2 to Stage 1): Min Speed = 1.19*P + 52.1

**ALARMS: (BASE FLOW WETWELL LEVELS HDWK-LIT-101)**

- LOW shutdown (alarm) 925.0 (2.6 ft. depth)
- LOW shutdown (normal) 926.0 (3.6 ft. depth)
- Normal control level (HIGH) 929.0 (6.6 ft. depth)
- HIGH HIGH alarm level 930.0 (7.6 ft. depth)

**STORM FLOW PUMPING SYSTEM (SFPS) (P&ID I941001-F-0004)**

**MODES OF OPERATION**

**Automatic Control:** in AUTO mode, the operator selects the Lead pump, Lag 1, and Lag 2 pumps. The pumps should all be placed in AUTO mode. If any pump fails to start, the next pump in series will start automatically in place of the failed pump if needed. A level setpoint will be set by the operator to establish the control level in the wet well. The pumps will START and STOP and operate under level control in the following manner:

- **Stage 1 Pump Control:** When a rising level reaches the level control setpoint with all pumps OFF, the Lead pump is turned ON at minimum speed. The speed of the pump is then automatically adjusted to maintain a constant level at the setpoint (initially set at 3 feet above the LOW level).

- **Stage 2 Pump Control:** If the Lead pump is unable to keep up with the flow entering the wet well, the pump speed will reach 100 percent. After a time delay, the Lag-1 pump is started and both pumps are driven to an initial preset speed setpoint. After an adjustable time, the pumps are released to the level control loop. The preset speed setpoint is intended to avoid excessive hunting by the control system when transitioning between stages.

- **Stage 3 Pump Control:** If the Lead and Lag-1 pumps together are unable to keep up with the flow entering the wet well, the pump speeds will reach 100 percent, and after a time delay, the Lag-2 pump will start and all three pumps will be driven to a preset speed setpoint for an adjustable time. After an adjustable time, the pumps are released to the level control loop.
If all three pumps are operating and are unable to keep up with the influent flow and the speeds reach 100 percent, the condition will be alarmed.

With falling level, the pumps will be shut down in the following manner:

- Algorithms in the control system will determine the minimum speed setpoint for the pumps based on pump header discharge pressure and the pump operating stage. The setpoints are determined to step down to the next lower stage when the pump station output is about 80 percent of the maximum output of the next lower stage. This ensures a deadband between stages. Following are the algorithms determined through system modeling ($P =$ system pressure in psig as measured at the pump discharge header HDWK-PIT-200):
  - Stage 3 to Stage 2: Min Speed = 0.94*P + 48.45
  - Stage 2 to Stage 1: Min Speed = 1.01*P +42.2
  - Stage 1 Shutdown: Min Speed = 1.05*P +42.5
- When the minimum speed setpoint for any condition is reached, after a time delay, the pump control system moves to the next lower stage. The Lag-1 or Lag-2 pump is shut down (depending on stage), and the speed of the remaining pump(s) adjusted as needed to control the wet well level to the setpoint.
- When the Lead pump is operating in Stage 1 and the minimum speed setpoint is reached, the pump remains running until the LOW level in the wet well is reached. If the pump does not respond to the LOW level shutdown, and a LOW-LOW level is reached, the pump shuts down and an alarm is sounded. The Lead pump is automatically changed upon normal pump shutdown.
- Following a normal shutdown on LOW level, the level will rise if flow continues to enter the wet well. When the level rises to the level setpoint, the Lead pump is again started at minimum speed and then responds the level control system.
- If the wet well level is above the pump shutdown level, but no pump is operating (rising level), and the storm flow, as measured by the Storm Flow Parshall Flume, reaches 0 gpm for 15 minutes (adjustable), the Lead storm pump will start and pump down the wet well to the LOW level setpoint. When the pump stops, the drain valve on the 3-inch SW/D line will open for 60 minutes to ensure that the 42-inch SW pipe is emptied to below frost level.
- If the Stormwater Tank reached a HIGH level, the SFPS will continue to operate with the flow control gate at the Intake structure moved to the closed (full raised) position. The SFPS will shut down when the LOW level is reached. The 42-inch pipe will then be drained as for a normal shutdown.

The control system will automatically switch the Lead, Lag and standby pumps to achieve equal time-of-operation for the pumps. This occurs whenever the Lead pump shuts down on LOW level. Lead selection may also be done manually, however, for an intermitently operating system automatic switching may be preferable.

Following are the key levels in the SFPS:

- LOW LOW shutdown (alarm) 917.8 (7.0-foot depth)
- LOW shutdown (normal) 918.8 (8.0-foot depth)
- Normal control level (HIGH) 921.8 (11.0-foot depth)
- HIGH HIGH alarm level 922.8 (12.0-foot depth)

The discharge pressure of each pump is continuously monitored, in addition to the common pump header pressure.

**Manual Control:** Manual operation of the pumps will normally only be used as part of pump maintenance to verify the pump is operating correctly after maintenance has been performed. Manual control is accomplished using locally mounted HOA and speed control handswitches. Manual operation may also be accomplished through the SCADA system.
**ALARM CONDITIONS**

In both AUTO and Manual modes:

- LOW-LOW level in the Storm Flow Wet Well is alarmed and stops the Lead Storm Flow pump (if still running).
- HIGH discharge pressure for any pump is alarmed and stops the associated pump.
- HIGH level in the Stormwater Storage Tank is alarmed and stops all Storm Flow Pumps.
- HIGH HIGH level in the Stormwater Storage Tank is alarmed, indication a pending emergency overflow.

**STORM WET WELL SUMP**

**PHILOSOPHY OF CONTROL**

Water that remains in the Storm Flow Wet Well after the Storm Flow Pumps shut down on LOW level after the storm flow ceases is pumped from the wet well to the Base Flow Wet Well by a sump pump system located in a sump at the north end of the wet well. The system consists of two submersible pumps, one Lead and one Standby.

**MODES OF OPERATION**

**Automatic Control:** Operator designates Lead/Lag pumps from SCADA. The Lead pump will run if HDWK-LSL-210 is made AND the system is in Stage 1 greater than 30 minutes (adjustable). If the Lead Pump fails the Lag pump will start and run instead. HDWK-LSLL-210 acts to stop both pumps from running.

**Manual Control:** The sump pumps may be operated using the local HOA handswitches. The pump will still shut down on LOW LOW level (HDWK-LSLL-210) in Manual Mode to protect the pump from running dry.

**ALARM CONDITIONS**

- HDWK-LSLL-210

**STORMWATER STORAGE TANK (P&ID I941001-F-0006)**

**PHILOSOPHY OF CONTROL**

The water level in the tank is monitored separately by two redundant pressure devices (HDWK-PIT-250-A, and HDWK-PIT-250-B) to control the mixers and return flow system, and provide input to the SFPS and influent flow control gate.

The following are the level setpoints for the tank operation and preliminary setpoints:

- LOW LOW – Enable flow return system (1 foot rising)
- LOW-1 – Shut down mixers (8.5 feet falling)
- LOW-2 – Start mixers (9 feet rising)
- HIGH – Alarm and shut down SFPS and fully raise Storm Flow Weir Gate (70.0 feet rising)
- HIGH HIGH – Alarm tank overflow (72.0 feet rising)
- Level Deviation Alarm - Greater than 6-inch difference between PIY-250-A and -250-B
- Use highest reading of PIT-250-A and -250-B for Control and Indication

**ALARM CONDITIONS**

- HIGH level in the Stormwater Storage Tank. This condition stops the storm flow by driving the storm flow control gate to the rest position (fully raised) and shutting down the SFPS. HIGH HIGH level is alarmed indicating an emergency overflow condition.
• HIGH tank level measurement DEVIATION as reported by the two level elements. When this occurs, in addition to alarming the condition, the higher of the two readings will be used as the control input for the above HIGH level alarm response.

STORMWATER STORAGE TANK MIXERS

MODES OF OPERATION

Automatic Control: The control system automatically starts the Storm Water Tank Mixers when the tank level rises above level LOW-2. The mixers are stopped when the level falls below level LOW-1. LOW-1 and LOW-2 should be set at least 6 inches apart to avoid cycling of the mixers.

Manual Control: The operator starts or stops the mixers. If the tank level drops below the minimum level, the mixers are automatically stopped in Manual mode as well as Auto mode. It is not possible to operate the mixers unless the level is above the minimum.

STORMWATER STORAGE TANK RETURN FLOW

MODES OF OPERATION

Automatic Control: The return flow system is enabled whenever the Stormwater Storage Tank level, as measured by the two level elements (HDWK-PIT-250-A, 250-B) on the tank, is above a setpoint minimum LOW LOW level (rising). When enabled, the flow control valve (HDWK-FCV-251) will be adjusted to deliver the difference between the base flow rate, as measured by the Base Flow Parshall flume (HDWK-FIT-100), and the setpoint of 3,000 gpm. The return flow line includes a flow meter (HDWK-FIT-250). FCV-251 modulates to control the return flow rate to equal the difference between 3,000 gpm and the actual influent base flow rate. The commencement of return flow is enabled when HDWK-FIT-100 drops below 2,900 gpm (adjustable). Once initiated, the return flow system continues to operate as long as the base flow is less than 2,900 gpm, until the tank is emptied, indicated by a zero flow rate at HDWK-FIT-250 with the HDWK-FCV-251 at the full open position. At this point, the automatic drain valve HDWK-FV-252 opens for a duration of 1 hour to ensure the drain pipe is emptied. At the end of the time period, the valve closes, and FCV-251 is driven to the fully closed position. At this point, the return flow system is disabled until the tank level again exceeds the LOW LOW level setpoint.

Manual Control: The return flow system may be operated manually by placing the actuator in LOCAL operation and adjusting the valve position manual. Alternatively, the valve position may be adjusted manually from SCADA.

BASE FLOW GRIT CHAMBER MIXER (I941001-F-0003)

MODES OF OPERATION

Manual Control: The Base Flow Grit Chamber Mixer HDWK-M-101 is operated in ON/OFF mode and is manually started and stopped by the operator from SCADA when the HOA switch is in Auto and Locally when the HOA switch is in Hand. There are no automatic functions associated with this mixer.

STORM FLOW GRIT CHAMBER MIXER (I941001-F-0004)

MODES OF OPERATION

Automatic Control: The Storm Flow Grit Chamber Mixer HDWK-M-201 is automatically started when flow to the storm side (HDWK-FIT-200) exceeds 1,000 gpm and remains in operation for an adjustable time period after the flow reduces below 700 gpm.

Manual Control: The mixer may be manually started and stopped by the operator from SCADA when the HOA switch is in the Auto position and the mixer is not in “SCADA” Automatic, or may be run locally by hand when the HOA switch is in Hand.

GRIT PUMPING, CLASSIFICATION, AND DEWATERING (P&ID I941001-F-0005)

MODES OF OPERATION

Automatic Control: Base Flow Grit Pumping and Processing System

• Automatic control is only possible if all associated equipment and automatic valves are all placed in AUTO. The pumping system is started automatically based on a frequency/duration control. Base Flow
Grit Pump HDWK-P-300-B is dedicated for use with the Base Grit system, and HDWK-P-300-A is dedicated for use with the Storm Flow Grit System. The standby pump HDWK-P-300-C may be selected for either Base or Storm service, and is operated accordingly. Either the Bas Grit Pump or the Storm Grit Pump or BOTH maybe operated. The operator selects the start time and duration of pumping for each pump. Only one system may pump grit to the classifier as a time, with a time delay after the end of pumping to allow the classifier to complete its cycle.

The following sequence applies for BOTH the Base and Storm Grit Pumping and Processing System with the following exception:

The Storm Flow grit pump is disabled when the flow to the Storm Side (as measured by the Parshall flume) drops below 700 gpm (1.0 mgd). It is enabled when the flow exceeds 1,000 gpm (1.4 mgd).

- The associated automatic valves (W2-FV-101 for Base suction, W2-FV-100 for Base Grit Chamber and W2-FV-201 for Storm Suction and W2-FV-200 for Storm Grit Chamber) on the plant water system are opened, causing water to enter the pump suction line and grit chamber and fluidize the grit. The associated pump suction valve (HDWK-FV-300-B for Base, and HDWK-FV-300-A for Storm) is closed during this operation.
- The Grit Classifier (HDWK-GC-301) is started.
- The pump suction valve is opened and the pump is started. Grit slurry flows to the Grit Classifier, where it is washed and dewatered. Grit is conveyed into a roll-off bin for disposal. Wash water gravity drains from the classifier back to the base flow influent channel. Since the washwater may contain grit if there is an upset in the classifier operation, the drain line discharges into the base side influent channel upstream of the base flow control gate. This location ensures that any grit in the drain water is disposed of to the base side for treatment, or (if the base side is out of service), to the storm side.
- The pump speed is automatically adjusted to maintain a setpoint pressure (HDWK-PIT-302) at the inlet to the grit cyclone.
- After a set period of time, the W2 pump suction flush valve is opened and the pump continues to run. After a time period, the pump is stopped and the pump suction valve and flushing valve are closed.
- After a set time period, the grit classifier is stopped.

**Automatic Control – Grit Classifier:** The grit classifier starts operation when the flushing sequence for the grit pump is completed and the grit pump begins to discharge grit slurry to the classifier. After the pump shuts down, the classifier continues to operate for a set duration in order to clear the grit conveyor of grit. Another grit pumping cycle is not allowed to commence until the grit classifier completes its cycle.

**Manual Control:** With manual operation for any of the above systems, the operator can perform the same steps as listed for automatic control using the HOA or OPEN/CLOSE switches for each process component. Speed control for each of the grit pumps shall be adjustable through a locally mounted speed control hand switch. Manual operation may also be accomplished through the SCADA system.

**ALARM CONDITIONS**

- HIGH pressure on either the suction or discharge of a Grit pump while running shuts down the pump and sounds an alarm.
- HDWK-PIT-300-A, -300-B, -300-C Suction Pressure for Grit Pumps P-300-A,-B,-C
- HDWK-PIT-301-A, -301-B, -301-C Discharge Pressure for Grit Pumps P-300-A,-B,-C

**GRIT PUMP ROOM SUMP (I941001-F-0005)**

**PHILOSOPHY OF CONTROL**

The Grit Pump Room Sump is a packaged sump pump system that operates on level control to handle washdown and other drainage that originates in the Grit Pump Room. The pumps discharge into the Base Flow Influent Channel.
**MODES OF OPERATION**

**Automatic Control:** The Lead and Lag sump pumps each start in sequence in response to level measurement in the sump. The Lead pump starts on LOW (HDWK-LSL-310) level. If the Lead pump is unable to handle the inflow to the sump, the level will rise to the HIGH (HDWK-LSH-310) level, and the Lag pump will start. Both pumps shut down on LOW LOW (HDWK-LSLL-310) level. An alarm is sounded if the HIGH HIGH level is reached.

**Manual Control:** The sump pumps may be operated manually from the packaged panel.

**ALARM CONDITIONS**
- HIGH HIGH (HDWK-LSHH-310) sump level sounds an alarm to indicate impending flooding of the Grit Pump Room floor.

**BASE FLOW ACID FEED (I941001-F-0007)**

**PHILOSOPHY OF CONTROL**
An acid feed system will deliver acid to the plant influent flow at to prevent scaling. The acid will be added to three locations as needed: 1) the common discharge pipe just downstream of the pump header; 2) the base flow influent channel upstream of the Parshall flume; and 3) the Storm flow influent channel upstream of the Parshall flume. The acid feed system will consist of storage totes and metering pumps. Three metering pumps will be provided along with a shelf spare pump. The output of each of the metering pumps will be calibrated against pump speed, and an algorithm relating pump speed to feed rate input to SCADA. The desired dosage in mg/L will be entered into SCADA, and the pump speed will be adjusted in response to the associated flow rate to deliver the desired dosage.

**MODES OF OPERATION**

**Automatic Control:** The acid feed rate will be flow paced based on the corresponding flow rate for the addition point (influent base flow, influent storm flow, and discharge flow from the BFPS) to provide a desired dosage.

**Manual Control:** The acid feed pump speed may be manually set at the pump.

**EQUALIZATION TANK AND EQ TANK DISCHARGE PUMPS (I941002-F-0001)**

**EQ TANK PUMPS**
The EQ pumps are designated by the operator as follows:
- Train A Pump
- Train B Pump
- Standby Pump.

By adjusting manual valves, the standby pump may be used to pump to either of the treatment trains. When the standby pump is placed into service, it must be selected at SCADA for either Train A or B service.

The EQ Tank discharge Flow Meters are used for flow ratio control of the chemical metering pumps for
- Sodium Bisulfite (added to the Dechlorination Tank).
- Organosulfide Polymer (added to the Polymer and Iron Coprecip Reaction Tank).
- Ferric Chloride (added to the Polymer and Iron Coprecip Reaction Tank).
- Flocculation Polymer (added to the Flocculation Tank).

The flow measurement system is also used for flow ratio control of the Recycle Sludge Pumps. (See Recycle Sludge Pumps and Sludge Waste Pumps section for details).

Two analog pressure transducers used for level measurement are provided on the EQ Tank where liquid pressure is converted to provide liquid level. The pressure transducers are located on the side of the tank near the bottom
and measure actual tank level over the entire range of depths. Two instruments are provided as redundancy for this critical measurement.

**EQ TANK SETPOINTS**

Flow Set-points derived from level (sent to EQ Pumps Speed control)

- 8.5 feet = 350 gpm (min)
- 43 feet = 5,000 gpm (max)
- Use a lookup table
- At 700 gpm, disable one of the Chem Trains (Operate designate Lead/Lag Chem train)

**LEVEL SETPOINTS**

- 45 feet = shutdown Base Flow Pumps and Backwash Wash Waste Pumps (FLTR-P-610-A, FLTR-P-610-B) flow into EQ Tank
- 9 feet = Enable Mixer CHTR-M-400
- 8.5 feet = Disable Mixer: CHTR-M-400

**ALARM CONDITIONS**

- Level Deviation Alarm greater than 6-inch difference between CHTR-PIT-405-A and CHTR-PIT-405-B
- LOW LOW-1 – Shut down EQTDPS (1.0 feet falling)
- LOW-LOW-2 – Start the EQTDPS enabled pump(s) and ramp to the speed (output) associated with the EQ Tank level (2 feet rising)
- LOW-1 – Shut down EQ Tank Mixer (8.5 feet falling) but keep pumping at 350 gpm
- LOW-2 – Start EQ Tank Mixer (9.0 feet rising)
- HIGH HIGH-1 – Alarm and shut down BFPS and BWPS (45 feet rising)
- HIGH HIGH-2 – Alarm tank overflow (46 feet rising)
- CHTR-PSH-40X-B High Discharge Pressure alarm and hardwire shutdown of associated pump
- CHTR-PSL-40X-A Low Suction Pressure alarm and hardwire shutdown of associated pump

**MODES OF OPERATION**

**Automatic Control:** The EQ Tank level establishes the EQTDPS discharge rate through a lookup table that compares EQ Tank depth to pump discharge rate. The variable pump discharge rate setpoint is then used to control the pump speed. The lookup table includes flow values for treatment Trains A and B, which are normally set equal to each other. The lookup table will be initially set up to provide a linear variation in flow from the minimum operating level to the maximum level.

**Manual Control:** The pumps may be operated manually through local HOA and speed control handswitches. Manual operation may also be accomplished through the SCADA system.

**EQUALIZATION TANK MIXER**

**MODES OF OPERATION**

**Automatic Control:** In Auto, the mixer is enabled/disabled based on level

- 9 feet = Enable Mixer CHTR-M-400
- 8.5 FEET = Disable Mixer: CHTR-M-400
Manual Control: The operator starts or stops the mixers using a locally mounted HOA handswitch. Manual operation may also be accomplished through the SCADA system.

EQUALIZATION TANK DISCHARGE TURBIDITY AND PH

- CHTR-AIT-400-A (pH and CHTR-AIT-400-B (turb)

ALARM CONDITIONS

- HIGH turbidity in the EQ Tank discharge is alarmed.
- LOW pH in the EQ Tank discharge is alarmed and requires inspection of the Headworks acid dosing system.
- HIGH pH in the EQ Tank discharge is alarmed and requires inspection of the Headworks acid dosing system.

REACTION TANKS (I941002-F-0002 AND I941002-F-0003)

The Chemical Treatment System consists of two trains of three Reaction Tanks each, followed by two clarifiers (each dedicated to one train of reaction tanks). This system is physically located between the EQ Tank and the filter complex. The order of the Reaction Tanks is as follows:

- Dechlorination Tank;
- Polymer and Iron Coprecip Tank; and
- Flocculation Tank.

The EQTDPs splits the flow equally between Trains A and B.

Under normal operation, both trains are in service.

< 700 gpm automatically switch to one train operation (operator to designate Lead Train, Lag Train will be disabled < 700 gpm)

- Shut Down associated EQ Pump
- Shutdown associated Chem feed
- Shutdown associated Clarifier Sludge Pump

The EQ pump for the remaining train continues operation and ramps up or down in speed in reaction to the EQ Tank level.

At 350 gpm with one train in service, the pumping rate will be held at that value. If the influent flow continues to be less than 350 gpm, the EQ Tank level will drop until the LOW-LOW-1 level(EQ Tank) is reached

- Shut Down associated EQ Pump
- Shutdown associated Chem feed
- Shutdown associated Clarifier Sludge Pump

<350 gpm, the system will cycle on and off as the EQ Tank level rises and falls.

At 800 gpm, the second train is returned to service by starting the associated EQTDPs pump, resuming the chemical feeds, and enabling the clarifier sludge pump.

REACTION TANK PH ANALYZERS

PHILOSOPHY OF CONTROL

Acid is added to the Dechlorination Tank or the Polymer and Iron Coprecip Tank to lower the pH, via a chemical metering system (see Chemical Metering Systems section for details). The operator selects one of the two tanks for pH control with a manual valve and enters the desired pH after acid addition. The measured pH, located on the
discharge piping of the selected tank, is used to control the dosing rate of the acid metering pump for each train. Two pH probes are provided on the discharge piping of each tank; the operator selects one probe as the lead (controlling) and the other as a redundant. The two pH measurements are compared and generate an alarm condition if the difference in the two measurements is greater than an adjustable set value of 0.2 pH units. If an alarm condition occurs, the pH measurement that is the lowest is placed in (or remains as) the lead probe used for pH control.

**Modes of Operation**

**Automatic Control:** In AUTO control, either the Dechlorination Tank or the Polymer and Iron Coprecip Tank is selected for pH control, the pH setpoint is entered and one of the probes is selected as the lead (controlling). The pH reading from the pH analyzer is used to control the dosing rate of the Acid Metering Pump.

**Manual Control:** Acid can also be added using Manual control of the acid metering pump. See Chemical Metering Systems section for details.

**ALARM CONDITIONS**
- HIGH differential in readings by the pair of pH probes in each tank is alarmed.

**Dechlorination Tank Level**

**ALARM CONDITIONS**
- HIGH level in the tanks is alarmed, and the associated EQTDPS train pump is shut down.

**DECHLORINATION AND FLOCCULATION REACTION TANK MIXERS**

**MODES OF OPERATION**

**Auto Control:** Speed control for the mixers will be manual and adjustable at the tank location to allow for observation of the tank contents and mixing effectiveness. These mixers do not have any automatic functions and are turned ON or OFF manually.

**Manual Control:** Local HOA and Speed Control handswitches are provided to allow for local operation of the top entry tank mixers. A local HOA handswitch is provided for the pipe insertion mixer.

**CLARIFIER/THICKENERS (1941002-F-0004)**

**CLARIFIER/THICKENER RAKE MECHANISM**

**PHILOSOPHY OF CONTROL**

The rake mechanism has a local speed control station with the option to allow speed adjustments through SCADA.

**ALARM CONDITIONS**
- HIGH torque on the thickener rakes is alarmed.
- HIGH-HIGH torque causes the rake to shutdown, generating an alarm.

**MODES OF OPERATION**

**Manual Control:** Local HOA and Speed Control hand switches are provided to allow for local operation of the thickener rakes. In "Auto" operator can start and stop and adjust speed of rake mechanism.

**CLARIFIER/THICKENER SLUDGE LEVEL**

**ALARM CONDITIONS**
- LOW – Alarm after an adjustable delay, initially set to zero with a maximum duration of an hour. Operator should reduce the sludge wasting rate set point (DQWS) in response.
- LOW LOW – Alarm and shut down the Sludge Waste Pump after an adjustable delay, initial set to zero with a maximum duration of 1 minute. Restart Waste Pump when level> LOW LOW setpoint
- HIGH – Alarm after 1 minute (adj between 1 min. 60 min.). Operator should increase the sludge wasting rate set point in response.
- HIGH HIGH – Alarm and increase the sludge wasting rate to maximum flow (after adj delay) Reset to normal when level drops to HIGH

RECYCLE SLUDGE PUMPS (I941002-F-0004) AND SLUDGE WASTE PUMPS (I941002-F-0013)

Each train has a dedicated Recycle Sludge Pump with a third pump used as a common spare. Sludge wasting is accomplished using Waste Sludge Pumps. There is a dedicated Sludge Waste Pump for each train, with a third pump used as a common spare. The three Sludge Waste Pumps discharge into a common header which feeds three Sludge Settling Tanks. An operator can choose which tank the Waste Sludge Pumps discharge to from the SCADA System.

PHILOSOPHY OF CONTROL

Sludge recycle is performed to maintain a relatively constant concentration of total suspended solids (TSS) in the Polymer and Iron Coprecip Tank. The required sludge recycle rate will depend on the EQTDPS flow rate, EQ tank TSS concentration, the ferric chloride dosage, and the desired TSS concentration in the Polymer and Iron Coprecip Tank.

The following algorithm shall be used to calculate the ratio of recycle sludge flow to the EQTDPS flow rate (for each operating train):

- Abbreviations:
  - R=recycle rate (used to calculate required sludge flow rate, see below)
  - XTSS = desired TSS concentration in Polymer and Iron Coprecip Tank, mg/L (operator enters setpoint in SCADA; see discussion below)
  - EQTSS = TSS concentration in EQ tank, mg/L (initially set at 50 mg/L; may be adjusted by operator in SCADA based on sample analyses of EQ tank; should be set to long term average condition)
  - DOSE = ferric chloride (as FeCl3 – 6H2O) dosage setpoint, mg/L (current setpoint value entered in SCADA that is controlling the ferric chloride metering pump)
  - RTSS = TSS concentration of recycled sludge, mg/L (initially set at 30,000 mg/L; may be adjusted by operator in SCADA based on sample analyses of recycled sludge; should be set to long-term average condition)

- Operator Entered Parameters:
  - XTSS <1000 gpm/train =3500 mg/L 1000-1500 (XTSS decrease linearly from 3500 to 750 mg/L)
  - EQTSS (50 mg/L nominal)
  - DOSE ferric chloride (as FeCl3 – 6H2O) dosage setpoint, mg/L (current setpoint value entered in SCADA that is controlling the ferric chloride metering pump)
  - RTSS (30,000 mg/L)
  - R = (XTSS – EQTSS - 0.395 x DOSE)/(RTSS – XTSS) where:

Note that this algorithm is dimensional (0.395 constant is a conversion factor).
The setpoint for XTSS will vary depending on the flow rate from the EQTDPS. If the flow per train is less than 1,000 gpm, the setpoint for XTSS will be constant, at 3,500 mg/L. As the flow increases from 1,000 gpm per train to 1,500 gpm per train, the setpoint will linearly decrease from 3,500 mg/L to 750 mg/L. Above 1,500 gpm per train, the XTSS setpoint will be constant at 750 mg/L. These flow setpoints and corresponding XTSS setpoints will all be adjustable at SCADA. The lower XTSS value at higher flows is needed because solids settling in the clarifier could be impeded by a combination of high solids concentrations and high EQTDPS flow rate, potentially causing solids carry over into the clarifier effluent. In addition to high flow rate, the XTSS setpoint will be reduced to 750 mg/L as a step change if the clarifier effluent turbidity exceeds a setpoint value, and the condition will be alarmed.

The sludge recycle rate is maintained as a ratio of the flow rate into each of the Clarifier/Thickeners, which is measured by the flow meters on the discharge from the EQTDPS. The operator enters setpoints as described above, and the calculated recycle ratio is used to adjust the Sludge Recycle Pump speed to provide the desired flow rate per the resulting floating setpoint. Because the pumped sludge flow rate is the sum of the recycled sludge and wasted sludge, the Sludge Pump flow rate setpoint will be set by the sum of the two sludge flow rates.

The recycle flow rate setpoint for the Recycle Sludge Pump for each train is determined using the following algorithm:

\[ Q_{SRP} = (R \times Q_{EQTDP}) + Q_{SWP} \]

where:
- \( Q_{SRP} \) = Flow setpoint for Sludge Recycle Pump, gpm
- \( Q_{EQTDP} \) = Equalization Tank Discharge Pump flow, gpm
- \( Q_{SWP} \) = Flow setpoint for Sludge Waste Pump (determined below), gpm
- \( R \) = Recycle rate FROM ABOVE

The required sludge waste pump operation is set by the operator as either INTERMITTENT or CONTINUOUS. In either case the operator sets the desired sludge wasting rate in gal/day. When selected for CONTINUOUS operation, the recycle flow rate is converted to gpm, and the pump speed set according based on an algorithm that relates pump speed to flow rate. This algorithm will be developed during startup through pump calibration. When selected for INTERMITTENT operation, the operator sets a base pumping rate and frequency of pumping. The pumping duration for each cycle is determined through an algorithm that converts the daily sludge wasting rate to a total duration, and then divides that duration among the number of pumping cycles per day as follows:

\[ SWPD = \frac{DQWS}{DWC \times Q_{SWP}} \]

where:
- \( SWPD \) = Sludge Waste Pump operating duration per pumping cycle, min
- \( DQWS \) = Daily waste sludge quantity, gpd
- \( DWC \) = Daily wasting cycles, cycles/day
- \( Q_{SWP} \) = Waste Sludge Pump flow setpoint, gpm

**Modes of Operation**

**Automatic Control:** To set-up the system for AUTO operation, the operator must take the following steps:

- Place Recycle Sludge Pumps for each clarifier in AUTO. The third pump is a common spare. Open and/or close manual valves as appropriate so that each clarifier is served by a single pump.
- Verify the constants used in the recycle rate equation are correct. With operating experience, it is expected that these constants will not need to be revised very often. Normally, the recycle ratio will be the same for each pump.
- Place Waste Sludge Pump for each sludge recycle line in AUTO. The third pump is a common spare. Open and/or close manual valves as appropriate so that each recycle line is served by a single pump.
- Place the automatic valves on the waste sludge discharge piping in AUTO.
- Set the desired daily sludge waste quantity in gal/day (DQWS). Decide whether to operate the Sludge Waste Pumps in CONTINUOUS or INTERMITTENT mode, and select accordingly at SCADA. If in CONTINUOUS, the sludge waste pumping rate (QSWP) will be based on the setpoint total daily sludge waste quantity (DQWS). If in INTERMITTENT MODE, set the desired frequency of sludge wasting in
times per day, and the desired pump flow setpoint (QSWP). SCADA will determine the pumping duration per cycle to achieve the setpoint daily waste sludge quantity (DQWS). With operating experience, it is expected that the setpoint for daily sludge wasting rate (DQWS) will be determined by the operator for typical operation. However, the operator will need to monitor the sludge level in the thickener. If the level is trending up, the DQWS should be adjusted upward; if the level is trending down, the DQWS should be adjusted downward.

With the Sludge Recycle Pumps in AUTO, the control system will calculate the setpoint of the flow controllers using the algorithm described above. The speed of the Sludge Recycle Pumps will be set in accordance with an algorithm that relates pump speed to pump discharge flow, in lieu of a flow meter on each discharge line.

Similarly, with the Sludge Waste Pumps in AUTO, the control system will calculate the setpoint of the flow controllers using the setpoints entered by the operator, depending on whether the system is selected for CONTINUOUS or INTERMITTENT operation. The speed of the Waste Sludge Pumps will be set in accordance with an algorithm that relates pump speed to pump discharge flow, in lieu of a flow meter on each discharge line. See the Sludge Settling and Dewatering section for discussion of the inlet control valves on the Sludge Settling Tanks.

Manual Control: The Sludge Recycle Pumps and Sludge Waste Pumps may be operated in MANUAL mode using locally mounted HOA and Speed Control handswitches. Semi-automatic operation involves setting the desired flow rate on the flow controllers at SCADA.

**ALARM CONDITIONS**

- Recycle Sludge Pumps:
  - Low Suction Pressure Trip and shutdown SLDP-PSL-700-X, (X=A,B,C)
  - High Discharge Pressure Trip and shutdown SLDP-PSH-700-X, (X=A,B,C)
  - Low Suction Pressure Alarm (set above PSL)
  - High Discharge Pressure alarm(set below PSH)

- Sludge Waste Pumps:
  - Low Suction Pressure Trip and shutdown SLDP-PSL-710-X, (X=A,B,C)
  - High Discharge Pressure Trip and shutdown SLDP-PSH-100-X, (X=A,B,C)
  - Low Suction Pressure Alarm (set above PSL)
  - High Discharge Pressure alarm (set below PSH)

**CLARIFIER EFFLUENT TURBIDITY AND FILTER AID POLYMER ADDITION**

A inline turbidimeter measures the turbidity of the water downstream of the clarifier effluent weir for each clarifier. Filter Aid Polymer is added to the effluent box of each clarifier, with mixing occurring in the effluent drop pipe. A HIGH turbidity level produces an alarm and causes the EQTDPS flow rate to be decreased by 10 percent for the affected train, for an adjustable duration of 1 hour. In addition, the flow control setpoint for the Influent Flow Contol system at the Headworks is likewise reduced by 10 percent for Stage 2 and stage 3 control. If the Headworks is in Stage 1 control, the influent is unaffected. After an hour, if the turbidity is below the setpoint, the flow reduction is stopped and the systems return to normal operation. If HIGH turbidity persists after 1 hour duration, alarm the condition and reduce the EQTDPS flow rate by an additional 10 percent, for an adjustable duration of 1 hour. The flow control setpoint at the Headworks is also reduced by an additional 10 percent. Again, after one hour, if the turbidity is below the setpoint, the control systems return to normal operation. This process continues until turbidity reaches acceptable set point.

Filter Aid Polymer is added at the Clarifier Effluent. See Chemical Metering for more information

**ALARM CONDITIONS**

- HIGH turbidity monitored from either clarifier is alarmed and causes the EQTDPS flow rate to be decreased 10 percent for an adjustable rate up to 1 hour.
GRAVITY FILTERS (I941002-F-0006 THRU -0011)

Each filter receives the same flow rate setpoint, equal to the combined flow rate from the upstream treatment trains (as measured at the EQ Tank Effluent as measured by CHTR-FIT-400-A, and CHTR-FIT-400-B) divided by the number of filters in service. Each filter is fed from the Filter Influent Channel. The Filter influent Channel is monitored by redundant level transmitters FLTR-LIT-600-A and:

- HIGH level in the channel is alarmed.
- HIGH HIGH level in the channel is alarmed and the EQTDPS is shutdown.
- HIGH LEVEL DEVIATION – alarm if the filter influent channel level deviates by more than 7 inches from the setpoint.
- HIGH level measurement deviation is alarmed. When this occurs, the higher of the two readings is used for control until the operator intervenes.

MODES OF OPERATION

Automatic Control: To set-up the system for AUTO operation, the operator must take the following steps:

- Place all filter isolation valves in AUTO for the filters in service, controlled by SCADA.
- Place the flow control valve in AUTO, controlled by SCADA through a floating flow setpoint for each filter.

FILTER FLOW CONTROL

FLTR-FCV-601-X Filter Effluent Flow Control Valve modulates to maintain the individual filter flow setpoint (equals (FLTR-FIT-401-A + FLTR-FIT-401-B)/# Filters online).

<table>
<thead>
<tr>
<th>Deviation from Level Setpoint, in</th>
<th>Adjustment of Flow Setpoint(^{1})</th>
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<tr>
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<tr>
<td>1</td>
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<tr>
<td>6</td>
<td>4% X Q</td>
</tr>
<tr>
<td>7</td>
<td>8% X Q</td>
</tr>
</tbody>
</table>

Notes:
1. If the deviation is positive (above the level setpoint), the adjustment of the flow setpoint is increased (positive adjustment). If negative, the flow setpoint is decreased (negative adjustment).

As shown, no adjustment is made until the level deviates by 4 inches from setpoint. This avoids excessive hunting by the control system.

Manual Control: Although not recommended, the filter effluent flow may be manually adjusted by manually adjusting the flow control valves either locally or through SCADA. Due to the complexities of manually managing up to six filters, manual operation is an unlikely scenario.
**ALARM CONDITIONS**

HIGH flow (each filter) – alarm if the filter effluent flow differs from the floating setpoint by more than 5 percent (adjustable) for longer than 30 seconds (adjustable), indicating a potential failure of the flow control valve.

**FILTER RUN VOLUME**

The filter flow rate and time are used to continuously calculate the filter run volume for each filter. The filter run volume value is reset to zero gallons following each backwash and begins to accumulate upon the start of filtering. This value is used along with effluent turbidity and filter headloss in the determination of need for backwashing.

**FILTER BACKWASH CONTROL (I94002-F-0012)**

**MODES OF OPERATION**

**Automatic Control of Backwash Initiation:** To set-up the system for AUTO backwash initiation, the system must be selected for AUTO initiation at SCADA. Backwashing of a filter is initiated when any of the following is met:

1) Filter HEADLOSS reaches a setpoint value.
2) Effluent TURBIDITY reaches a setpoint value.
3) Filter run volume (FRV) reaches a setpoint value.

The cause for backwash initiation is recorded at SCADA.

Backwashing of the filter cannot commence until the following occur:

1) Previous filter backwashing is complete, the filter is returned to service and the filter to waste sequence is completed; and
2) Backwash Waste Basin is sufficiently emptied to receive backwash waste from the next filter, based on a level setpoint.
3) Clearwell has sufficient level to supply a full backwash.

**Automatic Control of Backwash Sequence:** To set-up the system for AUTO operation, the operator must take the following steps:

- All automatic valves associated with the filters in service must be in the AUTO mode, allowing control by plant SCADA.
- In addition, ancillary systems, such as the backwash pumps and air scour blowers, must be enabled for operation when required by the filter control system.

The following are the backwash sequence steps and requirements:

1) Close the Filter Influent valve FLTR-FV-600-X.
2) ONLINE Filter is OFFLINE. Open the filter’s Backwash Waste (BWW) valve FLTR-FV-601-X.
3) OPEN the Filter Effluent valve FLTR-FCV-607-X to 50 percent (adjustable).
4) Allow the filter to drain through the filter effluent flow control valve until the water level in the filter reaches a minimum of 6 inches (adjustable) above the top of the media. NOTE: Filter must have water above the media before air is sent to the filter.
5) Close the Filter Effluent valve.
6) Open the Backwash Air isolation valve FLTR-FV-602-X.
7) Start the blower at lowest possible speed. Slowly ramp up to design flow over the minimum of 60 seconds. The blower will operate at the percent speed setpoint at Plant SCADA.
8) Scour filter with air for 5 minutes (adjustable) at an air scour rate of 4 scfm/sf (adjustable). Maximum total air flow 1040 scfm. The air flow rate is controlled by SCADA based on an algorithm relating blower speed to air output. The algorithm will be developed based on the blower selected.
9) At the end of the air scour period, shut off blower and close Back Wash Air isolation valve.

10) Open backwash supply (BWS) isolation valve FLTR-FV-603-X, start backwash supply pump at minimum speed and raise water level in filter to set point. Then increase backwash supply pump discharge flow to 18 gpm/sf (4,680 gpm) over a period of 30 seconds (adjustable) to allow air to purge from filter media and under drains. Continue high rate backwash for a period of 5 minutes. Process variables and intervals shall be adjustable via Plant SCADA.

11) After a setpoint period of high rate backwashing, decrease backwash supply pump discharge flow to a low rate wash, 11.5 gpm/sf (3,000 gpm) as set at plant SCADA, over a period of 30 seconds. Backwash at low rate for 4 minutes. Process variables and intervals shall be adjustable via Plant SCADA.

12) Decrease backwash flow to a rinse rate 5.8 gpm/sf (1500 gpm). Backwash at rinse rate for approximately 3 minutes. Process variables and intervals shall be adjustable via Plant SCADA.

13) Close BWW and BWS valves. At this point backwashing is complete.

14) Open the filter influent valve and allow filter to fill to influent channel level.

15) Open the filter-to-waste valve FLTR-FV-605-X.

16) Ramp the filter effluent flow control valve open to the provide the setpoint flow from the filter. Reset common filter flow setpoint to reflect the return of the filter to service.

17) After 25 minutes, maximum (adjustable), open the filter effluent isolation valve and close the filter-to-waste valve. At this point the filter is fully returned to service.

**Automatic Control of Filter Shutdown:** During normal operation, starting at 25 minutes following a backwash (adjustable), if the effluent turbidity from a filter exceeds the HIGH HIGH setpoint the filter influent and filter effluent valve will close and an alarm sounded. REMAINS OFFLINE UNTIL RESET BY OPERATOR

**Manual Control of Backwash Initiation:** The backwash procedure may be manually initiated at SCADA. This requires an operator assessment of filter run volume, effluent turbidity and headloss.

**Manual Control of Backwash Sequence:** The backwash sequence may be controlled manually, requiring manual actuation of valves, and manual control of both air scour flow and BWS flow. This mode of operation would only be used in unusual circumstances.

**ALARM CONDITIONS**

The following conditions result in alarms related to the backwashing controls.

- HIGH flow (each filter) – alarm if an individual filter effluent flow differs from the floating setpoint by more than 10 percent (adjustable) for longer than 30 seconds (adjustable), indicating a potential failure of the flow control valve.
- HIGH filter level – alarm a HIGH level during backwash and shut down the backwash supply pump.
- HIGH effluent turbidity – alarm if the effluent turbidity exceeds a setpoint (higher than the backwash initiation setpoint) for more than 5 minutes (adjustable).
- HIGH HIGH effluent turbidity – alarm and remove filter from service as identified above.
- LOW filter water level (below drawdown setpoint)
- Manual backwash initiation ABORT will occur and be alarmed if an attempt is made to initiate a backwash sequence if either another filter is in a backwash sequence, or the level in the Backwash Waste Basin is above the setpoint, indicating inadequate volume for receiving backwash waste, as noted above.
- Filter-to-waste initiation – alarm initiation of filter-to-waste if it occurs during normal filter operation.
- LOW clearwell water level (below minimum volume needed for backwash).
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BACKWASH WASTE COLLECTION AND PUMPING (I94002-F-0012)

PHILOSOPHY OF CONTROL

There will be two backwash waste pumps. The operator designates the Lead and the Standby pumps. There are redundant level transmitters in the Backwash Waste Basin (FLTR-LIT-610-A, -B). The pumps cycle between level setpoints to empty the basin. There will be sufficient volume in the BWW basin accommodate a BW; however, if a HIGH HIGH level is reached, an ongoing backwash sequence is stopped if in process, and no new backwash sequencing is allowed. Manual resumption of the backwash sequence is required at SCADA, and will not be allowed if the basin level is above the HIGH level setpoint.

Automatic Control: To set-up the system for AUTO operation, the operator must take the following step:

- The Backwash Waste pumps must be in the AUTO mode, allowing control by plant SCADA. One pump is initially selected as the lead pump, and the lead is switched with each pumping cycle to distribute wear.

The lead pump is started when the level reaches the HIGH level setpoint. It is shut down when the level reaches the LOW level setpoint. The HIGH setpoint is relatively close to the LOW setpoint so that an excessive amount of water is not retained in the basin, resulting in a minimum volume differential that will avoid excessive pump starts. By rotating Lead status, less volume is needed for pump cycling. A HIGH HIGH level setpoint alarms of potential flooding of the Backwash Waste Basin. If this level is reached, all backwashing is terminated, filter-to-waste is terminated, and a new backwash sequence is not allowed to commence. Generally, the pump output will be less than the backwash waste flow rate, so that the pump is operating throughout the backwash sequence. This reduces the wait time prior to the next backwash sequence.

Manual Control: The backwash waste pumping system may be operated manually by placing the pumps in MANUAL at SCADA or at the local control station.

FILTER BACKWASH SUPPLY PUMPING SYSTEM (I94002-F-0012)

PHILOSOPHY OF CONTROL

The backwash supply pumping system consists of two pumps located in the Clearwell. One pump is Lead and the second is Standby. Both pumps are variable speed, and the discharge flow rate is measured and used for pump control. The flow setpoint originates from the filter backwash control system in SCADA.

Automatic Control: To set-up the system for AUTO operation, the operator must take the following step:

- The Backwash Supply pumps must be in the AUTO mode, allowing control by plant SCADA. One pump is initially selected as the lead pump, and the lead is switched with each backwash cycle to distribute wear.

In response to the backwash control system in SCADA, the lead Backwash Supply pump will start and ramp to the flow setpoint. Throughout the course of the backwash sequence, the flow setpoint changes and the pump output changes in response. The pump stops and Lead is changed at the end of the backwash sequence. A LOW LOW level set point alarms of impending draining of the clearwell (which would damage the pumps). If this level is reached, all backwashing is terminated and a new backwash sequence is not allowed to commence.

Manual Control: The backwash supply pumping system may be operated manually by placing the pumps in MANUAL at SCADA or at the local control station. The speed may be manually adjusted at either SCADA or at the AFD.

FILTER AIR SCOUR BLOWER SYSTEM (I94002-F-0025)

PHILOSOPHY OF CONTROL

The air scour blower system supply low pressure air to the filters during the backwash sequence. The air scour serves to loosen materials embedded in the filter media prior to backwashing with water. The air flow rate from the blower system is locally measured.

Automatic Control: To set-up the system for AUTO operation, the operator must take the following step:

- The Air Scour Blowers must be in the AUTO mode, allowing control by plant SCADA. One blower is initially selected as the Lead blower, and the second blower is the standby blower. Lead is switched with each backwash cycle to distribute wear.
In response to the backwash control system in SCADA, the lead Air Scour Blower will start and ramp (over a minimum of 60 seconds) to meet the airflow setpoint. The blower speed will be adjusted automatically during backwashing to meet the airflow setpoint. The blower stops and Lead is changed at the end of the air scour sequence.

**Manual Control:** The air scour blower system may be operated manually by placing the blowers in MANUAL at SCADA or at the local control station. The speed may be manually adjusted at either SCADA or at the AFD.

**ALARM CONDITIONS**
- Blower FAIL – originates from blower package control system.
- HIGH deviation of airflow rate from setpoint – alarm is the actual air flow differs from the setpoint by more than 10 percent (adjustable). This also serves to indicate a blower or automatic valve failure (zero air flow).

**CLEARWELL PH MEASUREMENT AND CHEMICAL FEED (I94002-F-0012)**

**PHILOSOPHY OF CONTROL**

The pH of the water collected in the Clearwell is continuously monitored for both HIGH and LOW pH. Capability to add sodium hydroxide to the effluent channel just downstream clear well will be provided from the chemical feed systems. The pH of the water will be measured again upstream of the Plant Effluent Parshall Flume. This addition will be either manually or automatically initiated.

**ALARM CONDITIONS**
- HIGH or LOW pH – alarm and shut down the EQTDPS and close all filter effluent isolation valves.

**EFFLUENT FLOW MEASUREMENT AND PH MEASUREMENT (I94002-F-0012)**

**PHILOSOPHY OF CONTROL**

The effluent water leaving the clearwell flows over a weir wall and through a Parshall flume for flow measurement (FLTR-LIT-615), prior to discharge to the UEFPC. The effluent pH (FLTR-AIT-600) is monitored downstream of the flume.

**EFFLUENT FLUME LEVEL**

**PHILOSOPHY OF CONTROL**

FLTR-FIT-615 serves to monitor flow through the parshall flume and doubles as a channel level measurement. If a high level is detected, the EQTDPS is shut down and all of the filter effluent valves closed to stop flow to the outfall. At the same time, the EQTDPS is shut down to stop flow to the MTF. Eventually, the BFPS at the Headworks Facility may be shut down if the EQ Tank reaches a HIGH level.

**ALARM CONDITIONS**
- HIGH level – alarm and shut down the EQTDPS and close all filter effluent isolation valves.

**SLUDGE SETTLING AND DEWATERING**

Sludge collected in the clarifiers is periodically pumped (wasted) to one of the Sludge Settling Tanks. The three Sludge Settling Tanks will typically be configured as follows:
- One will be selected to receive waste sludge from the Inclined Plate Clarifiers.
- One will be in use for processing waste sludge, which includes settling, decanting, and pumping to the Filter Press for dewatering.
- The third will be on standby, which may include being available to receive water or sludge from tanker trucks (from other remediation activities) or receive excess sludge when the Sludge Settling Tank selected to receive sludge becomes full.
Typically, the Sludge Settling Tank that is being used to process waste sludge will be emptied before the Sludge Settling Tank that is receiving waste sludge becomes full. Therefore, two tanks will alternate between receiving and processing sludge, while the third tank will be on standby and available for backup of the sludge receiving tank.

**SLUDGE SETTLING TANKS (I94002-F-0014)**

**PHILOSOPHY OF CONTROL**

A portion of the sludge from the Inclined Plate Clarifiers is wasted to one of three Sludge Settling Tanks. The operator selects one of the three Sludge Settling Tanks to receive the waste sludge. The inlet valve of the selected tank is automatically Opened while the inlet valves on the tanks non-selected remain Closed.

The contents of the Sludge Settling Tank are processed in batch mode, including periods of filling, solids settling, decanting, and sludge transfer to filter presses for dewatering.

There is a decant draw off port and automatic valve in each tank, located near the top of the tank. In addition to a liquid level detector, a blanket level detector monitors the sludge/water interface over a distance of about 4 feet down from the decant port. As the tank receives waste sludge, the liquid level in the tank rises and the sludge tends to separate from the water, forming a detectable interface. In order to reduce the amount of water sent to the dewatering process, it is advantageous to remove excess water to the extent possible in the Sludge Settling Tanks. With the decant valve open, water will automatically be decanted from the tank after the liquid level reaches the decant port. Since the waste sludge flow enters near the bottom of the tank and is a relatively small flow rate, it is anticipated that the upper regions of the tank will be relatively quiescent, encouraging sludge settling to occur. When the sludge interface approaches the decant port, the valve is closed to prevent solids loss, and the sludge wasting is directed to the next tank in series. The initial tank is then ready for processing through the Filter Press.

As the sludge is removed from the tank, a point is reached where the sludge blanket detector probe is no longer submerged. At this point, a spray flush valve mounted near the top of the tank automatically opens and flushes solids off the probe so that it is relatively clean for the next cycle. The duration of the flushing is adjustable and should initially be set to 15 seconds. This spray valve can also be opened manually through a locally mounted OCA hand switch. On HIGH liquid level in the filtrate sump, the open decant valve will be closed.

The nature of the truck unloading process is such that the decanting procedure described above is not feasible. However, if there is a significant liquid/solids interface, waste sludge could be bled into the tank to raise the level and push decant water out as normally done for waste sludge alone. This assumes that the trucked material is compatible with the normal waste sludge from the treatment process.

**MODES OF OPERATION**

**Automatic Control:** In AUTO control, the operator selects the Sludge Settling Tank that will receive sludge, which causes inlet valve on the selected tank to be Opened and the inlet valves on the non-selected tanks to be Closed. In addition, the decant valve for the tank will be opened. When the tank is full and the decant valve closes, the sludge valves are switched to send sludge to the next tank in sequence. The operator shall also designate the tank that will process sludge. The operator shall initiate sludge transfer from the processing tank.

**Manual Control:** The inlet valves and decant valves at the tanks can also be manually Opened or Closed by the operator.

**ALARM CONDITIONS**

In both AUTO and Manual modes:

- HIGH BLANKET Level in the Sludge Settling Tanks A, B, or C sounds an alarm to alert the operator of the fact that the tank is full and decanting is complete. The inlet valves are also switched to direct waste clarifier sludge to the next tank in series.

- For tanker truck unloading to Sludge Settling Tank A, manual valves and a dedicated line to the tank will be used. On HIGH liquid level in the tank, a local alarm (both audible and visual) near the truck unloading area will alert the operator that the tank is full and truck unloading should be stopped. HIGH liquid level alarm indicates pending overflow of tank, and closes the fill valve.

- HIGH liquid level alarm for Sludge Settling Tanks A, B, or C alarms and switches the waste feed to the next sequence.
HIGH liquid level in the Filtrate Sump will result in closing all open decant valves in addition to alarming the condition.

FILTER PRESS AND FILTER PRESS FEED PUMP CONTROL (I94002-F-0015)

PHILOSOPHY OF CONTROL

After decanting clear liquid from the Sludge Settling Tank, the operator readies the Filter Press for processing sludge by choosing the Filter Press to be cycled. Each Filter Press has a dedicated Filter Press Feed pump. Filter Press Feed Pumps share a common suction header allowing the pumps to draw sludge from any of the sludge tanks through adjustment of manual valves.

Thickening Aid Polymer is injected into the Filter Press Feed Line ahead of the Filter Press when the Filter Press is actively filtering. Each Filter Press has a dedicated polymer feed pump. The operation of the polymer feed pumps is controlled by the Filter Press control panel.

The operator initiates sludge dewatering from the filter press local vendor control panel, which automatically starts the associated Filter Press Feed Pump and monitors the inlet pressure and flow rate to the Filter Press. A high inlet pressure (defined by filter press manufacturer) indicates that the Filter Press is full, stops the Filter Press Feed Pump. The Filter Press runs through a dewatering cycle that includes a core blow process. A deceleration chamber at the discharge of the core blow piping drains sludge to the Filtrate Wet Well, where a solenoid valve is triggered to run rinse water for an adjustable duration of time after core blow is complete. After the dewatering process is complete the operator manually opens the Filter Press to release the dewatered solids to a roll-off bin below the Filter Press. All water removed in the filter press operation is sent to the Filtrate Wet Well. The Filter Press and Filter Press Feed Pumps will provide signals to SCADA for monitoring each stage of dewatering, within a dewatering cycle. A flow meter is provided on the Filter Press Feed Pump discharge to monitor flowrate; this signal is used by vendor provided PLC to control the feed rate by adjusting the pump speed.

MODES OF OPERATION

Automatic Control: The Filter Press operation is typically performed in an AUTO mode after the operator manually sets up the Filter Press, Filter Press Feed Pump, and Sludge Settling Tank for operation and initiates the Filter Press operation at the local panel. Detailed control of the filter press operation is provided through a local vendor control panel. Alarm conditions and status signals are transmitted to SCADA for each stage of dewatering. Filter Press Feed Pumps are controlled by the local vendor control panel. Once the Filter Press operation is initiated, the local vendor control panel starts the Filter Press Feed Pump and Thickening Aid Polymer Feed Pump associated with that Filter Press, and adjusts the pump speed to control flow rate. The polymer feed pump speed is controlled based on the Filter Press sludge flow rate. The pumping rate will be at a maximum when the Filter Press run is initiated. As the Filter Press fills with solids, the inlet pressure increases and the pump speed is reduced. The pump is stopped when the Filter Press inlet pressure rises to a high level or when the Sludge Settling Tank level falls to zero, indicating the tank is empty. After Filter Press core blow, the deceleration chamber solenoid valve is opened for rinsing for an adjustable duration.

Manual Control: Manual operation of the filter press is not possible. Core blow deceleration chamber rinsing may be manually activated using a local control station.

ALARM CONDITIONS

- Common FAIL for the Filter Press Equipment: Generally, if a common FAIL alarm occurs, the filter press will shut down and the filter press local panel must be consulted to determine the specific cause for the FAIL alarm.
- HIGH Filter Press Feed Pressure: This condition is alarmed and the associated Filter Press Feed Pump is shut down.
- LOW Filter Press Feed Pump Suction Pressure: This condition is alarmed and the Filter Press Feed Pump is shut down.

FILTER PRESS FEED PUMP PRESSURE RELIEF BYPASS

PHILOSOPHY OF CONTROL

Each Filter Press Feed Pump has an emergency pressure relief valve on the pump discharge that that relieves sludge to atmosphere in the event of an excessive discharge head condition. This serves to prevent
over-pressurizing the discharge piping, which can occur if the positive displacement pump discharge is restricted excessively or shut off by a closed valve. A pressure switch (FLPS-PSH-719-A,-B) is located on each pump discharge upstream of the pressure relief valve and shuts the pump down prior to reaching a relief pressure.

FILTRATE WET WELL (I94002-F-0015)

PHILOSOPHY OF CONTROL

The Filtrate Wet Well has a packaged sump pump system, that operates on level control to handle various flow streams, including filtrate from the filter presses, core blow from the filter presses, decant flow from the sludge storage tanks, and operations wash-down. The pumps discharge into the backwash waste channel where it is collected in the Backwash Waste Basin.

MODES OF OPERATION

Automatic Control: The Lead and Lag sump pumps each start in sequence in response to level measurement in the sump. The Lead pump starts on HIGH level. If the Lead pump is unable to handle the inflow to the sump, the level will rise to the HIGH-HIGH level, and the Lag pump will start. Both pumps shut down on LOW level. An alarm is sounded if the HIGH-HIGH level is reached. Prior to the start of a filter press cycle, the Lead pump is started, regardless of level in the sump, and pumps down to the LOW shutoff level to empty the sump.

Manual Control: The sump pumps may be operated manually from the packaged panel.

ALARM CONDITIONS

- HIGH-HIGH sump level sounds an alarm to indicate impending flooding of the Filter Press Room floor and closes all open sludge decant valves (see Loop Sludge Settling Tanks).

Chemical Metering Systems

Each of the chemical metering pumps is equipped with an adjustable frequency drive that receives an analog signal from SCADA. The analog signal is based on either flow pacing or an analytical input (pH or ORP). With flow pacing, the operator sets the desired chemical dose, and SCADA uses the flow rate of the stream that is receiving the chemical and an associated algorithm to adjust the metering rate. With analytical input, the metering rate is adjusted to meet the desired setpoint. For example, if the desired pH is 7.5 and the measured pH is 7.0, the metering rate of the sodium hydroxide pump will be increased to drive the pH from 7.0 to 7.5. This adjustment is dampened significantly to avoid excessive hunting and allow for process response to changes.

A high turbidity alarm on suction line to the EQ Tank Discharge Pumps alerts the operator that a higher dose of ferric chloride or polymer may be needed. The operator must reset the chemical dose if needed based on observations, past experience and jar tests performed at the time the water composition changes.

Sulfuric acid and ferric chloride at the MTF will be delivered in bulk and will be offloaded to chemical storage tanks. All other chemicals will be delivered in totes.

CHEMICAL STORAGE TANK LEVEL (I94002-F-0016, -0017)

PHILOSOPHY OF CONTROL

The level of each chemical storage tank is indicated and used for alarming. During tank filling, a HIGH Level alarm will indicate the tank is full and offloading should be stopped. This alarm will include visual (flashing beacon) and audible alarms at the unloading area. A HIGH-HIGH Level alarm will indicate that the tank is near overflowing into the secondary containment area and offloading must be stopped immediately. LOW Level alarms will indicate that the tank is low. LOW-LOW Level alarms will indicate that the tank is empty and stop the chemical feed pumps. The Sulfuric acid storage tank is monitored locally through a Truck Unloading Panel 941002LCP531. The Ferric Chloride storage tank is monitored locally through a Truck Unloading Panel 941002LCP520. At each unloading panel the respective tank level is displayed as well as a high level beacon and horn to warn of overfilling. A silence button is provided to silence the horn. The analog level for each tank is wired into the PLC which in turn drives the local indicator at the panel with an analog output. Tank level high level setpoints are programmed at the PLC for both tanks. A discrete output form the PLC to each panel activates the horn and beacon. The silence button at each panel is wired as a Discrete Input to the PLC.
SULFURIC ACID, SODIUM HYDROXIDE, AND SODIUM BISULFITE METERING PUMP AFDS

PHILOSOPHY OF CONTROL

Automatic Control: The speeds of the Sulfuric Acid, Sodium Hydroxide, and Sodium Bisulfite metering pumps are controlled based on the pH or ORP measurement in the tank where the chemicals are added. For metering pump control in Auto mode, see discussions for the various chemical feed points.

In addition to control based on oxidation-reduction potential (ORP) level in the pH Control/Dechlorination Tank, sodium bisulfite can also be added based on flow ratio control using a dosage setpoint and the measure total flow rate from the EQ Tank. For this chemical, the operator selects either ORP Control or Dosage Control and enters the desired dosage if Dosage Control is selected.

Manual Control: The metering pumps can be operated in Manual mode, although this mode of operation is not recommended for long-term operation. In Manual mode, the operator places the metering pump in Manual and sets the metering pump speed directly at the AFD. Manual mode will typically be used to calibrate the metering pump flow rate.

ORGAN SULFIDE, FERRIC CHLORIDE, AND POLYMER METERING PUMP AFDS

PHILOSOPHY OF CONTROL

The speeds of the Organosulfide, Ferric Chloride, and Polymer metering pumps are controlled based on flow ratio control. The operator enters the desired dosage (in mg/L), and the control system determines the metering rate based on the flow rate of the wastewater stream that receives the chemical addition. The flow rate from the EQ Tank is used for Organosulfide, Ferric Chloride, Flocculant Polymer, and Filter Aid Polymer addition to the Dechlorination tanks, Reaction tanks, Clarifiers and Multimedia Filters. Thickening Aid Polymer added to the Filter Press feed line is controlled based on the flow rate to the Filter Press. Operation of the Thickening Aid Polymer system is enabled and disabled by the Filter Press control panel.

MODES OF OPERATION

Automatic Control: for Auto control, the operator must enter the following information into SCADA:

- Metering rate (in gallons/hour) at 100 percent metering pump speed. This rate is determined by calibrating the metering pump. Calibration consists of pumping a known volume of chemical at a set speed (typically 100 percent) and measuring the time required, giving the metering rate. Typically, this value will not need to be revised once it has been determined by the initial calibration of the metering pump.

- Chemical concentration of chemical that will be pumped. For example, 93 percent sulfuric acid, 40 percent ferric chloride, 40 percent sodium bisulfite, 15 percent sodium hydroxide, and 100 percent organosulfide. Most polymers will have a concentration of 100 percent. Typically, this value will not need to be revised.

- Specific gravity of chemical that will be pumped. Typically, this value will not need to be revised.

- Desired dosage in mg/L.

As part of the control system programming, an algorithm will be developed that uses the above information, along with the flow rate of the stream receiving the chemical, to calculate the metering pump speed that will provide the desired dosage.

Manual Control: The metering pumps can be operated in Manual mode, although this mode of operation is not recommended for long-term operation. In Manual mode, the operator places the metering pump in Manual and sets the metering pump speed directly at the AFD. Manual mode will typically be used to calibrate the metering pump flow rate.

POLYMER BLENDING SYSTEMS FOR POLYMERS

PHILOSOPHY OF CONTROL

Polymers are typically supplied at 100 percent concentration. For optimum dosing, polymers should be diluted (usually to 0.5 to 1 percent concentration) prior to being added to the receiving stream. A polymer blending system provides two dilution steps. The first dilution step is performed in a rapid-mix compartment where about one-half...
of the necessary dilution occurs. Dilution water is fed to the rapid-mix compartment through a rotameter which is used to set the dilution water flow rate. A second dilution step is available by adding water in-line to the tubing downstream of the rapid-mix compartment, but it is not anticipated that this will be necessary. The flow rate of the secondary dilution water is also adjusted using a rotameter. Dilution water flow rates are manually set for maximum polymer metering rate. Therefore, when polymer metering rate is less than the maximum rate, the polymer concentration after dilution will be less. The dilution water supply line has a solenoid valve that is automatically closed whenever the polymer metering pump is stopped.

END OF SUPPLEMENT
Package Control Systems

Revision History:

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Document Review & Approval:

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PART 1 GENERAL

1.01 REFERENCES

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

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.

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.

C. See Section 40 90 00, Instrumentation and Control for Process Systems, Supplement Control Panel Schedule, for list of panels.

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 preplumbed panels and interconnecting plumbing diagrams.
6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.

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.

1.05 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:

   1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
   2. Light Bulb: 100 percent, 2 minimum, of each type used.
   3. Fuse: 100 percent, 5 minimum, of each type used.
   4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Section 40 90 00, Instrumentation and Control for Process Systems.

2.02 SIGNAL CHARACTERISTICS

A. Analog Signals:

   1. 4 to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
   2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.
   1. Power source: Less than 30V dc.

C. Discrete Signals:
   1. Two-state logic signals.
   2. Utilize 120V ac sources for control and alarm signals.
   3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:
   1. Northern Instruments; Model Zerust VC.
   2. Hoffmann Engineering; Model A-HCI.

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.

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.

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.

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.

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.

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.
   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 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Gray body.
f. Spacing: 0.25 inch, maximum.
g. Manufacturer and Product: Entrelec; Type M4/6.

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.

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.

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.

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.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

I. Relays:

1. General:
   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.
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 KUP.

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.

J. Intrinsic Safety Barriers:

   1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.

K. Programmable Controllers:

   1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
   2. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
3. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.

4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.

5. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.

6. Furnish with a handheld, CRT, or personal computer programmer that plugs into controller. Program using conventional relay ladder diagram notation and drum sequencer chart notation. Programmer shall provide a force function to set inputs or outputs to a given state regardless of program or input conditions. Programmer shall indicate power flow through internal elements.

7. Manufacturers:
   a. Allen-Bradley.
   b. Modicon.
   c. GE.

8. PLCs supplied as part of a Package Control system shall be of the same manufacture as the plant PLCs.

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.

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. 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. 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.
   f. Manufacturers and Products for Units with up to 12 Selection Positions:
      1) Rundel-Idec; Standard Cam Switch.
      2) Electroswitch; 31.

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.

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. 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.

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.

N. Transmitters:
   1. “Smart” microprocessor-based field transmitters shall be installed wherever possible.
   2. All field transmitters shall be provided with a local signal indicator calibrated in percent or actual engineering units. The signal indicator should be integral to the field instrument if possible and may be an analog or discrete type.
   3. If required, instrument air shall meet the quality requirements of International Society of Automation (ISA) RP7.3. For reliability, at least two compressors shall be provided with each air supply system. All air dryers for instrument air shall use desiccants.

2.06 INSTRUMENT TAG NUMBERS

A. A shorthand tag number notation is used. For example:

<table>
<thead>
<tr>
<th>Notation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIT</td>
<td>ISA designator for Analysis Indicator</td>
</tr>
<tr>
<td>I941001</td>
<td>Unit process number. I941001=headworks, I941002=Main Treatment Facility(MTF)</td>
</tr>
<tr>
<td>0012</td>
<td>Loop number</td>
</tr>
</tbody>
</table>
2.07 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:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>ON</td>
<td>Green</td>
</tr>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>Red</td>
</tr>
<tr>
<td>OPEN</td>
<td>OPEN</td>
<td>Green</td>
</tr>
<tr>
<td>CLOSED</td>
<td>CLOSED</td>
<td>Red</td>
</tr>
<tr>
<td>LOW</td>
<td>LOW</td>
<td>Amber</td>
</tr>
<tr>
<td>FAIL</td>
<td>FAIL</td>
<td>Amber</td>
</tr>
<tr>
<td>HIGH</td>
<td>HIGH</td>
<td>Amber</td>
</tr>
<tr>
<td>AUTO</td>
<td>AUTO</td>
<td>White</td>
</tr>
<tr>
<td>MANUAL</td>
<td>MANUAL</td>
<td>Yellow</td>
</tr>
<tr>
<td>LOCAL</td>
<td>LOCAL</td>
<td>White</td>
</tr>
<tr>
<td>REMOTE</td>
<td>REMOTE</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

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 individual Loop Specifications:
<table>
<thead>
<tr>
<th>Tag Function</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>OO</td>
<td>ON</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>Black</td>
</tr>
<tr>
<td>OC</td>
<td>OPEN</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>CLOSE</td>
<td>Black</td>
</tr>
<tr>
<td>OCA</td>
<td>OPEN</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>CLOSE</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
<td>Black</td>
</tr>
<tr>
<td>OOA</td>
<td>ON</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
<td>Black</td>
</tr>
<tr>
<td>MA</td>
<td>MANUAL</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
<td>Black</td>
</tr>
<tr>
<td>SS</td>
<td>START</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>STOP</td>
<td>Black</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET</td>
<td>Black</td>
</tr>
<tr>
<td>EMERGENCY</td>
<td>EMERGENCY</td>
<td>Red</td>
</tr>
<tr>
<td>STOP</td>
<td>STOP</td>
<td></td>
</tr>
</tbody>
</table>

b. Lettering Color:
1) Black on white and yellow buttons.
2) White on black, red, and green buttons.

2.08 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.
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.
2. 120V ac Lines: Emerson Edco HSP-121.
3. 480-Volt, Three-Phase Power Supplies: Square D Model SDSA3650.
4. Field Mounted at Two-Wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Edco SS64 series.
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 [A: fiberglass] [B: Type 316 stainless steel] with door.
      2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Emerson Edco; SLAC series.
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
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Monorail Hoists

Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

Document Review & Approval:

Originator:

Steven R. Polson, P.E./Lead Process Mechanical

Design Verification Complete:

Qingshan Wang, P.E./Process Mechanical QC Reviewer

Approved:

W. Laird Ellis, Jr. PE/Design Manager
PART 1   GENERAL

1.01 REFERENCES

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

2. American Society of Mechanical Engineers (ASME):
   b. B30.11, Monorails and Underhung Cranes.
   e. HST 4M, Performance Standard for Overhead Electric Wire Rope Hoists.
3. National Electrical Manufacturer’s Association (NEMA):
   a. MG 1, Motors and Generators.
   b. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
5. Occupational Safety and Health Act (OSHA).
6. Underwriters Laboratory (UL): 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN REQUIREMENTS


C. Trolley: ANSI MH27.1.

D. Wire Rope Hoist Service Class: ASME HST 4M.

E. Hook: ASME 30.10.


G. Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ASME B30.11 and OSHA requirements.
H. Provide system, equipment, and components, including supports and anchorages, designed in accordance with Section 01 61 00, Common Product Requirements.

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, materials of construction, and specifications on hoist, wheels, gears and bearing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
   c. Structural design calculations for monorail track and support system and calculations of deflection and loads on building steel stamped by a registered professional engineer.
   d. Detail Shop Drawings of monorail track, brackets, hangers, and their attachments to building structural steel.
   e. Power and control wiring diagrams, including terminals and numbers.
   f. Motor nameplate data in accordance with NEMA MG 1, and include any motor modifications.
   g. Factory finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer’s printed installation instructions.
3. Manufacturer’s Certification of Compliance that factory finish system is identical to requirements specified herein.
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 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Maximum 104 degrees F; minimum 50 degrees F.
B. Humidity: 50 percent.
C. Atmosphere: Mildly corrosive.

PART 2 PRODUCTS

2.01 GENERAL

A. Hoist and trolley manufacturer to coordinate equipment requirements with steel structures, drive motor, hoisting cable, hook, track, stops, and electrical equipment controls.
B. Where adjustable speed drives or remote control systems are required, crane manufacturer to furnish a coordinated operating system.

2.02 SUPPLEMENTS

A. See supplements to this section for additional requirements.

2.03 TRACK

A. Furnish monorail track in accordance with Section 05 12 00, Structural Steel Framing.
B. Track Design Criteria:
   1. Cross-Section: Design for stresses not exceeding 60 percent of material’s yield strength and deflection not to exceed 1/800 of span.
   2. Span: Not to exceed 45 feet with one load per span used in computing total capacity of track. Ratio of span to top flange width shall not exceed 60 to 1 for spans over 16 feet. Lower load-carrying flange minimum of 3-1/4-inch width and have raised running or wear tread.
   3. Couplings: Web type at track joints with maximum gap at track ends of load-carrying flange of 1/16 inch and 3/16 inch at turntable, switch, or free ends.
   5. Design for vertical force increased by 25 percent for impact.
   7. Design for torsional forces caused by eccentric loading, lateral forces, or offset connections.
   8. Consider fatigue and stress on bottom flange due to wheel loading.
C. Track Suspension:

1. Furnish clamps, hanger rods, and fittings to support live and dead load of hoist, trolley, controls, motors, and track.
2. Hanger Rods: High carbon, cold-rolled alloy steel with unified national fine, Class 2 screw thread ends.
3. Vertical Adjustment: 1 inch adjustable.
4. Lubricant: Permanent factory prelubricated joints.

2.04 TROLLEY

A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Construct to control deflection of trolley assembly while transmitting the carrying load to running surface.

B. Drive shall consist of chain sprocket mounted on shaft. Furnish chain to within 5 feet of operating floor level. Drive shaft shall drive the trolley wheels through a gear and pinion or spur gear arrangement.

C. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Furnish fixed alloy steel axles. Minimum tread hardness 210 Brinell.

D. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

E. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.

F. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.11.

2.05 HOIST

A. Wire Rope Type Hoist:

1. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on Supplements at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.

2. Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting
rope extra flexible, improved plow steel wire rope, made especially for hoist service.

3. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.

4. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.

2.06 ELECTRICAL

A. Furnish electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit.

B. Electrical: In accordance with NFPA 70, NEC Article 610.

C. Monorail conductor voltage drops from monorail track supply taps shall permit the hoist and trolley motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.

D. Enclosed Bus Bar Conductors: Stainless steel clad Hard copper enclosed in insulation. Collector sliding noncopper bearing, carbon shoe type, with adjustable spring tension arms for contact between bus bar and controls. Collector mechanism components aluminum, stainless steel, plastic, or other noncorrosive materials.

E. Cable Reel Conductors: Flexible cable, housed on a circular wheel, counter-torque spring to dispense and retrieve cable, with sag not more than 3 feet below connection point on hoist or trolley at maximum travel.

F. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.07 CONTROLS

A. Hoist and Trolley: Pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.

B. Pushbuttons: Fully magnetic, plain reversing type, housed in NEMA 250, Type 12 enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified hoist service class.

C. Pendant Pushbutton Control Stations: Heavy-duty, oiltight, suspended from trolley, hoist, with control transformers to supply 120V ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire
rope. Control wire cable attached to support chain or wire rope at not more than 6-foot intervals.

2.08 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.

2.09 FACTORY FINISHING
A. Prepare and prime coat in accordance with manufacturer’s standard.

2.10 SOURCE QUALITY CONTROL
A. Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.
B. Factory Tests and Adjustments: No-load run test one furnished.
C. Factory test report shall include Test Data Sheets.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer’s printed instructions.
B. Provide lubrication and lubrication fittings.

3.02 FIELD QUALITY CONTROL
A. Functional Tests: Conduct on each hoist and monorail system.
   1. Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.
B. Performance Test:
   1. Conduct on each hoist and monorail system.
   2. Load tests in compliance with OSHA, ASME B30.11, and ANSI MH27.1

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. 1/2 person-day for installation assistance and inspection.
2. 1/2 person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.

B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

3.04 SUPPLEMENTS

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

1. Hoist/Monorail Data Sheet Filter Press Monorail.
2. Hoist/Monorail Data Sheet Equipment Monorail, Mercury Treatment Facility.
3. Hoist/Monorail Data Sheet Equipment Monorail, Headworks Facility.

END OF SECTION
**HOIST/MONORAIL DATA SHEET FILTER PRESS MONORAIL**

Project: OF200 Mercury Treatment Facility  
Owner: Y-12 National Security Complex  
Service: Mercury Treatment Facility -- Filter Press Monorail A & B  
Equip. Tag Number(s): 941002-LIFT-MON-100-A & B  
Number of Units: 1

**GENERAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>Equipment Capacity</th>
<th>1/4 ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory Testing</td>
<td>Power Supply:</td>
</tr>
<tr>
<td>Method of Control: Pendant</td>
<td>Required Not Required</td>
</tr>
<tr>
<td>Location of Control: Hoist</td>
<td>Field Testing: Not required</td>
</tr>
<tr>
<td>Equipment Location: Indoors Outdoors</td>
<td>Required, functional and performance</td>
</tr>
</tbody>
</table>

**HOIST TROLLEY**

| Type: Electric, Wire Rope Hand Operated, Chain |
| Speed (fpm): 36 to 36 |
| Motor hp: 0.75 |
| Speed (fpm): ___40__ to __40___ |

**SPECIAL REQUIREMENTS**

| Accessories: Central Lubrication System OSHA operating and safety devices |
| Remote Controls: Infrared, line-of-sight Frequency modulated (FM) |
| Special Electrical Requirements: Manufacturer: |
| Electric Conductors: Bus Bar Festoon Cable Reel |

See Hoist/Monorail Dimension Sheet for clearances, lift distances, and details.
HOIST/MONORAIL DIMENSION SHEET FILTER PRESS MONORAIL
BUILDING CLEARANCES FOR MONORAIL CRANES

Project: OF200 Mercury Treatment Facility
Owner: Y-12 National Security Complex
Equipment Tag Number(s): 941002-LIFT-MON-100-A & B

A: 22’ – 6”  D: N/A  G: W8x10
B: 1’ - 6”  E: 1’- 4”  H: 2’ – 0”
C: EL 927.50  F: 20'-0”

Notes:
1. Monorail Track Length: See Drawings
# INDUCTION MOTOR DATA SHEET

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project:</td>
<td>OF200 Mercury Treatment Facility</td>
</tr>
<tr>
<td>Owner:</td>
<td>Y-12 National Security Complex</td>
</tr>
<tr>
<td>Equipment Name:</td>
<td>Filter Press Monorail A &amp; B</td>
</tr>
<tr>
<td>Equipment Tag Number(s):</td>
<td>941002-LIFT-MON-100-A &amp; B</td>
</tr>
<tr>
<td>Type:</td>
<td>Squirrel-cage induction meeting requirements of NEMA MG 1</td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.</td>
</tr>
<tr>
<td>Hazardous Location:</td>
<td>□ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.</td>
</tr>
<tr>
<td>Motor Horsepower:</td>
<td>3/4</td>
</tr>
<tr>
<td>Guaranteed Minimum Efficiency at Full Load:</td>
<td>percentages</td>
</tr>
<tr>
<td>Voltage:</td>
<td>460</td>
</tr>
<tr>
<td>Guaranteed Minimum Power Factor at Full Load:</td>
<td>percentages</td>
</tr>
<tr>
<td>Phase:</td>
<td>3</td>
</tr>
<tr>
<td>Service Factor (@ rated max. amb. temp.):</td>
<td>□ 1.0  ☑ 1.15</td>
</tr>
<tr>
<td>Frequency:</td>
<td>60</td>
</tr>
<tr>
<td>Enclosure Type:</td>
<td>IP55 Rated</td>
</tr>
<tr>
<td>Synchronous Speed:</td>
<td>rpm</td>
</tr>
<tr>
<td>□ Thermal Protection:</td>
<td></td>
</tr>
<tr>
<td>□ Space Heater:</td>
<td>volts, single-phase</td>
</tr>
<tr>
<td>□ Multispeed, Two-Speed:</td>
<td>□  / □</td>
</tr>
<tr>
<td>□ Winding:</td>
<td>□ One  □ Two</td>
</tr>
<tr>
<td>□ Mounting Type:</td>
<td>□ Horizontal  □ Vertical</td>
</tr>
<tr>
<td>□ Vertical Shaft:</td>
<td>□ Solid  □ Hollow</td>
</tr>
<tr>
<td>□ Vertical Thrust Capacity (lb):</td>
<td>□ Up □ Down</td>
</tr>
<tr>
<td>□ Adjustable Speed Drive:</td>
<td>See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.</td>
</tr>
<tr>
<td>Operating Speed Range:</td>
<td>□ Variable Torque</td>
</tr>
<tr>
<td>□ Constant Torque</td>
<td></td>
</tr>
<tr>
<td>Additional Motor Requirements:</td>
<td>☑ See Section 26 20 00, Low Voltage AC Induction Motors.</td>
</tr>
<tr>
<td>Special Features:</td>
<td></td>
</tr>
</tbody>
</table>

PW/DEN001/662886  MONORAIL HOISTS  
JUNE 30, 2017  41 22 23.19 SUPPLEMENT 1 - 3
# HOIST/MONORAIL DATA SHEET
## EQUIPMENT MONORAIL, MERCURY TREATMENT FACILITY

| Project: OF200 Mercury Treatment Facility | Manufacturer: Harrington |
| Owner: Y-12 National Security Complex | Model No.: (N)ERM015S-L/S |
| Service: Mercury Treatment Facility -- Equipment Monorail | Number of Units: 1 |
| Equip. Tag Number(s): 941002LIFT-MON-200 | Rev/Date/By: / / |

## GENERAL REQUIREMENTS

| Equipment Capacity: 1-1/2 tons | Factory Testing: |
| Power Supply: | Method of Control: Pendant |
| Required | Not Required |
| Voltage: 460 | Field Testing: Not required |
| Location of Control: Hoist | Frequency: |
| Required, functional and | |
| Indoors | Outdoors |

## HOIST

| Type: Electric, Wire Rope | Hand Operated, Chain |
| Service Class (ANSI): H1 (standby) | H2 (light) |
| H3 (standard) | H4 (heavy) |
| H5 (severe) | |
| Speed (fpm): 18 to 18 | Two Speed |
| Constant Speed | Variable Speed |
| Motor hp: 2.4 | |
| Hook: See Hoist/Monorail Dimension Sheet | |
| Hook Manufacturer: | |
| Reeving: | |

## TROLLEY

| Type: Top Running | Underhung |
| Service Class (ANSI): A1 (standby) | A2 (infrequent) |
| B (light) | C (moderate) |
| D (heavy) | |
| Speed (fpm): 40 to 40 | |
| Constant Speed | Variable Speed |
| Hand Operated | |
| Electric Conductors: Bus Bar | Festoon |
| Cable Reel | |

## SPECIAL REQUIREMENTS

| Accessories: Central Lubrication System | Remote Controls: Infrared, line-of-sight |
| OSHA operating and safety devices | Frequency modulated (FM) |
| Manufacturer: | |
| Extended Grease Fittings | |

See Hoist/Monorail Dimension Sheet for clearances, lift distances, and details.
HOIST/MONORAIL DIMENSION SHEET  EQUIPMENT MONORAIL BUILDING CLEARANCES FOR MONORAIL CRANES

Project: OF200 Mercury Treatment Facility
Owner: Y-12 National Security Complex
Equipment Tag Number(s): 

A: 41’ – 6”    D: N/A    G: W8x10
B: 2’ – 0”     E: 2’ – 0”    H: 2’ – 0”
C: EL 927.50   F: 38’ – 0”

Notes:
1. Monorail Track Length: See Drawings
### INDUCTION MOTOR DATA SHEET

**Project:** OF200 Mercury Treatment Facility  
**Owner:** Y-12 National Security Complex  
**Equipment Name:** Equipment Monorail  
**Equipment Tag Number(s):** 941002-LIFT-MON-200  

**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:** 2.4  
**Guaranteed Minimum Efficiency at Full Load:** _____ percent  

**Voltage:** 460  
**Guaranteed Minimum Power Factor at Full Load:** _____ percent  

**Phase:** 3  
**Service Factor (@ rated max. amb. temp.):**  
- 1.0  
- 1.15  

**Frequency:** 60  
**Enclosure Type:**  

**Synchronous Speed:** _____ rpm  
- **Multispeed, Two-Speed:** _____ / _____ rpm  

- **Thermal Protection:**  
- **Space Heater:** volts, single-phase  

- **Mounting Type:**  
- **Vertical Shaft:**  
- **Vertical Thrust Capacity (lb):** Up _____ Down _____  

- **Adjustable Speed Drive:** See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.  

**Operating Speed Range:** _____ to _____% of Rated Speed  
- **Variable Torque**  
- **Constant Torque**  

**Additional Motor Requirements:**  
- See Section 26 20 00, Low Voltage AC Induction Motors.  

**Special Features:**  

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PW/DEN001/662886  
JUNE 30, 2017  
MONORAIL HOISTS  
41 22 23.19 SUPPLEMENT 2 - 3
**HOIST/MONORAIL DATA SHEET EQUIPMENT MONORAIL, HEADWORKS FACILITY**

**Project:** OF200 Mercury Treatment Facility  
**Owner:** Y-12 National Security Complex  
**Service:** Headworks Facility -- Equipment Monorail  
**Manufacturer:** Harrington  
**Model No.:** RH02S  
**Number of Units:** 1  
**Equip. Tag Number(s):**  

**GENERAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Capacity</td>
<td>1-1/2 tons</td>
<td></td>
</tr>
<tr>
<td>Factory Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>Voltage 460</td>
<td></td>
</tr>
<tr>
<td>Method of Control</td>
<td>Pendant</td>
<td>Required</td>
</tr>
<tr>
<td>Location of Control</td>
<td>Hoist</td>
<td>Indoor</td>
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<tr>
<td>Equipment Location</td>
<td></td>
<td>Required, functional and performance</td>
</tr>
<tr>
<td>Motor hp</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Speed (fpm)</td>
<td>18 to 18</td>
<td></td>
</tr>
<tr>
<td>Speed (fpm)</td>
<td>40 to 40</td>
<td></td>
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<tr>
<td>Electric Conductors</td>
<td>Bus Bar</td>
<td></td>
</tr>
<tr>
<td>Reeving</td>
<td>Cable Reel</td>
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**HOIST**

<table>
<thead>
<tr>
<th>Type</th>
<th>Electric, Wire Rope</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Service Class (ANSI)</td>
<td>H1 (standby)</td>
<td>H2 (light)</td>
</tr>
<tr>
<td>Speed (fpm)</td>
<td>Constant Speed</td>
<td></td>
</tr>
<tr>
<td>Motor hp</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Hook</td>
<td>See Hoist/Monorail Dimension Sheet</td>
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</tr>
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</table>

**TROLLEY**

<table>
<thead>
<tr>
<th>Type</th>
<th>Top Running</th>
<th>Underhung</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Class (ANSI)</td>
<td>A1 (standby)</td>
<td>A2 (infrequent)</td>
</tr>
<tr>
<td>Speed (fpm)</td>
<td>Constant Speed</td>
<td></td>
</tr>
<tr>
<td>Motor hp</td>
<td>0.54</td>
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</tr>
<tr>
<td>Electric Conductors</td>
<td>Bus Bar</td>
<td>Festoon</td>
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</table>

**SPECIAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Remote Controls</th>
<th>Special Electrical Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Lubrication System</td>
<td>Infrared, line-of-sight</td>
<td>Frequency modulated (FM)</td>
</tr>
<tr>
<td>OSHA operating and safety devices</td>
<td>Manufacturer:</td>
<td></td>
</tr>
</tbody>
</table>

See Hoist/Monorail Dimension Sheet for clearances, lift distances, and details.
Project: OF200 Mercury Treatment Facility

Owner: Y-12 National Security Complex

Equipment Tag Number(s):

A: 10’-0”
B: N/A
C: EL 940.00

D: 33’-3”
E: 2’ – 0”
F: 46’-6”

G: W8x10
H: N/A

Notes:

1. Monorail Track Length: See Specification
**INDUCTION MOTOR DATA SHEET**

Project: OF200 Mercury Treatment Facility

Owner: Y-12 National Security Complex

Equipment Name: Equipment Monorail

Equipment Tag Number(s): __________________________________________________________

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: 2.4 Guaranteed Minimum Efficiency at Full Load: _____ percent

Voltage: 460 Guaranteed Minimum Power Factor at Full Load: _____ percent

Phase: 3 Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☑ 1.15

Frequency: 60 Enclosure Type: ____________________________________________________

Synchronous Speed: _____ rpm ☐ Multispeed, Two-Speed: _____ / _____ rpm

☐ Thermal Protection: __________ Winding: ☐ One ☐ Two

☐ Space Heater: volts, 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 System.

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: ☑ See Section 26 20 00, Low Voltage AC Induction Motors.

Special Features:

__________________________________________

__________________________________________

__________________________________________
Compressed Air Systems

Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

Document Review & Approval:

**Originator:**

Steven R. Polson, P.E./Lead Process Mechanical

**Design Verification Complete:**

Qingshan Wang, P.E./Process Mechanical QC Reviewer

**Approved:**

W. Laird Ellis, Jr. PE/Design Manager
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): PTC 10, Compressors and Exhausters.
3. American Society of Mechanical Engineers (ASME): ASME B31.3 Process Piping
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Standard Cubic Foot per Minute (scfm): Volume flow rate of air at standard conditions of 60 degrees F, 14.7 psia, and 36 percent relative humidity.

B. Standard Inlet Conditions: 60 degrees F, 14.7 psia and 36 percent relative humidity.

C. Rated Inlet Conditions: 105 degrees F, 14.2 psia (950 feet elevation), 36 percent relative humidity.

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, and specifications.
   c. Detailed mechanical and electrical drawings showing equipment fabrications. Include dimensions, size, and locations of connections to other Work.
   d. External utility requirements such as air, water, power, and drain for each component.
e. Functional description of internal and external instrumentation and controls including list of parameters monitored, controlled, or alarmed.

f. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.

g. Power and control wiring diagrams, including terminals and numbers.

h. Manufacturer’s diagrams for air compressor piping.

i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s recommended vibration limits of compressed air system.

2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

3. Field performance test procedures.

4. Manufacturer’s Instructions:
   a. Installation of equipment.
   b. Installation of vibration isolators.

5. Factory test reports of each test and inspection.

6. Field test reports for each functional and performance test of equipment.

7. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

8. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

9. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.04 EXTRA MATERIALS

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

1. V-Belts: One set per compressor type.

2. Intake Filter Cartridges: Three per compressor type.

3. Pre-filter Replaceable Elements: Five for each compressor type.

4. Oil Filter Replaceable Elements: Three for each compressor type.

5. Special Tools: One set.
PART 2         PRODUCTS

2.01       EQUIPMENT

A.  General:

1. Furnish air compressors as a complete system that includes compressor, motor, controls, and accessories.
2. Reference Motor data sheet located at the end of this section as a supplement and equipment layout on Drawings.
3. Compressor Inlet Conditions:
   a. Maximum Temperature: 105 degrees F.
   b. Minimum Temperature: 50 degrees F.
   c. Elevation: 950 feet above sea level.
   d. Max Relative Humidity: 60 percent.

B. Equipment Tag Number(s):

1. 941002-CAIR-COMP-800-A.
2. 941002-CAIR-COMP-800-B.

C. Receiver Mounted. Rotary Screw Air Compressor:

1. Manufacturer and Product:
   a. Quincy Northwest; QGS Series.
   b. Gardner Denver; Apex Series.
   c. Ingersoll Rand; R-Series.
   d. Approved equal.
2. Air cooled, single-stage, rotary, oil-flooded, screw type with receiver tank mounted motor and V-belt drive with guard in sound enclosure, with convenient means for belt tensioning.
3. Rated for continuous operation at 105 degrees F at specified output without overheating.
4. Base mount and size to deliver 43 scfm at 150 psig under operating conditions of 14.2 psia and 105 degrees F at compressor inlet, with rotary screw speed on male drive rotor of not more than manufactures safe operating speed.
5. Oil Filter: Full flow type with replaceable elements capable of at least 1,000 hours of operation between changes.
6. Inlet Air Filter: Dry type.
7. Equip with pressure relief valve and vibration isolators.
8. Motor: In accordance with NEMA MG 1.
   a. Type: Squirrel-cage, energy efficient.
   b. Enclosure: Open drip-proof.
   c. Windings: Copper.
   d. Duty Cycle: Continuous.
   e. Temperature Rating: 40 degrees C ambient.
g. Rpm: Maximum 1,800.
h. Volts: 460V.
i. Phase: Three.
j. Frequency: 60-Hz.
k. Service Factor: 1.15.
l. See Section 26 20 00, Low Voltage AC Induction Motors, for additional requirements, including acceptable manufacturers.

9. Connected Load: Not to exceed motor nameplate horsepower rating at discharge pressures up to 150 psig.

10. Wet Receiver:
   a. Horizontal welded steel receiver bearing ASME code stamp and with inspection openings.
   b. Maximum Volume: 120 gallons.
   d. Operating Pressure: 150 psig.
   e. Corrosion Allowance: 1/16 inch.
   f. Safety relief valve set for 165 psig.
   g. Pressure gauge with gauge cock.
   h. Automatic condensate drain valve with isolation valve.
   i. Manual blowdown valve located at low point in receiver.

11. Controls:
   a. ON/OFF cyclic operation.
   b. Automatic low oil pressure shutdown with indicating light and oil pressure gauge.
   c. Enclosure: NEMA 250, Type 12 panel for indoor installation to house complete control system including:
      1) Control power transformer.
      2) HAND/OFF/AUTOMATIC switch.
      3) Pressure switches.
      4) Relays.
      5) System pressure indicator.
      6) Indicating light(s).
      7) Combination motor starter (NEMA Size 1 minimum) with overload protection.
   d. Control Panel: Mount in accessible location on receiver.
   e. Prewired control components.
   f. Control Components: Operate on 120-volt ac power supply.

D. Filtration/Dryer Skid:

1. The Filtration/Dryer Skid shall include, but not be limited to the following equipment:
   a. Pre Dryer Particulate Filter:
      1) 941002-CAIR-F-800-A.
      2) 941002-CAIR-F-800-B.
b. Pre Dryer Coalescing Filter:
   1) 941002-CAIR-F-801-A.
   2) 941002-CAIR-F-801-B.

c. Heatless Desiccant Air Dryer:
   1) 941002-CAIR-DR-800-A.
   2) 941002-CAIR-DR-800-B.

d. Post Dryer Particulate Filter:
   1) 941002-CAIR-F-802-A.
   2) 941002-CAIR-F-802-B.

e. Instrument Air Receiver:
   1) 941002-CAIR-T-804.

2. Filtration/dryer skid shall have maximum overall dimensions of 4 feet wide, 10 feet long and 8 feet tall, and shall be designed by a structural engineer in accordance with Section 05 50 00, Metal Fabrications.

3. Equipment shall have adequate clearances to perform general maintenance, as specified by equipment manufacturer.

4. Valves and equipment on the skid shall be accessible from grade.

5. Skid piping and valve shall be the same materials of construction as identified on piping schedule and drawings, and shall conform to Section 40 27 00, Process Piping – General, and Section 40 27 02, Process Valves and Operators.

6. Heatless Desiccant Air Dryer:
   a. Manufacturers and Products:
      1) Quincy.
      2) Wilkerson Corp.
      3) Hankison.
      4) Approved equal.

   b. Air Dryer:
      1) Dual drying chambers and control system, complete, skid mounted.
      2) Rated Outlet Flow: 43 scfm at 150 psig.
      3) Pressure Dew Point: Minus 40 degrees F with 100 degrees F inlet air and 100 degrees F ambient air temperature.
      5) Provide two ASME code rated chambers utilizing a heaterless regeneration design.
      6) Fill towers with activated alumina desiccant on stainless steel supports to help prevent channeling of the air.
      7) Provide drain and fill ports for each tower without piping disconnects.

   c. Dryer Interconnecting Piping:
      1) Provide check valve in each tower discharge line and a four-way switching valve in inlet air piping.
      2) Furnish purge air piping for tower drying.
      3) Equip purge discharge line with purge air muffler.
4) Equip purge air supply line with flow regulating device, factory adjusted and locked in position.
5) Supply purge air from discharge side of the dryer and provide with air filter upstream of control connections.
6) Pipe purge air to flow through the tower countercurrent to the process air.
7) Equip each tower with ASME code rated safety relief valve and pressure gauge.
8) Dryer preassembled with interconnecting piping installed.

d. Dryer Control System:
   1) Automatically alternate towers for regeneration to provide an uninterrupted air supply without downstream pressure fluctuations.
   2) Equalize pressures in both desiccant chambers prior to changeover.

e. Switching Valve:
   1) Provide to change a tower from drying mode to regeneration mode.
   2) Type: Four-way, enclosed, pneumatic cylinder-operated, nonlubricated and equipped with Teflon sealing surfaces.
   3) Control switching valve with four-way solenoid valve to direct dry air to air cylinder on the control valve.
   4) Electrical Power Supply to Control System: 120 volts, single-phase.

7. Coalescing Filter:
   a. Manufacturers and Products:
      1) Quincy.
      2) Wilkerson Corp.
      3) Hankison.
      4) Approved equal.
   b. Provide to protect desiccant bed from oil or free water contamination in compressed air supply.
   c. Capable of removing 100 percent of aerosols 0.75 micron and larger, and 100 percent of 0.3-micron solid particles.
   d. Include automatic float drain.

8. Particulate Filter:
   a. Manufacturers and Products:
      1) Quincy.
      2) Wilkerson Corp.
      3) Hankison.
      4) Approved equal.
   b. Protect air-lines from desiccant dust fines carried over from desiccant towers.
   c. Capable of removing 100 percent of 1 micron and larger particles.
9. Instrument Air Receiver:
   a. Vertical welded steel receiver bearing ASME code stamp and with inspection openings.
   c. Operating Pressure: 135 psig.
   d. Corrosion Allowance: 1/16 inch.
   e. Safety relief valve set for 165 psig.
   f. Diameter: 12 inches.
   g. Length: 33 inches.
   h. Capacity: 15 gallons.
   i. Fabrication: Welded carbon steel plate with ASME code required inspection openings.
   j. Plate Thickness: For a maximum allowable working pressure of 200 psig plus a 1/16-inch corrosion allowance.
   k. Provide a valved blowdown/drain connection at a low point on the tank.
   l. In accordance with ASME Code for Unfired Pressure Vessels.

E. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

F. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high: die-stamped block type equipment identification number and letters indicated in this Specification and as shown on Drawings.

G. 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.

2.02 ACCESSORIES

A. Process Air Receiver:

   1. Vertical welded steel receiver bearing ASME code stamp and with inspection openings.
   5. Length: 144 inches.
   8. Plate Thickness: For a maximum allowable working pressure of 200 psig plus a 1/16-inch corrosion allowance.
9. Provide a valved blowdown/drain connection at a low point on the tank.
10. In accordance with ASME Code for Unfired Pressure Vessels.

B. Oil/Water Separator:

1. Equipment Tag Number(s):
   a. 941002-CAIR-OWS-806-A.
   b. 941002-CAIR-OWS-806-B.

2. Manufacturers and Products:
   a. Quincy.
   b. Wilkerson Corp.
   c. Hankison.
   d. Approved equal.

3. Oil/water separator shall be loose shipped and installed as shown on drawings and meet the following criteria:
   a. Minimum Operating Temperature: 40 degrees F.
   b. Maximum Operating Temperature: 140 degrees F.
   c. Maximum Operating Pressure: 250 psig.
   d. Must be able to remove 10 mg/L of oil or less.

C. Flexible Discharge Connections Manufacturer and Product:

1. Stainless steel expansion bellows capable of meeting or exceeding the following operating conditions:
   a. MAWP: 200 psig.
   b. Minimum Temperature Rating: 300 degrees F.

2. Manufactures and Products:
   a. U.S. Flex; BMH.
   b. Metraflex.
   c. Approved equal.

D. Safety Valves:

1. Equipment Tag Nos:
   a. CAIR-PSV-800-A.
   b. CAIR-PSV-800-B.
   c. CAIR-PSV-803.
   d. CAIR-PSV-804.

2. Manufacturers and Products:
   a. Consolidated
   b. Crosby
   c. Approved equal.

3. Fabrication: Bronze body, bronze base, disc with steel spring, top outlet, and malleable iron lifting lever.

4. In accordance with ASME Code for Unfired Pressure Vessels.

5. Set to relieve at 165 psig and relieve full capacity of 43 scfm at 110 percent accumulation.
E. Automatic Drain Trap (ADT-2):

1. Equipment Tag Nos:
   a. CAIR-FV-800-A.
   b. CAIR-FV-800-B.
   c. CAIR-FV-801-A.
   d. CAIR-FV-801-B.
   e. CAIR-FV-802-A.
   f. CAIR-FV-802-B.
2. Manufacturer and Product:
   a. Quincy.
   b. Armstrong;
3. Electronic timer type for liquid drainage.
4. Fabrication:
   a. Bronze construction.
   b. Viton seat.
6. Adjustable frequency and duration of water release.

2.03 SHOP/FACTORY FINISHING

A. Prepare, and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Furnish manufacturer’s standard baked enamel finish, color as selected.

2.04 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install equipment on vibration isolators in accordance with manufacturer’s instructions.

   1. Piping: Equip with full-size flexible discharge connection, check valve, and isolation valve.

B. Air Compressor Piping:

   1. Install in accordance with manufacturer’s piping diagrams.
   2. Pipe relief valve, tank drain, and separator drain to floor drain.
3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each piece of equipment in the system.
   1. Vibration Test:
      a. System shall not develop amplitudes of vibration in excess of manufacturer’s recommendations.
      b. Test with units installed and in normal operation.
      c. If units exhibit vibration in excess of the limits specified adjust or modify as necessary to resolve excess vibration. Units which cannot be adjusted or modified to conform as specified shall be replaced.

B. Performance Test:
   1. Conduct on each compressor and dryer skid, assisted by manufacturer’s representative.
   2. Perform under actual or approved simulated operating conditions.
   3. Test for a continuous 3-hour period without malfunction.
   4. Perform with Engineer present.
   5. Adjust, realign, or modify units and retest.

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. 3 person-days for installation assistance and inspection.
   2. 3 person-days for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
   3. 2 person-days for prestartup classroom or Site training.
   4. 2 person-days for facility startup.
   5. 2 person-days 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 and Engineer.

B. See Section 01 43 33, Manufacturers’ Field Services.

3.04 SUPPLEMENTS

A. The supplement(s) listed below, following “End of Section,” are a part of this Specification.
   1. Induction Motor Data Sheet.

END OF SECTION
### INDUCTION MOTOR DATA SHEET

**Project:** OF 200 Mercury Treatment Facility

**Owner:**

**Equipment Name:** Air Compressor

**Equipment Tag Number(s):** 941002-CAIR-COMP-800-A, 941002-CAIR-COMP-800-B

**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:** 15 hp  
**Guaranteed Minimum Efficiency at Full Load:** __91.7_ percent

**Voltage:** 460 V  
**Guaranteed Minimum Power Factor at Full Load:** _____ percent

**Phase:** 3  
**Service Factor (@ rated max. amb. temp.):** 1.0  ☒ 1.15

**Frequency:** 60-Hz  
**Enclosure Type:** ODP

**Synchronous Speed:** 1800 rpm  
**Multispeed, Two-Speed:** _____ / _____ rpm

**Thermal Protection:**  
**Winding:** One  ☒ Two

**Space Heater:** _____ volts,  
**Mounting Type:**  
**Single-phase**

**Vertical Shaft:**  
**Hollow**

**Vertical Thrust Capacity (lb):** Up _____ Down _____

**Adjustable Speed Drive:** See Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems.

**Operating Speed Range:** _____ to _____% of Rated Speed

- [ ] Variable Torque
- [ ] Constant Torque

**Additional Motor Requirements:**  
**See Section 26 20 00, Low-Voltage AC Induction Motors.**

**Special Features:**
**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Miscellaneous Mixers

### Revision History:

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<th>Description</th>
<th>Date</th>
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<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
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### Document Review & Approval:

**Originator:**
Karen M. Leber, PE/Process Lead Engineer

[Signature]

6/19/17

**Design Verification Complete:**
Mark Davis/ Senior Technical Consultant

[Signature]

6/15/17

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager

[Signature]

Digitally signed by W. Laird Ellis, Jr.
Date: 2017.06.16 10:42:41 -06'00'
PART 1  GENERAL

1.01  SUMMARY

A. Comply with Section 01 61 00, Common Product Requirements, and Section 26 05 02, Basic Electrical Requirements.

B. Section includes the supply, delivery, site storage, installation, testing and placement into operation of specified mount mixers, including all appurtenances required to complete operating systems as specified.

C. Section includes supply and installation of all components necessary to install two side mount mixers for the stormwater storage tank and one side mount mixer for the equalization tank.

D. Section includes supply and installation of all components necessary to install top mount mixers for the dechlorination tanks.

E. Section includes supply and installation of all components necessary to install two low shear top mount mixers for the dip tubes in the iron coprecipitation tanks (one per dip tube per tank).

F. Section includes supply and installation of all components necessary to install a clamp-mount mixer for the thickening aid polymer day tank.

1.02  REFERENCES

A. American National Standards Institute (ANSI).

B. American Water Works Association (AWWA).

C. ASTM International (ASTM).

1.03  SUBMITTALS

A. Action Submittals:

1. General layout, mast, complete engineering description, and performance characteristics and minimum liquid level at which mixer can operate.

2. Size, details, and complete list of materials.

3. Certified performance curves that show efficiency, speed range, and brake horsepower.
4. Wiring schematics.
5. Commissioning 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. Manufacturer’s Certificate of Proper Installation per Section 01 43 33, Manufacturers’ Field Services.
3. 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.

1.04 QUALITY ASSURANCE

A. Provide a written guarantee that the mixer will provide uniform mixing. 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.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Sharpe.
B. Mixtec.
C. Lightnin Mixers.
D. Substitutions: Permitted with Engineer Approval.

2.02 SIDE MOUNT MIXERS

A. Design the side mount mixers for continuous duty and guarantee the mixers based on the design conditions specified on the data sheet. Design and construct all units to permit economical maintenance. Select all units to allow as much interchangeability of parts as possible. Unspecified details of design and construction of the mixing unit shall be manufacturer’s standard.

B. Stormwater Tank Dimensions:

1. Diameter: 70 feet.
2. Height: 75 feet.
3. Minimum Operating Depth: 8.5 feet.
4. Number of Mixers: Two.
   a. Location: Tank 941001-HDWK-T-250.
5. Mixers shall be selected/sized by the equipment supplier in conformance with requirements detailed in the Stormwater Tank Mixer Data Sheet.

C. Equalization Tank Dimensions:
   1. Diameter: 44 feet.
   2. Height: 48 feet.
   3. Minimum Operating Depth: 8.5 feet.
   4. Number of Mixers: One.
      a. Location: Tank 941002-CHTR-T-400.
   5. Mixer shall be selected/sized by the equipment supplier in conformance with requirements detailed in the Equalization Tank Mixer Data Sheet.

2.03 TOP MOUNT MIXERS

A. Design the top mount mixers for continuous duty and guarantee the mixers based on the design conditions specified on the data sheet. Design and construct all units to permit economical maintenance. Select all units to allow as much interchangeability of parts as possible. Unspecified details of design and construction of the mixing unit shall be manufacturer’s standard.

B. Dechlorination Tank Dimensions:
   1. Diameter: 11 feet.
   2. Height: 16 feet.
   3. Number of Mixers: Two total, one per each tank.
      a. Location: Tank 941002-CHTR-T-410-A/B.
   4. Mixers shall be selected/sized by the equipment supplier in conformance with the requirements detailed in the Dechlorination Tank Mixer Data Sheet.

2.04 LOW SHEAR TOP MOUNT MIXERS

A. Design the dip tube top mount mixers for continuous full load duty and guarantee the mixers based on the design conditions specified on the data sheet. Design and construct all units to permit economical maintenance. Select all units to allow as much interchangeability of parts as possible. Unspecified details of design and construction of the mixing unit shall be manufacturer’s standard.

B. Flocculent Aid Polymer - Dip Tube Dimensions:
   1. Diameter: 12 inches.
   2. Height: Impeller shall be located 6 inches below horizontal dip tube opening.
3. Number of Mixers: Two total, one per each tank.
   a. Location: Tank 941002-CHTR-T-420-A/B.
4. Mixers shall be selected/sized by the equipment supplier in conformance with the requirements detailed in the Clarifier Polymer Inline Mixer Data Sheet.

2.05 CLAMP-MOUNT MIXER

A. Design the clamp-mount mixer for continuous full load duty and guarantee the mixer based on the design conditions specified on the data sheet. Design and construct unit to permit economical maintenance. Unspecified details of design and construction of the mixing unit shall be manufacturer’s standard.

B. Thickening Aid Polymer Day Tank Dimensions:
   1. Diameter: 6 feet 1 inch.
   2. Height: 8 feet 6 inches.
   3. Number of Mixers: One.
      a. Location: Tank 941002-CHEM-T-513.
   4. Mixer shall be selected/sized by the equipment supplier in conformance with the requirements detailed in the Thickening Aid Polymer Mixer Data Sheet.

2.06 PAINTING

A. Non wetted equipment shall meet requirements of Section 09 90 00, Painting and Coating, System No. 4.

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.

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 START-UP

A. A manufacturer’s technical representative for the equipment specified herein shall be present at the Job Site and/or classroom designated by Owner for the minimum person-days listed for the services hereinafter, travel time excluded:

1. 1 person-day for inspection of equipment and materials upon arrival at the Job Site and inventory.
2. 2 person-days for inspection, certification of the installation, and instructing the Contractor on proper installation procedures and adjustment of equipment after installation.
3. 2 person-days for functional testing.
4. 1 person-day for prestartup classroom or Job Site training.
5. Note: The manufacturer’s representative shall be present at the Job Site for whatever duration is necessary to assure proper assembly, installation, testing, startup and certification of the equipment specified herein.

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 verify 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. Functional Test: 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 due to failure of materials or construction to meet specifications.
I. Unconditionally guarantee the equipment to meet or exceed the design criteria detailed in this Specification.

3.04 SUPPLEMENTS

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

2. Equalization Tank Mixer Equipment Data Sheet.
3. Dechlorination Tank Mixer Equipment Data Sheet.
4. Clarifier Polymer Inline Mixer Equipment Data Sheet.
5. Thickening Aid Polymer Mixer Equipment Data Sheet.

END OF SECTION
STORMWATER TANK MIXER

GENERAL
Service: Wastewater
Mfr.: *
Vessel Reference Data DWG/Spec No.: Spec 33 16 13.13
Model: *
Vendor to Furnish: □ Agitator □ Drive □ Motor □ Starter □ VFD

PROCESS DATA

PROCESS FUNCTION
□ Blending □ Dissolving □ Emulsifying □ Gas Dispersion □ Heat Transfer □ Suspending

MIXING INTENSITY
□ Violent □ Vigorous □ Moderate □ Mild

TYPE OF OPERATION
□ Batch: □ Continuous: 37,000 gpm (Max)
Smallest/Largest: N/A
Operating During Filling? No
Operating During Draw-off? Yes
Mixing Time Required:

INGREDIENTS TO BE MIXED:

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<td>1 Stormwater</td>
<td>2,000,000</td>
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Mixture:

SOLIDS' SUSPENSION
TSS ~ 50 ppm, TDS ~ 300 ppm

Characteristics and Type of Solids:
□ Soluble □ Insoluble □ Abrasive □ Sticky □ Crystalline □ Fluffy
Particle Size, (microns): TBD
Settling Velocity, FPM: TBD
Suspension Sp. Gr.: 1.0

Solids Suspension Degree:
□ None □ Total Uniformity □ Moderate Uniformity □ Slight Uniformity

FOAMING TENDENCY:
□ None □ Slight □ Moderate □ Severe

DESIGN DATA
Max. Operating Temp., °F: 100
Max. Operating Pressure (psig): 0
Agitator Location on Vessel: side mounted, 45° apart
Agitator Angle in Vessel: *
Type of Agitator Mount on Vessel: Flange Mounted bolted connection
Required Opening (Nozzle) Size: *
Nozzle Rating: Nozzle Facing: *
Mounting Flange Moment: *
Mounting Flange Torque: *
Surface Finish of All SS Product Contact Parts (Ra): 20 Max, Passivate
Surface Finish of All SS Non-Product Contact Parts (Ra): 35
Ability to Withstand CIP: Required
Ability to Withstand SIP: Required
Ability to Run Dry: Required
Agitator Weight (lbs): *
Room and Height Available to Install and Remove Agitator: Yes
## MISCELLANEOUS MIXERS

### 43 22 56.01 DATA SHEET 01 - 2

#### PW/DE001/662886

**Owner:** Equip. No.: 941001-HDWK-M-250A/B

**Project No.:** 6662886

**Site:** Headworks

**Project:** OF200 Mercury Treatment Facility

**Facility Date:** 5/24/2016

**Owner:** Equip. No.: 941001-HDWK-M-250A/B

**Project:** OF200 Mercury Treatment Facility

**Facility Date:** 5/24/2016

**Site:** Headworks

## AGITATOR

### EQUIPMENT DATA SHEET

**By:** UCOR

**Items Req.:** 2

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<td>No. of Blades</td>
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- **Largest Opening Available to Install and Remove Impeller(s):** [NOTE 1]

### SHAFT COUPLING

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### DRIVE ASSEMBLY

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<td>*</td>
</tr>
<tr>
<td></td>
<td>Size:</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Type Service:</td>
<td>Reduction Ratio:</td>
</tr>
<tr>
<td></td>
<td>Rated HP:</td>
<td>* (40, min)</td>
</tr>
<tr>
<td></td>
<td>Mechanical Efficiency, %:</td>
<td>* (75, min)</td>
</tr>
<tr>
<td></td>
<td>Output Speed, RPM:</td>
<td>*</td>
</tr>
</tbody>
</table>

### BAFFLES

- **No. of Baffles:** 0
- **Baffle Type:** N/A

### VESSEL SPEC.

**Operating Volume:** 2,000,000 gallons

**Tank Dimensions:** 70' D x 75' total height

**Water depth:** 71 Ft (max)

### MATERIALS OF CONSTRUCTION

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vessel:</td>
<td>Welded Steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impeller:</td>
<td>SS316L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shaft:</td>
<td>SS316L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mtg. Flange:</td>
<td>316L SS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stuffing Box:</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seal:</td>
<td>Mechanical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elastomers:</td>
<td>*</td>
<td></td>
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<tr>
<td></td>
<td>Other Wetted Parts:</td>
<td>316L SS</td>
<td></td>
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<tr>
<td></td>
<td>Bushing:</td>
<td>*</td>
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### ELECTRICAL AND MOTOR DATA

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Service Available (V/Ph/Hz):</td>
<td>480/3/60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UL Stamp:</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Motor Manufacturer:</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HP:</td>
<td>30[NOTE 3]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RPM:</td>
<td>1750</td>
<td></td>
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<tr>
<td></td>
<td>Volts/Ph/Hz:</td>
<td>480/3/60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FLA:</td>
<td>*</td>
<td></td>
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<tr>
<td></td>
<td>Service Factor:</td>
<td>1.15</td>
<td></td>
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<tr>
<td></td>
<td>Efficiency:</td>
<td>Premium</td>
<td></td>
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<tr>
<td></td>
<td>Insul. Class:</td>
<td>Per 26 20 00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amb. Temp.:</td>
<td>40 °C</td>
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</tr>
<tr>
<td></td>
<td>NEMA Design:</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inverter Duty:</td>
<td>no</td>
<td></td>
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### MECHANICAL DATA

<p>| | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nozzle design loadings:</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Max. torque</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Max. vertical agitating force</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Weight agitator</td>
<td>1650 lb [NOTE 3]</td>
</tr>
<tr>
<td></td>
<td>Max. bending moment</td>
<td>* ft-lb</td>
</tr>
<tr>
<td></td>
<td>Weight driver</td>
<td>* lb</td>
</tr>
</tbody>
</table>

### REMARKS / NOTES

- Manufacturer to provide information.

1. For vessel dimensions refer to Section 33 16 13.13, Welded Stainless Steel Tanks, and Drawings.

2. Motors are to conform to IEEE 841.

3. Manufacturer is to check and validate this information and change if needed

4. Similar to MixTec Model 5622
**EQUALIZATION TANK MIXER**

**GENERAL**

- Service: Wastewater
- Mfr.: *
- Vessel Reference Data DWG/Spec No.: Spec 33 16 13.13
- Model: *
- Vendor to Furnish: Agitator, Drive, Motor, Starter, VFD

**PROCESS DATA**

- **PROCESS FUNCTION**
  - Blending
  - Dissolving
  - Emulsifying
  - Gas Dispersion
  - Heat Transfer
  - Suspending

- **MIXING INTENSITY**
  - Violent
  - Vigorous
  - Moderate
  - Mild

- **TYPE OF OPERATION**
  - Batch
  - Continuous:

- Smallest/Largest: N/A
- Flow Rate: 3,333 gpm (Max)
- Operating During Filling?: No
- Operating During Draw-off?: Yes
- Mixing Time Required: 150 minute hydraulic residence time

**INGREDIENTS TO BE MIXED:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Wastewater (WW)</td>
<td>500,000</td>
<td>0</td>
<td>1.00</td>
<td>1.129</td>
<td>36-87</td>
<td>7.6-8.1</td>
</tr>
</tbody>
</table>

**SOLIDS' SUSPENSION**

- TSS ~ 150 ppm, TDS ~ 300 ppm
- Characteristics and Type of Solids:
  - Soluble
  - Insoluble
  - Abrasive
  - Sticky
  - Crystalline
  - Fluffy
- Particle Size, (microns): TBD
- Settling Velocity, FPM: TBD
- Suspension Sp. Gr.: 1.0
- Solids Suspension Degree:
  - None
  - Total Uniformity
  - Moderate Uniformity
  - Slight Uniformity

**FOAMING TENDENCY:**

- None
- Slight
- Moderate
- Severe

**DESIGN DATA**

- Max. Operating Temp., °F: 100
- Max. Operating Pressure (psig): 0
- Agitator Location on Vessel: Side Mounted
- Agitator Angle in Vessel: *
- Type of Agitator Mount on Vessel: Flange Mounted, bolted connection
- Required Opening (Nozzle) Size: *
- Nozzle Rating: Nozzle Facing: *
- Mounting Flange Moment: Mounting Flange Torque: *
- Surface Finish of All SS Product Contact Parts (Ra): 20 Max, Passivate
- Surface Finish of All SS Non-Product Contact Parts (Ra): 35
- Ability to Withstand CIP: Required
- Ability to Withstand SIP: Required
- Ability to Run Dry: Required
- Agitator Weight (lbs): *
- Room and Height Available to Install and Remove Agitator: Yes
# AGITATOR EQUIPMENT DATA SHEET

## Project Details
- **Project No.**: 662886
- **Owner**: UCOR
- **Site**: MTF
- **Project**: OF200 Mercury Treatment Facility
- **Date**: 5/24/2016

## Design Data (Continued)

### Impellers

<table>
<thead>
<tr>
<th>Type</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>N/A</td>
<td>27 inches [NOTE 3]</td>
</tr>
<tr>
<td>No. of Blades</td>
<td>N/A</td>
<td>4 [NOTE 4]</td>
</tr>
<tr>
<td>Speed</td>
<td>N/A</td>
<td>Shaft speed 347 rpm; tip speed 41 fps [NOTE 3]</td>
</tr>
</tbody>
</table>

Largest Opening Available to Install and Remove Impeller(s): [NOTE 1]

### Shaft Coupling

<table>
<thead>
<tr>
<th>Type</th>
<th>Solid shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer and Model:</td>
<td>*</td>
</tr>
<tr>
<td>Shaft Length:</td>
<td>22” [NOTE 3]</td>
</tr>
<tr>
<td>Shaft Diameter:</td>
<td>*</td>
</tr>
</tbody>
</table>

### Drive Assembly

<table>
<thead>
<tr>
<th>Type</th>
<th>Single-Reduction V-Belt Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>*</td>
</tr>
<tr>
<td>Rated HP:</td>
<td>* (15, min)</td>
</tr>
<tr>
<td>Mechanical Efficiency, %:</td>
<td>* (75, min)</td>
</tr>
<tr>
<td>Output Speed, RPM:</td>
<td>* Variable RPM: NA</td>
</tr>
</tbody>
</table>

### Baffles

| No. of Baffles: | 0 |
| Baffle Type:    | N/A |

### Vessel Spec.

- **Operating Volume**: 500,000 gallons
- **Tank Dimensions**: 44’ D x 48’ total height
- **Water depth**: 44’ [NOTE 5]

### Materials of Construction

<table>
<thead>
<tr>
<th>Vessel:</th>
<th>Welded Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mtg. Flange:</td>
<td>316L SS</td>
</tr>
<tr>
<td>Mechanical Seal:</td>
<td>*</td>
</tr>
<tr>
<td>Bushing:</td>
<td>*</td>
</tr>
</tbody>
</table>

### Electrical and Motor Data

<table>
<thead>
<tr>
<th>Service Available (V/Ph/Hz):</th>
<th>480/3/60</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL Stamp: Required</td>
<td></td>
</tr>
<tr>
<td>Motor Manufacturer: *</td>
<td>Per 26 20 00</td>
</tr>
<tr>
<td>HP:</td>
<td>15</td>
</tr>
<tr>
<td>RPM:</td>
<td>1750</td>
</tr>
<tr>
<td>Enclosure:</td>
<td>TEF C</td>
</tr>
<tr>
<td>Insul. Class: Per 26 20 00</td>
<td>Amb. Temp.: 40 °C</td>
</tr>
<tr>
<td>Area Electrical Classification:</td>
<td>Non-classified</td>
</tr>
<tr>
<td>Emergency Power: None</td>
<td></td>
</tr>
<tr>
<td>Motor Type:</td>
<td>*</td>
</tr>
<tr>
<td>FLA:</td>
<td>*</td>
</tr>
<tr>
<td>NEMA Design: B</td>
<td>Inverter Duty: No</td>
</tr>
<tr>
<td>Insul. Class: Per 26 20 00</td>
<td>Motor Orientation: Horizontal</td>
</tr>
</tbody>
</table>

### Mechanical Data

<table>
<thead>
<tr>
<th>Nozzle design loadings: *</th>
<th>Max. torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. vertical agitating force</td>
<td>Weight agitator</td>
</tr>
<tr>
<td>Max. bending moment * ft-lb</td>
<td>Weight driver * lb</td>
</tr>
</tbody>
</table>

### Remarks / Notes

- * - Manufacturer to provide information.
- 1. For vessel dimensions refer to Section 33 16 13.13, Welded Stainless Steel Tanks, and Drawings
- 2. Motors are to conform to IEEE 841
- 3. Manufacturer is to check and validate this information and change if needed
- 4. Similar to Sharpe Model No. 15SV20M-5.05
- 5. Provide minimum depth that mixer can operate
**DECHLORINATION TANK MIXER**

**GENERAL**
Service: Wastewater
Mfr.: *
Vessel Reference Data DWG/Spec No.: Spec 43 40 02
Model: *
Vendor to Furnish: Agitator
Drive
Motor
Starter
VFD

**PROCESS DATA**

**PROCESS FUNCTION**
- Blending
- Dissolving
- Emulsifying
- Gas Dispersion
- Heat Transfer
- Suspending

**MIXING INTENSITY**
- Violent
- Vigorous
- Moderate
- Mild

**TYPE OF OPERATION**
- Batch:
- Continuous:

Smallest/Largest: N/A
Flow Rate: 1,667 gpm (Max)
Operating During Filling? No
Operating During Draw-off? Yes
Mixing Time Required: 5 minute hydraulic residence time

**INGREDIENTS TO BE MIXED:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Wastewater (WW)</td>
<td>9,530</td>
<td>0</td>
<td>1.00</td>
<td>1.129</td>
<td>36-87</td>
<td>7.6</td>
</tr>
<tr>
<td>2 Sodium bisulfite</td>
<td>0.5 gph</td>
<td>0</td>
<td>1.34</td>
<td>1.4</td>
<td>60</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Mixture:

**SOLIDS’ SUSPENSION**
TSS= 150 ppm, TDS = 300 ppm

Characteristics and Type of Solids:
- Soluble
- Insoluble
- Abrasive
- Sticky
- Crystalline
- Fluffy

Particle Size, (microns): TBD
Settling Velocity, FPM: TBD
Suspension Sp. Gr.: 1.0

Solids Suspension Degree:
- None
- Total Uniformity
- Moderate Uniformity
- Slight Uniformity

**FOAMING TENDENCY:**
- None
- Slight
- Moderate
- Severe

**DESIGN DATA**

Max. Operating Temp., °F: 100
Max. Operating Pressure (psig): 0
Agitator Location on Vessel: center
Agitator Angle in Vessel: *
Type of Agitator Mount on Vessel: Provide Mounting Plate
Required Opening (Nozzle) Size: *
Nozzle Rating: Nozzle Facing: *
Mounting Flange Moment: *
Mounting Flange Torque: *
Surface Finish of All SS Product Contact Parts (Ra): 20 Max, Passivate
Surface Finish of All SS Non-Product Contact Parts (Ra): 35
Ability to Withstand CIP: Required
Ability to Withstand SIP: Required
Ability to Run Dry: Required
Agitator Weight (lbs): *

Room and Height Available to Install and Remove Agitator: Yes

---

Project No.: 662886
Owner: UCOR
Project: OF200 Mercury Treatment Facility
Site: MTF
Datasheet No.: 43 2256.01 DATA SHEET 03 - 1

**AGITATOR**
EQUIPMENT DATA SHEET

By: CH2M
Items Req.: 2 (1 per tank)
**AGITATOR EQUIPMENT DATA SHEET**

**By:** CH2M

---

**IMPELLERS**

| Type: | N/A | Hydrofoil |
| Diameter: | N/A | 40 inches [NOTE 3] |
| No. of Blades: | N/A | * |
| Speed: | N/A | Shaft speed 56 rpm [NOTE 3] |

**Largest Opening Available to Install and Remove Impeller(s): [NOTE 1]**

**SHAFT COUPLING**

| Type: | * |
| Manufacturer and Model: | * |
| Shaft Length: | * |
| Shaft Diameter: | * |

**DRIVE ASSEMBLY**

| Type: | Parallel Helical Gear, electrical motor |
| Manufacturer: | * |
| Model: | * |
| Size: | * |
| Type Service: | Reduction Ratio: | * |
| Rated HP: | Maximum BHP: | * |
| Mechanical Efficiency, %: | No. of Reductions: | * |
| Output Speed, RPM: | Variable RPM: | * |

**BAFFLES**

| No. of Baffles: | 3 |
| Baffle Type: | Wall Mounted |

**VESSEL SPEC. [NOTE 1]**

| Operating Volume: 9,530 gallons |
| Tank Dimensions (2 ea.): 11’ D x 16’ total height |
| Water depth: 13.4’ |

**MATERIALS OF CONSTRUCTION**

| Vessel: | FRP |
| Impeller: | SS316L |
| Shaft: | SS316L |
| Mtg. Flange: | 316L SS |
| Stuffing Box: | * |
| Shaft Bearings: | * |
| Seal: | Vapor Seal |
| Elastomers: | * |
| Other Wetted Parts: | 316L SS |
| Bushing: | * |

**ELECTRICAL AND MOTOR DATA**

| Service Available (V/Ph/Hz): 480/3/60 |
| Area Electrical Classification: | Non-classified |
| Motor Starters: | VFD |
| UL Stamp: Required |
| Emergency Power: None |
| Motor Manufacturer: Per 26 20 00 |
| Motor Type: | * |
| HP: | 2 |
| RPM: | 1750 |
| Volts/PH/Hz: 480/3/60 |
| FLA: | * |
| Enclosure: IEEE 841 |
| Motor Frame: | * |
| Service Factor: 1.0 |
| Efficiency: Premium |
| Insul. Class: Per 26 20 00 |
| Amb. Temp.: 40 °C |
| NEMA Design: B |
| Inverter Duty: Yes |
| Environment: Outside/exposed |
| Motor Orientation: Vertical |

**MECHANICAL DATA**

| Nozzle design loadings: | * |
| Max. torque | * |
| Max. vertical agitating force | * |
| Weight agitator | 400 lb [NOTE 3] |
| Max. bending moment | * ft-lb |
| Weight driver | * lb |

**REMARKS / NOTES**

- Manufacturer to provide information.
- 1. For vessel dimensions refer to Section 43 40 02, Fiberglass Reinforced Plastic Tank, and Drawings.
- 2. Provide shaft grounding brush on the driven (shaft) end. Motors are to conform to IEEE 841.
- 3. Manufacturer is to check and validate this information and change if needed.
- 4. Similar to Sharpe Model No. 1N2V-31
**CLARIFIER POLYMER INLINE MIXER**

### GENERAL
- **Service:** Wastewater
- **Vessel Reference Data DWG/Spec No.:** Spec: 43 40 02
- **Vendor to Furnish:** Agitator
- **Drive**
- **Motor**
- **Starter**
- **VFD**

### PROCESS DATA

#### PROCESS FUNCTION
- Blending
- Dissolving
- Emulsifying
- Gas Dispersion
- Heat Transfer
- Suspending

#### MIXING INTENSITY
- Violent
- Vigorous
- Moderate
- Mild

#### TYPE OF OPERATION
- Batch
- Continuous

#### Smallest/Largest:
- Flow Rate: 1,700 gpm (Max)
- Operating During Filling: No
- Operating During Draw-off: Yes
- Mixing Time Required: Negligible hydraulic residence time

### INGREDIENTS TO BE MIXED:

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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. Wastewater (WW)</td>
<td>1,700 gpm</td>
<td>0</td>
<td>1.00</td>
<td>1.129</td>
<td>36-87</td>
<td>6.4</td>
</tr>
<tr>
<td>2. Polymer</td>
<td>0.25 gph</td>
<td>0</td>
<td>1.05</td>
<td>200</td>
<td>60</td>
<td>8</td>
</tr>
</tbody>
</table>

### SOLIDS' SUSPENSION
- **TSS – 750-3,500 ppm, TDS ~ 400 ppm**

#### Characteristics and Type of Solids:
- Soluble
- Insoluble
- Abrasive
- Sticky
- Crystalline
- Fluffy

#### Particle Size, (microns): Settling Velocity, FPM: TBD

#### Solids Suspension Degree:
- None
- Total Uniformity
- Moderate Uniformity
- Slight Uniformity

### FOAMING TENDENCY:
- None
- Slight
- Moderate
- Severe

### DESIGN DATA

| Max. Operating Temp., °F: | 100 | Max. Operating Pressure (psig): | 0 |
| Agitator Location on Vessel: | center | Agitator Angle in Vessel: | *
| Type of Agitator Mount on Vessel: | Provide Mounting Plate | Required Opening (Nozzle) Size: | *
| Nozzle Rating: | | Nozzle Facing: | *
| Mounting Flange Moment: | | Mounting Flange Torque: | *
| Surface Finish of All SS Product Contact Parts (Ra): | 20 Max, Passivate | Surface Finish of All SS Non-Product Contact Parts (Ra): | 35 |
| Ability to Withstand CIP: | Required | Ability to Withstand SIP: | Required |
| Ability to Run Dry: | Required | Agitator Weight (lbs): | *

Room and Height Available to Install and Remove Agitator: Yes
**AGITATOR EQUIPMENT DATA SHEET**

**By: CH2M**

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### DESIGN DATA (Continued)

<table>
<thead>
<tr>
<th>IMPELLERS</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>N/A</td>
<td>Hydrofoil</td>
</tr>
<tr>
<td>Diameter:</td>
<td>N/A</td>
<td>10 inches [NOTE 3]</td>
</tr>
<tr>
<td>No. of Blades:</td>
<td>N/A</td>
<td>3</td>
</tr>
<tr>
<td>Speed:</td>
<td>N/A</td>
<td>Tip speed less than 2 fps [NOTE 3]</td>
</tr>
</tbody>
</table>

Largest Opening Available to Install and Remove Impeller(s): [NOTE 1]

### SHAFT COUPLING

<table>
<thead>
<tr>
<th>Type:</th>
<th>Manufacturer and Model:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft Length:</td>
<td>* [NOTE 1]</td>
</tr>
<tr>
<td>Shaft Diameter:</td>
<td>*</td>
</tr>
</tbody>
</table>

### DRIVE ASSEMBLY

<table>
<thead>
<tr>
<th>Type:</th>
<th>Helical Gear, electrical motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model:</td>
<td>*</td>
</tr>
<tr>
<td>Type Service:</td>
<td>*</td>
</tr>
<tr>
<td>Rated HP:</td>
<td><em>(0.25, min)</em></td>
</tr>
<tr>
<td>Mechanical Efficiency, %:</td>
<td><em>(75, min)</em></td>
</tr>
<tr>
<td>Output Speed, RPM:</td>
<td>*</td>
</tr>
</tbody>
</table>

### BAFFLES

| No. of Baffles: | 0 |
| Raffle Type: | N/A |

### VESSEL SPEC.

Operating Flow Rate in Dip Tube: 1700 gpm

Inside Dimensions (2 ea.): dip tube 12-inch diameter

Water depth: NA

### MATERIALS OF CONSTRUCTION

<table>
<thead>
<tr>
<th>Vessel:</th>
<th>FRP Pipeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impeller:</td>
<td>SS316L</td>
</tr>
<tr>
<td>Shaft:</td>
<td>SS316L</td>
</tr>
<tr>
<td>Mtg. Flange:</td>
<td>316L SS</td>
</tr>
<tr>
<td>Stuffing Box:</td>
<td>*</td>
</tr>
<tr>
<td>Mechanical Seal:</td>
<td>N/A</td>
</tr>
<tr>
<td>Elastomers:</td>
<td>*</td>
</tr>
<tr>
<td>Other Wetted Parts:</td>
<td>316L SS</td>
</tr>
<tr>
<td>Bushing:</td>
<td>*</td>
</tr>
</tbody>
</table>

### ELECTRICAL AND MOTOR DATA

| Service Available (V/Ph/Hz): | 480/3/60 |
| Area Electrical Classification: | Non-classified |
| Motor Starters: | VFD |
| UL Stamp: | Required |
| Emergency Power: | None |
| Motor Manufacturer: | Per 26 20 00 |
| Motor Type: | * |
| HP: | 0.25 |
| RPM: | 1750 |
| Volts/PH/Hz: | 480/3/60 |
| FLA: | * |
| Enclosure: | TEFC |
| Motor Frame: | * |
| Service Factor: | 1.0 |
| Efficiency: | Premium |
| Insul. Class: | Per 26 20 00 |
| Amb. Temp.: | 40 °C |
| NEMA Design: | B |
| Inverter Duty: | Yes |
| Environment: | Outside/exposed |
| Motor Orientation: | Vertical |

### MECHANICAL DATA

| Nozzle design loadings: | * |
| Max. torque | * [NOTE 3] |
| Max. vertical agitating force | * [NOTE 3] |
| Weight agitator | * [NOTE 3] |
| Max. bending moment | * ft-lb |
| Weight driver | * lb |

### REMARKS / NOTES

- Manufacturer to provide information.
- For vessel dimensions refer to Section 43 40 02, Fiberglass Reinforced Plastic Tank, and Drawings.
- Provide shaft grounding brush on the driven (shaft) end. Motors are to conform to IEEE 841.
- Manufacturer is to check and validate this information and change if needed.
- Similar to Sharpe Model No. 0.25N1-25
THICKENING AID POLYMER MIXER

GENERAL
Service: Wastewater  Mfr.: *
Vessel Reference Data DWG/Spec No.: Spec 43 40 01  Model: *
Vendor to Furnish:
- Agitator
- Drive
- Motor
- Starter
- VFD

PROCESS DATA

PROCESS FUNCTION
- Blending
- Dissolving
- Emulsifying
- Gas Dispersion
- Heat Transfer
- Suspending

MIXING INTENSITY
- Violent
- Vigorous
- Moderate
- Mild

TYPE OF OPERATION
- Batch:
- Continuous:

Smallest/Largest: N/A  Flow Rate: 6 gpm (Max)
Operating During Filling?: Yes  Operating During Draw-off?: Yes
Mixing Time Required: Polymer storage for approximately 3 filter press batches

INGREDIENTS TO BE MIXED:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dilute Cationic Polymer</td>
<td>1375</td>
<td>0</td>
<td>1.03</td>
<td>600</td>
<td>50-80</td>
<td>4-6</td>
</tr>
</tbody>
</table>

Mixture:

SOLIDS’ SUSPENSION  TSS~ <5 ppm

Characteristics and Type of Solids:
- Soluble
- Insoluble
- Abrasive
- Sticky
- Crystalline
- Fluffy

Particle Size, (microns):  Settling Velocity, FPM: TBD  Suspension Sp. Gr.: 1.03

Solids Suspension Degree:
- None
- Total Uniformity
- Moderate Uniformity
- Slight Uniformity

FOAMING TENDENCY:
- None
- Slight
- Moderate
- Severe

DESIGN DATA

Max. Operating Temp., °F: 100  Max. Operating Pressure (psig): 0
Agitator Location on Vessel: *  Agitator Angle in Vessel: *
Type of Agitator Mount on Vessel: Clamp Mounted  Required Opening (Nozzle) Size: *
Nozzle Rating: *  Nozzle Facing: *
Mounting Flange Moment: *  Mounting Flange Torque: *
Surface Finish of All SS Product Contact Parts (Ra): 20 Max, Passivate  Surface Finish of All SS Non-Product Contact Parts (Ra): 35
Ability to Withstand CIP: Required  Ability to Withstand SIP: Required
Ability to Run Dry: Required  Agitator Weight (lbs): *
Room and Height Available to Install and Remove Agitator: Yes
### AGITATOR

#### EQUIPMENT DATA SHEET

**By:** CH2M

---

### IMPELLERS

<table>
<thead>
<tr>
<th>Type</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter:</td>
<td>N/A</td>
<td>16.5 inches [NOTE 3]</td>
</tr>
<tr>
<td>No. of Blades:</td>
<td>N/A</td>
<td>*</td>
</tr>
<tr>
<td>Speed:</td>
<td>N/A</td>
<td>Shaft speed 350 rpm[NOTE 3]</td>
</tr>
</tbody>
</table>

Largest Opening Available to Install and Remove Impeller(s): [NOTE 1]

### SHAFT COUPLING

| Type: | * |
| Manufacturer and Model: | * |
| Shaft Length: | * |
| Shaft Diameter: | * |

### DRIVE ASSEMBLY

| Type: | Single-Reduction Helical Gear, electrical motor |
| Manufacturer: | * |
| Model: | * |
| Size: | * |
| Type Service: | Reduction Ratio: | * |
| Rated HP: | * (1.5, min) | Maximum BHP: | * |
| Mechanical Efficiency, %: | * (75, min) | No. of Reductions: | * |
| Output Speed, RPM: | * | Variable RPM: | * |

### BAFFLES

| No. of Baffles: | NA |
| Baffle Type: | NA |

### VESSEL SPEC. [NOTE 1]

- Operating Volume: 1375 gallons
- Tank Dimensions: 6’1” D x 8’6” total height
- Water depth: 7’6”

### MATERIALS OF CONSTRUCTION

- Vessel: PE or HDPE
- Impeller: SS316L
- Shaft: SS316L
- Mtg. Flange: 316L SS
- Stuffing Box: *
- Shaft Bearings: *
- Seal: Viton Lip Seal
- Elastomers: *
- Other Wetted Parts: 316L SS
- Bushing: *

### ELECTRICAL AND MOTOR DATA

- UL Stamp: Required
- Service Available (V/Ph/Hz): 480/3/60
- Area Electrical Classification: Non-classified
- Motor Starters: Full Voltage
- Motor Manufacturer: Per 26 20 00
- HP: 1.5
- RPM: 1750
- Volts/PH/Hz: 480/3/60
- FLA: *
- Motor Type: *
- Efficiency: Premium
- Insul. Class: Per 26 20 00
- Amb. Temp.: 40 °C
- NEMA Design: B
- Inverter Duty: Yes

### MECHANICAL DATA

- Nozzle design loadings: *
- Max. torque: *
- Max. vertical agitating force: *
- Weight agitator: 105 lb [NOTE 3]
- Max. bending moment: * ft-lb
- Weight driver: *
- Motor Orientation: Vertical

### REMARKS / NOTES

- Manufacturer to provide information.
- For vessel dimensions refer to Section 43 40 02, Fiberglass Reinforced Plastic Tank, and Drawings.
- Provide shaft grounding brush on the driven (shaft) end. Motors are to conform to IEEE 841.
- Manufacturer is to check and validate this information and change if needed.
- Similar to Sharpe Model No. G-150
**Specification Title & Description:** (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Vertical Hyperboloid Mixers

**Revision History:**

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

**Document Review & Approval:**

**Originator:**
Karen M. Leber, PE/Process Lead Engineer

**Design Verification Complete:**
Mark Davis/Senior Technical Consultant

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager
PART 1 GENERAL

1.01 SUMMARY

A. Comply with Section 01 61 00, Common Product Requirements, and Basic Electrical Requirements.

B. This section covers the Work necessary to provide vertical hyperboloid mixers for low shear mixing and appurtenant work described herein.

C. The manufacturer shall provide all of the equipment components specified herein to enhance compatibility, and ease of operation and maintenance. The Contractor shall install the components according to the manufacturer’s instructions.

D. Mixer components shall be supplied by a single manufacturer to assure single source responsibility for the performance of the system. The manufacturer shall assume complete responsibility for conformance of the Mixers with this Specification.

E. The manufacturer shall coordinate all facets of this Project with the Contractor to ensure compliance with the Specifications and compliance with required performance. All facets include structural, mechanical, electrical, and instrumentation.

1.02 SYSTEM DESCRIPTION

A. Vertical hyperboloid mixers including:

1. Impellers.
2. Shaft and pinions.
3. Couplings.
4. Housings.
5. Lifting lugs.
7. Inverter Duty Motors
8. Over temperature controls for equipment protection.
1.03 SUBMITTALS

A. Action Submittals:

1. Complete specifications, dimensional drawings, and descriptive literature on the mixers and their accessories to be furnished, including:
   a. Vertical loads, bending moments, and torque.
   b. Shaft sizing calculations, impeller style and dimensions, motor HP rating.
2. Certified performance curves that show efficiency, speed range, and brake horsepower.

B. Informational Submittals:

1. Manufacturer’s literature and catalog data, including assembly and installation instructions.
2. Operations and Maintenance Manual and Data as specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer’s Certificate of Proper Installation per Section 01 43 33, Manufacturer’s Field Services.
4. Recommended Spare Parts List.

PART 2 PRODUCTS

2.01 EQUIPMENT AND TAG NUMBERS

A. Polymer/Iron Coprecipitation Tank Mixers: 941002-CHTR-M-420-A/B.
B. Flocculation Tank Mixers: 941002-CHTR-M-430-A/B.

2.02 ACCEPTABLE MANUFACTURERS

A. Invent.
B. Substitutions: Must be approved by Engineer.

2.03 DESIGN AND SERVICES CONDITIONS

A. Comply with attached Equipment Data Sheets.

2.04 GENERAL REQUIREMENTS

A. Materials: Fabricate equipment using appropriate materials for wastewater containing ferric hydroxide precipitant with TDS concentrations near 400 mg/L, such as FRP or Type 304 stainless steel.
B. Agitator Design:

1. Comply with attached Equipment Data Sheets and Mechanical Drawings.
2. Construct system for optimum accessibility and safety during operation and routine maintenance work.
3. Provide complete agitator system, integrated with motor gear drive, shaft, and mixer body.
4. Comply with AGMA or DIN standards for gears with a service factor of 2.0 or better and design for 24-hour operation.
5. Gear reducer and motor in one assembly.
6. Provide bearings with minimum L10 life of 100,000 hours. Adequately seal bearings to prevent contamination or loss of lubricant during testing and operation.
7. Provide positive gear and bearing lubrication. Provide a means of lubricant level verification.
8. Connect shaft and drive using a hollow shaft.
9. Design shaft so that critical speed is at or above 125 percent of maximum speed. Provide shaft which is stable at high speed in free air or in liquid with tank level varying between empty and full, including liquid level at impeller level.
10. Provide OSHA approved removable guards for rotating parts.
11. Match mark components for assembly and provide means to retain accuracy of alignment during reassembly.
12. Provide lugs or lifting supports required to install equipment.
13. Design agitators to facilitate ready access for replacement of wear parts.
14. Provide special materials required to install agitators.
15. Design agitator system to protect personnel from injury, accommodate safe access during maintenance, and facilitate cleaning.
16. Provide silencing equipment necessary to limit noise level to 85 dB at distance of 3 feet.
17. Provide oil or grease lubricated bearings. Provide easily accessible external grease fittings.

C. Motors:

1. Comply with attached Equipment Data Sheets.
2. Provide electrical equipment suitable for specified service conditions stated on the Equipment Data Sheets and conform to NEC and efficiency according to NEMA. Provide IEEE 841 inverter duty motors.
3. Provide UL listed motors.

2.05 FABRICATION/SHOP ASSEMBLY

A. Painting: Non-wetted equipment shall meet requirements of Section 09 90 00, Painting and Coating, System No. 4.
PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s written instructions and as shown on the Drawings.

3.02 MANUFACTURER’S FIELD SERVICES

A. Provide manufacturer’s representative at site for 2 person-days for installation assistance, inspection, testing, and certification of proper installation and 2 person-days for startup assistance.

3.03 SUPPLEMENTS

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

1. Flocculation Tank Mixer Equipment Data Sheet.
2. Polymer and Iron Coprecipitation Reaction Tank Mixer Equipment Data Sheet.

END OF SECTION
### Flocculation Tank Mixer

**EQUIPMENT DATA SHEET**

**Project No.: 662886**  
**Owner: UCOR**  
**Project: OF200 Mercury Treatment Facility**  
**Site: MTF**  
**Datasheet No.:**  
**Equip. No.: 941002-CHTR-M-430-A/B**  
**Date: 5/24/2016**  
**By: CH2M**  
**Items Req.: 2**

**GENERAL**

- **Service:** Wastewater  
- **Mfr.:** *  
- **Vendor to Furnish:** Agitator, Drive, Motor, Starter, VFD

**PROCESS DATA**

**PROCESS FUNCTION**

- **Blending**  
- **Dissolving**  
- **Emulsifying**  
- **Gas Dispersion**  
- **Heat Transfer**  
- **Suspending**

**MIXING INTENSITY**

- **Violent**  
- **Vigorous**  
- **Moderate**  
- **Mild**

**TYPE OF OPERATION**

- **Batch:** ✓  
- **Continuous:** ¶

**Smallest/Largest:** N/A  
**Flow Rate:** 1,700 gpm (Max)

**Operating During Filling?** No  
**Operating During Draw-off?** Yes

**Mixing Time Required:** Minimum of 9 minute hydraulic residence time

**INGREDIENTS TO BE MIXED:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wastewater (WW)</td>
<td>17,080</td>
<td>0</td>
<td>1.00</td>
<td>1.129</td>
<td>36-87</td>
<td>6.4</td>
</tr>
<tr>
<td>Mixture:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOLIDS' SUSPENSION**

- **TSS maximum 3,500 ppm, TDS ~ 400 ppm**

**Characteristics and Type of Solids:**

- **Soluble**  
- **Insoluble**  
- **Abrasive**  
- **Sticky**  
- **Crystalline**  
- **Fluffy**

**Particle Size, (microns):** Settling Velocity, FPM: TBD  
**Suspension Sp. Gr.:** 1.0

**Solids Suspension Degree:**

- **None**  
- **Total Uniformity**  
- **Moderate Uniformity**  
- **Slight Uniformity**

**FOAMING TENDENCY:**

- **None**  
- **Slight**  
- **Moderate**  
- **Severe**

**DESIGN DATA**

<table>
<thead>
<tr>
<th>Max. Operating Temp., °F:</th>
<th>100</th>
<th>Max. Operating Pressure (psig):</th>
<th>0</th>
</tr>
</thead>
</table>
| Agitator Location on Vessel: | center | Agitator Angle in Vessel: | *
| Type of Agitator Mount on Vessel: | Plate mounted bolted connection | Required Opening (Nozzle) Size: | *
| Nozzle Rating: | Nozzle Facing: | * |
| Mounting Flange Moment: | * | Mounting Flange Torque: | *
| Surface Finish of All SS Product Contact Parts (Ra): | 20 Max, Passivate | Surface Finish of All SS Non-Product Contact Parts (Ra): | 35 |
| Ability to Withstand CIP: | Required | Ability to Withstand SIP: | Required |
| Ability to Run Dry: | Required | Agitator Weight (lbs): | * |

**Room and Height Available to Install and Remove Agitator:** Yes
### IMPELLERS (Continued)

<table>
<thead>
<tr>
<th>Component</th>
<th>Upper</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>N/A</td>
<td>Hyperboloid</td>
</tr>
<tr>
<td>Diameter</td>
<td>N/A</td>
<td>78.7 inches [NOTE 4]</td>
</tr>
<tr>
<td>No. of Blades</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>Speed (RPM)</td>
<td>N/A</td>
<td>10.4 (low tip speed, minimum ≤ 2 fps, maximum 6 fps) [NOTE 4]</td>
</tr>
</tbody>
</table>

Largest Opening Available to Install and Remove Impeller(s): [NOTE 1]

### SHAFT COUPLING

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Hollow shaft, feather key connector</td>
</tr>
<tr>
<td>Manufacturer and Model</td>
<td>*</td>
</tr>
<tr>
<td>Shaft Length</td>
<td>*</td>
</tr>
<tr>
<td>Shaft Diameter</td>
<td>4.5 inches [NOTE 4]</td>
</tr>
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</table>

### DRIVE ASSEMBLY

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Helical Gear, electrical motor</td>
</tr>
<tr>
<td>Model</td>
<td>*</td>
</tr>
<tr>
<td>Type Service</td>
<td>Reduction Ratio:</td>
</tr>
<tr>
<td>Rated HP</td>
<td>* (1.0, min)</td>
</tr>
<tr>
<td>Mechanical Efficiency, %</td>
<td>* (75, min)</td>
</tr>
<tr>
<td>Output Speed, RPM</td>
<td>*</td>
</tr>
</tbody>
</table>

### BAFFLES

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Baffles</td>
<td>3</td>
</tr>
<tr>
<td>Baffle Type</td>
<td>Wall Mounted</td>
</tr>
</tbody>
</table>

### VESSEL SPEC.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Volume</td>
<td>17,080 gallons</td>
</tr>
<tr>
<td>Inside Dimensions (2 ea.): Diameter</td>
<td>15.5 ft</td>
</tr>
<tr>
<td>Inside Dimensions (2 ea.): Height</td>
<td>16 ft</td>
</tr>
<tr>
<td>Water depth</td>
<td>12.1 ft</td>
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### MATERIALS OF CONSTRUCTION

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel</td>
<td>FRP open top</td>
</tr>
<tr>
<td>Mtg. Flange</td>
<td>316L SS</td>
</tr>
<tr>
<td>Impeller</td>
<td>FRP (*Type)</td>
</tr>
<tr>
<td>Stuffing Box</td>
<td>*</td>
</tr>
<tr>
<td>Mechanical Seal</td>
<td>N/A</td>
</tr>
<tr>
<td>Elastomers</td>
<td>*</td>
</tr>
<tr>
<td>Other Wetted Parts</td>
<td>316L SS</td>
</tr>
<tr>
<td>Bushing</td>
<td>*</td>
</tr>
</tbody>
</table>

### ELECTRICAL AND MOTOR DATA

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Available (V/Ph/Hz)</td>
<td>460/3/60</td>
</tr>
<tr>
<td>UL Stamp</td>
<td>Required</td>
</tr>
<tr>
<td>Motor Manufacturer</td>
<td>Per 26 20 00</td>
</tr>
<tr>
<td>HP: Motor Type</td>
<td>*</td>
</tr>
<tr>
<td>Enclosure</td>
<td>IEEE 841</td>
</tr>
<tr>
<td>Insul. Class</td>
<td>Per 26 20 00</td>
</tr>
<tr>
<td>Amb. Temp.</td>
<td>40 °C</td>
</tr>
<tr>
<td>Area Electrical Classification</td>
<td>Non-classified</td>
</tr>
<tr>
<td>Motor Starters</td>
<td>VFD</td>
</tr>
<tr>
<td>Emergency Power</td>
<td>None</td>
</tr>
<tr>
<td>Service Factor</td>
<td>1.0</td>
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<tr>
<td>Inverter Duty</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nozzle design loadings</td>
<td>*</td>
</tr>
<tr>
<td>Max. torque</td>
<td>12,492 in-lb [NOTE 4]</td>
</tr>
<tr>
<td>Max. vertical agitating force</td>
<td>463 lb-force [NOTE 4]</td>
</tr>
<tr>
<td>Weight agitator</td>
<td>463 lb [NOTE 4]</td>
</tr>
<tr>
<td>Max. bending moment</td>
<td>* ft-lb</td>
</tr>
<tr>
<td>Weight driver</td>
<td>* lb</td>
</tr>
</tbody>
</table>

### REMARKS / NOTES

* - Manufacturer to provide information.

1. For vessel dimensions refer to Section 43 40 02, Fiberglass Reinforced Plastic Tank, and Drawings.
2. Provide shaft grounding brush on the driven (shaft) end. Motors are to conform to IEEE 841
3. Provide motor space heaters
4. Manufacturer is to check and validate this information and change if needed
5. Similar to Invent Model HCM/2000-18-1.00 hp
**Polymer and Iron Coprecip Reaction Tank Mixer**

**GENERAL**

- **Service:** Wastewater
- **Vessel Reference Data DWG/Spec No.:** Spec 43 40 02
- **Vendor to Furnish:** Agitator, Drive, Motor, Starter, VFD

**PROCESS DATA**

**PROCESS FUNCTION**

- Blending
- Dissolving
- Emulsifying
- Gas Dispersion
- Heat Transfer
- Suspending

**MIXING INTENSITY**

- Violent
- Vigorous
- Moderate
- Mild

**TYPE OF OPERATION**

- Batch: Continuous
- Smallest/Largest: N/A
- Operating During Filling? No
- Operating During Draw-off? Yes
- Mixing Time Required: Minimum of 9 minute hydraulic residence time

**INGREDIENTS TO BE MIXED**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Wastewater (WW)</td>
<td>18,630</td>
<td>0</td>
<td>1.00</td>
<td>1.129</td>
<td>36-87</td>
</tr>
<tr>
<td>2 40% Ferric Chloride</td>
<td>2.2-17.3 gph</td>
<td>0</td>
<td>1.42</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>4 Organosulfide</td>
<td>0.9-2.1 gph</td>
<td>0</td>
<td>1.15</td>
<td>10.3</td>
<td>60</td>
</tr>
<tr>
<td>5 Sludge Recycle</td>
<td>75-195 gpm</td>
<td>1.03</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**SOLIDS’ SUSPENSION**

- TSS maximum 3,500 ppm, TDS ~ 400 ppm

**Characteristics and Type of Solids:**

- Soluble
- Insoluble
- Abrasive
- Sticky
- Crystalline
- Fluffy

**Solids Suspension Degree:**

- None
- Total Uniformity
- Moderate Uniformity
- Slight Uniformity

**FOAMING TENDENCY:**

- None
- Slight
- Moderate
- Severe

**DESIGN DATA**

- Max. Operating Temp., °F: 100
- Max. Operating Pressure (psig): 0
- Agitator Location on Vessel: Center
- Agitator Angle in Vessel: *
- Type of Agitator Mount on Vessel: Plate mounted bolted connection
- Required Opening (Nozzle) Size: *
- Nozzle Rating: *
- Nozzle Facing: *
- Mounting Flange Moment: *
- Mounting Flange Torque: *
- Surface Finish of All SS Product Contact Parts (Ra): 20 Max, Passivate
- Surface Finish of All SS Non-Product Contact Parts (Ra): 35
- Ability to Withstand CIP: Required
- Ability to Withstand SIP: Required
- Ability to Run Dry: Required
- Agitator Weight (lbs): *
- Room and Height Available to Install and Remove Agitator: Yes

**IMPELLERS (Continued)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>78.7 inches [NOTE 4]</td>
</tr>
</tbody>
</table>
# AGITATOR

## EQUIPMENT DATA SHEET

**By:** CH2M  
**Items Req.:** 2

<table>
<thead>
<tr>
<th>No. of Blades:</th>
<th>N/A</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (RPM):</td>
<td>N/A</td>
<td>10.4 (low tip speed, minimum ≤ 2 fps, maximum 6fps) [NOTE 4]</td>
</tr>
</tbody>
</table>

**Largest Opening Available to Install and Remove Impeller(s):** [NOTE 1]

## SHAFT COUPLING

<table>
<thead>
<tr>
<th>Type: Hollow shaft, feather key connector</th>
<th>Manufacturer and Model: *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft Length: *</td>
<td>Shaft Diameter: 4.5 inches [NOTE 4]</td>
</tr>
</tbody>
</table>

## DRIVE ASSEMBLY

<table>
<thead>
<tr>
<th>Type: Helical Gear, electrical motor</th>
<th>Manufacturer: *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model: *</td>
<td>Size: *</td>
</tr>
<tr>
<td>Type Service:</td>
<td>Reduction Ratio: *</td>
</tr>
<tr>
<td>Rated HP: * (1.0, min)</td>
<td>Maximum BHP: *</td>
</tr>
<tr>
<td>Mechanical Efficiency, %: * (75, min)</td>
<td>No. of Reductions: *</td>
</tr>
<tr>
<td>Output Speed, RPM: *</td>
<td>Variable RPM: *</td>
</tr>
</tbody>
</table>

## BAFFLES

<table>
<thead>
<tr>
<th>No. of Baffles:</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raffle Type:</td>
<td>Wall Mounted</td>
</tr>
</tbody>
</table>

## VESSEL SPEC.  [NOTE 1]

| Operating Volume: 18,630 gallons | Inside Dimensions (2 ea.): 15.5 ft diam. 16ft” wall height | Water depth: 13.2ft |

## MATERIALS OF CONSTRUCTION

<table>
<thead>
<tr>
<th>Vessel: FRP open top</th>
<th>Impeller: FRP (* Type)</th>
<th>Shaft: FRP (* Type)</th>
<th>Shaft Bearings: *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mtg. Flange: 316L SS</td>
<td>Stuffing Box: *</td>
<td>Mechanical Seal: N/A</td>
<td>Elastomers: *</td>
</tr>
<tr>
<td>Mechanical Seal: N/A</td>
<td>Other Wetted Parts: 316L SS</td>
<td>Bushing: *</td>
<td></td>
</tr>
</tbody>
</table>

## ELECTRICAL AND MOTOR DATA

<table>
<thead>
<tr>
<th>Service Available (V/Ph/Hz): 460/3/60</th>
<th>Area Electrical Classification: Non-classified</th>
<th>Motor Starters: VFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL Stamp: Required</td>
<td>Emergency Power: None</td>
<td></td>
</tr>
<tr>
<td>Motor Manufacturer: Per 26 20 00</td>
<td>Motor Type: *</td>
<td></td>
</tr>
<tr>
<td>HP: *</td>
<td>RPM: *</td>
<td>Volts/Ph/Hz: 460/3/60</td>
</tr>
<tr>
<td>Enclosure: IEEE 841</td>
<td>Motor Frame: *</td>
<td>Service Factor: 1.0</td>
</tr>
<tr>
<td>Insul. Class: Per 26 20 00</td>
<td>Amb. Temp.: 40 °C</td>
<td>NEMA Design: B</td>
</tr>
<tr>
<td>Environment: Outside/exposed</td>
<td>Motor Orientation: Vertical</td>
<td></td>
</tr>
</tbody>
</table>

## MECHANICAL DATA

| Nozzle design loadings: | Max. torque | 12,492 in-lb [NOTE 4] |
| Max. bending moment | ft-lb | Weight driver: * lb |

**REMARKS / NOTES**

* - Manufacturer to provide information.
1. For vessel dimensions refer to Section 43 40 02, Fiberglass Reinforced Plastic Tank, and Drawings
2. Provide shaft grounding brush on the driven (shaft) end. Motors are to conform to IEEE 841
3. Provide motor space heaters
4. Manufacturer is to check and validate this information and change if needed
5. Similar to Invent Model HCM/2000-18-1.00 hp
Polyethylene Storage Tank
SECTION 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers the work necessary to furnish and install bulk chemical storage tanks for sodium hydroxide, sodium hypochlorite, and hydrofluosilicic acid.

1.02 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   b. B-16.5, Pipe Flanges and Flanged Fittings.
3. ASTM International (ASTM):
   d. D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   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.
   l. D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   m. D1940, Method of Test for Porosity of Rigid Cellular Plastics.
1.03 DEFINITIONS

A. XLHDPE: Cross-linked high-density polyethylene.

1.04 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 Underwriters Laboratories Listing for Nonmetallic Aboveground Tanks for Chemicals.

1.05 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 anchor and support systems. Both plan and elevation views shall be provided. All piping terminal points shall be clearly shown and fully dimensioned. Details for manways, vents and flexible connectors shall be provided.
      c. Tank and fitting materials:
         1) Resin manufacturer’s data sheet for resin used for each tank and all supporting specifications for resins.
         2) Fitting materials.
         3) Gasket style and material.
         4) Bolting material.
      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. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.
      f. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
g. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.

h. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a listing of procedures used in testing.

i. 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.

j. 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 upon request.

B. Informational Submittals:

1. Complete design calculations for tanks, supports and appropriate accessories sealed by a professional engineer, registered in the State of Tennessee. Diagrams and calculations shall be provided that indicate all static and dynamic loads. Reactions (uplift, shear, gravity loads, etc.) shall be indicated for each of the applicable loading combinations. Calculations for anchor bolt type, size, and location shall be indicated for the controlling load condition.

2. Fabricator’s Certificate of Compliance with fabrication requirements.

3. Quality Assurance Inspection:

4. Special shipping, storage and protection, and handling instructions.

5. Fabricator’s written/printed unloading, installation, and tank support instructions.

6. Manufacturer’s Certificate of Proper Installation.

7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

8. Manufacturer’s warranty.

1.06 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 (i.e., ISO9001).
1.07 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 the 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.

1.08 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 equal.

2.03 SERVICE CONDITIONS
A. Location: Indoors.
B. Ambient Air Temperature Range: 55 to 86 degrees F.
C. Relative Humidity: Up to 80 percent.
D. Operating Pressure: Atmospheric.
E. Stored Materials:

<table>
<thead>
<tr>
<th>Stored Materials</th>
<th>Chemical</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickening Aid Polymer</td>
<td>BASF Zetag 8844FS, 0.5% solution</td>
<td>1.0</td>
</tr>
</tbody>
</table>

2.04 TANK DESIGN CRITERIA
A. Seismic: See Section 01 66 00, Common Product Requirements.
B. Live Load: N/A
C. Concentrated Load: N/A.
D. Special Loads: Design tanks for dead loads from all attached piping.
E. Hydrostatic Load: For specific gravities of stored materials specified herein. Tanks shall be designed to withstand the hydrostatic pressure resulting from a full tank.

2.05 TANK CONSTRUCTION
A. Tanks specified herein shall be cross linked high-density polyethylene construction and shall meet or exceed all requirements of ASTM D1998.
B. Tanks shall be vertical, flat bottom, open top construction with translucent materials to allow observation of liquid level.

C. The tank shall be supplied with one overflow connection and two discharge connections located 60 degrees apart and centered opposite from the overflow connection.

D. Tank shall be supplied with a freestanding mixer support for a Sharp Mixer model G-150 clamp-mount portable mixer or similar mixer.

E. 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.

F. The XLHDPE tanks shall be constructed using the rotational molding process.

G. Tanks shall be fabricated to the dimensions shown on the Drawings and as listed in the Tank Schedule:

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Minimum Capacity</th>
<th>Maximum Diameter*</th>
<th>Sidewall Height*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM-T-513, Thickening Aid Polymer Day Tank</td>
<td>1,800 gal</td>
<td>6’-1”</td>
<td>8’-6”</td>
</tr>
</tbody>
</table>

*Tank sizes are nominal sizes.

H. Materials shall meet or exceed the following properties:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ASTM Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>D1505</td>
<td>0.944-0.946 gm/cc</td>
</tr>
<tr>
<td>Environmental Stress, Cracking Resistance (F50)</td>
<td>D1693</td>
<td>1,000 hrs</td>
</tr>
<tr>
<td>Tensile Strength, Ultimate (2” min.)</td>
<td>D638</td>
<td>2,600-3,000 psi</td>
</tr>
<tr>
<td>Elongation at Break (2” min.)</td>
<td>D638</td>
<td>400%</td>
</tr>
<tr>
<td>Vicat Softening Point</td>
<td>D1525</td>
<td>240 degrees F</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>D790</td>
<td>100,000 psi</td>
</tr>
<tr>
<td>Brittleness Temperature</td>
<td>D746</td>
<td>-130 degrees F</td>
</tr>
<tr>
<td>Heat Distortion Temp</td>
<td>D648</td>
<td>67 degrees C</td>
</tr>
<tr>
<td>Polyethylene Notch Test (PENT)</td>
<td>F1473</td>
<td>&gt;1,000 hours</td>
</tr>
</tbody>
</table>
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 seismic restraints, complete with plate, anchor bolts, nuts, and washers for proper anchoring of the tank. Actual number of restraints 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 the Drawings.

<table>
<thead>
<tr>
<th>Fitting/Opening Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
</tr>
<tr>
<td>(1) each, Overflow</td>
</tr>
<tr>
<td>(2) each, Discharge</td>
</tr>
<tr>
<td>(1) each, Drain</td>
</tr>
</tbody>
</table>

B. Provide one 2-inch molded overflow connection located 6 inches below the top of tank with an overflow line extending down the outside of the tank. The overflow pipe shall be supported from the tank.

C. Provide two flanged discharge connections located 60 degrees apart and centered opposite of the overflow connection. fill pipe drop leg inside tank connecting to fill connection.

D. Provide one 2-inch flanged drain connection.

E. Fittings shall be CPVC 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.

F. All flanged fittings shall be gasketed with materials compatible with the chemical service.

G. Bolted fittings shall use Type 316 stainless steel bolts and CPVC external flanges.

H. 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 Type 316 stainless steel 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. Flexible Expansion Joints: 100 percent virgin PTFE flexible expansion joint with a minimum of three convolutions, stainless steel limit cables and FRP composite flanges, Type 316 stainless steel bolts, Viton gaskets, meeting the tank manufacturer’s flexibility requirements, Poly Processing Flexijoint or equivalent.

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 Job Site and/or 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 SUPPLEMENTS

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


END OF SECTION
Fiberglass Reinforced Plastic 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):
         b. RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment.

      2. ASTM International (ASTM):

1.02 DEFINITIONS

   A. FRP: Fiberglass reinforced plastic.

1.03 DESIGN REQUIREMENTS

   A. Design Loads: In accordance with Section 01 61 00, Common Product Requirements.

   B. Tanks specified to be fabricated to ASME RTP-1 requirements shall be designed, fabricated, and code stamped. ASME RTP-1 shall be all inclusive for tanks so specified.

   C. The User’s Basic Requirements Specification (UBRS) for RTP-1 tanks is a part of this Specification.

   D. Design tank, including resin selection (unless specified), wall thickness, methods and locations of support, and stiffener requirements. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.
E. Coordinate with manufacturer of mixers and other equipment to be installed in tank to ensure tank baffle design and support design are suitable for use with mixers and other equipment actually being supplied. Secure the following:

1. Manufacturer drawings of required mixer and other equipment supports.
2. Description of tank modifications required by mixer and other equipment manufacturer to optimize mixing.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fabricators catalog information, descriptive literature, specifications, and identification of materials of construction, including complete resin system information.
   b. Letter from resin manufacturer stating that selected resin is suitable for intended service.
   c. Detailed fabrication drawings.
   d. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.
   e. Tank capacity chart indicating gallons of volume for each 6 inches of depth and cumulative total from bottom.
   f. Fabricator’s detailed requirements for tank foundations.
   g. Recommended bolt torque for bolted FRP connections.
   h. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
   i. Description of insulation and exterior weather barriers.
   j. Pad-type tank heaters and insulation design and details including complete catalog information, wiring diagrams, RTD information, and selection criteria for the pad-type tank heaters and RTDs.

2. Samples: Laminate sample representative of production quality of surface finish and visual imperfections.

B. Informational Submittals:

1. Complete design calculations for tanks, supports appropriate accessories.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Complete calculations for pad-type tank heaters and RTDs.
4. Certification to ASME RTP-1.
5. Fabricator’s Certificate of Compliance with fabrication requirements.
7. Copy of fabricator’s Quality Assurance Program.
8. Quality Assurance Inspection:
   b. Initial QA Inspection Report.
9. Certification that equipment supports, tank baffle design, and access nozzles have been coordinated with actual equipment being furnished.
10. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
11. Special shipping, storage and protection, and handling instructions.
12. Fabricator’s printed installation and tank support instructions.
13. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

C. Contract Closeout Submittals: Service records for repairs performed during construction.

1.05 QUALITY ASSURANCE

A. Fabricator’s Quality Assurance Supervisor: Minimum of 5 years’ experience in fabrication of fiberglass structures.

B. Designer: Registered professional engineer licensed in the state of Tennessee.

C. Independent FRP Quality Assurance Inspector:
   1. Minimum 5 years’ experience as FRP inspector.
   2. Representing a corporately and financially independent organization that can function as an unbiased inspection authority.
   3. Professionally independent of manufacturers, suppliers, and installers of systems being inspected.

D. Acoustic Emission Testing Agency: Minimum 5 years’ experience in acoustic emission testing of fiberglass structures.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements. In addition, prepare and protect tank for shipment as follows:
   1. Mount tank on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
   2. Protect flanged nozzles with wooden blinds bolted to flange and having a diameter of 2 inches greater than outside diameter of flange.
3. Provide either rigid plugs inside ends to prevent deflection or wooden boxes for unflanged components. Brace open end of tank with suitable stiffening member to prevent deflection.
4. Do not ship components or other pieces loose inside tank.
5. Load tank with at least 2 inches of clearance between tank (including fittings) and bulkheads, or bed of vehicle.
6. Regardless of mode of transportation, firmly fasten and pad components to prevent shifting of load or flexing of components while in transit.

1.07 SEQUENCING AND SCHEDULING
A. Do not ship tank from factory until Engineer’s review of Certification of Factory Testing is completed.

PART 2 PRODUCTS

2.01 SUPPLEMENTS
A. Some specific requirements relative to this section are attached as supplements at the end of section.

2.02 SERVICE CONDITIONS
A. As specified on User’s Basic Requirements Specification (UBRS) attached as supplement at the end of this section.

2.03 MATERIALS
A. Filament-Wound: Fabricate in accordance with ASTM D3299, Type I, Grade 1 and ASME RTP-1.

B. Resin:
1. Suitable for intended service as identified on tank datasheets.
2. Premium grade and corrosion resistant, such as chlorendic polyester, vinyl ester, or bisphenol A fumarate polyester.
3. Use same resin throughout entire tank shell.
4. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
5. No dyes, pigments, or colorants, except in exterior gel coat.
6. No fillers or thixotropic agents.
7. Additives may be added to achieve fire retardancy. The Flame-Spread Rating of finish laminate shall be less than 25, as determined by ASTM E84. Additives shall not be added to interior layer, unless specifically required.
8. Curing System:
   a. As recommended by resin manufacturer or as specified herein.
   b. Cure products as specified in ASTM D3299 and ASME RTP-1.
   c. Measure Barcol hardness according to ASTM D2583.

9. Post-cure tank and appurtenances in accordance with resin manufacturer’s recommendation for time and temperature. Post-curing should be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.

C. Reinforcements:

1. Surfacing Veil: Chemical surfacing mat, Type C (chemical) glass, 10 mils thick, with a finish and a binder compatible with the lay-up resin.

2. Other Reinforcements: In accordance with ASTM D3299 and ASME RTP-1.

D. Laminate:

1. Consists of inner surface (corrosion barrier), interior layer, and exterior layer (structural layer).

2. Meet visual acceptance criteria in ASME RTP-1.

3. Meet requirements of mechanical properties in ASME RTP-1.

4. Reinforce inner surface with resin-rich surfacing veil as specified herein.

5. Apply a white color coat after inspection of laminate has been completed.

E. Marking:

1. Identify each tank with fabricator’s name, capacity in gallons, maximum temperature, design pressure/vacuum, specific gravity, pH, resin, minimum thickness, tank number, tank name, and date of manufacture.

2. Provide permanent marking. Seal decals, labels, etc., into laminate exterior with clear resin.

3. Calibration Strips (required for tank CHEM-T-520 only):
   a. Translucent, 6 inches wide.
   b. Calibration: Multiples of 100 gallons or less.
   c. Stencil gallonage in 2-inch-high numerals.

F. Nozzles:

1. Gusset 4-inch or smaller nozzles with conical or plate type gussets. Larger nozzles shall be gusseted, if noted.

2. Finish flush with inside surface of tank, unless otherwise indicated.
3. Gaskets:
   a. Provide two per nozzle, 1/8-inch-thick, full-face elastomeric material having a hardness of Shore A60 plus or minus 5.
   b. Material shall be suitable for intended service.
   c. Provide two gaskets for all manways and blind flanges.

4. Flanged Nozzles: Rated at 100 psi, with other dimensions and bolting corresponding to ASME B16.5 for Class 150 steel flanges.

5. Back face of flanges shall be spot-faced, flat and parallel to flange face of sufficient diameter to accept SAE metal washer under bolthead or nut.

G. Dip-Pipes:

1. Provide inside and outside surfaces of dip-pipes with corrosion barrier.
2. Surfacing veil for this corrosion barrier shall be same as specified for tank.
3. Corrosion barrier shall consist of appropriate surfacing veil, backed by two layers of fiberglass mat.
4. If “ready-made” pipe is used, it shall have an equivalent internal corrosion barrier and shall have specified corrosion barrier applied to outside surface.

H. Free Vent:

1. Atmospheric tanks shall be directly vented to atmosphere through an open top or through a minimum height, permanently attached vent.
2. Vents for atmospheric tanks shall have a crosssectional area equal to or exceeding the combined areas of inlets or outlets, whichever is greater.
3. Atmospheric tanks may not be equipped with a flanged vent or a removable vent.
4. If “ready-made” pipe is used, it shall have an equivalent internal corrosion barrier and shall have specified corrosion barrier applied to outside surface.

2.04 TANK INSULATION

A. Insulate tanks with 2-pound density polyurethane foam board with thickness as indicated on tank data sheets. Install insulation board in 1-inch thick layers to obtain specified thickness, stagger joints. Insulation shall be applied to tank structural laminate before laminate has hardened, bonding the insulation to the tank wall.

B. Provide 3/16-inch thick minimum protective exterior fiberglass laminate over the polyurethane foam. The final outside layer of the laminate shall be white pigmented gel-coat. Straight shell protective laminate shall incorporate expansion joints as required for thermal expansion. Provide lip at expansion
joints to prevent water from penetrating joint. Minimum overlap shall be 1 inch.

C. At tank fittings, cope insulation back from fitting to provide bolt access and reinforce connection with fiberglass laminate to the outer side of the structural wall laminate. Replace insulation, cover with fiberglass laminate, and caulk interface around fitting.

D. Indicate the location of each tank heating pad by permanent dashed lines molded in the outer covering.

2.05 TANK HEATERS

A. Flexible heating pads shall be installed as shown on Tank Data Sheets. Multiple heating pads shall be equally spaced around the periphery of the tank. The heating system shall be furnished with all the necessary components to ensure a complete installation. These components shall include, but not be limited to, NEMA 4X control enclosure, power contactor, control devices, high limit cutoff thermostat, failure alarm, RTDs, conduit and cable, connectors, end caps, solvents, splice kits, pad and RTD installation kits, and aluminum tape.

B. The tank heating system shall maintain a minimum tank temperature of 40 degrees F and shall be designed for exposure to a minimum outdoor air temperature of 0 degrees F with a design wind speed of 20 mph. Heating pads shall be rated at 277V ac, single-phase, and have a maximum heat output of 0.7 watt per square inch. Install pads and bulbs on structural wall laminate in accordance with manufacturer’s installation instructions. Install high limit cutoff thermostat on heating pad per manufacturer’s installation instructions.

C. Cover heating pads and thermostat bulbs with insulation of the same type and thickness as the tank insulation prior to installation of manway covers.

D. Group the heating pads into multiple circuits such that maximum single circuit capacity does not exceed 16 amps when starting the circuit at 0 degrees F. Each circuit shall serve half of the heating pads.

E. Control System:

1. Control panels shall be rated NEMA 4X and shall conform to Section 40 99 90, Package Control Systems. Separate electrical enclosures must be provided for voltages less than 50 volts and greater than 50 volts.

2. Control panels shall be stanchion mounted next to tank, installation of panels by others.
3. Control panels shall incorporate 30 mA ground-fault equipment protection devices in accordance with NEC. Ground-fault protection shall initiate alarm and trip functions.
4. Provide a 4-20 mA output signal for remote temperature monitoring.
5. Provide a set of dry contacts for remote alarm annunciation.
6. Coordinate power supply to electrical panels with facility lockout/tagout procedures and disconnect requirements. Each electrical panel or enclosure shall be supplied by no more than one source of power.

F. Manufacturers and Products:

2. Or approved equal.

2.06 APPURTENANCES

A. Supports:

1. Pipe Supports:
   a. Provide for tank overflow pipes, loading pipes and recirculation pipes, where shown on Plans and Tank Data Sheets.
   b. Spacing of supports shall be as recommended by fabricator, but shall not be greater than 4 feet on center.
   c. As shown on Drawings, shall allow removal of pipe.
   d. FRP or Type 316 stainless steel complete with necessary bolts, nuts, and washers.
2. Level Probe Supports: FRP or stainless steel.
3. Mixer and Other Equipment Supports and Connections:
   a. Mixers are not supported by tanks, coordinate mixer dimensions and clearances with mixer manufacturer to ensure no interferences.
   b. Fabricate with baffles recommended by mixer manufacturer.
      1) Minimum Support System:
         a) Baffles shall be supported as identified by mixer manufacturer and as shown on Tank Data Sheets.

B. Platforms, Ladders, Handrails, and Kickplates:

1. Provide OSHA Compliant ladders, handrails, kickplates and platforms as shown on Tank Data Sheets and Drawings.
2. Material: FRP.
3. Fasteners: Type 316 stainless steel or FRP.
4. Supports, FRP: Locate as required for field installation of ladders, platforms, or handrails.

C. Non-Skid Surfaces: Provide non-skid surfaces on tank tops.
D. Lifting Lugs: Provide suitably attached for tank weighing over 100 pounds.

E. Anchor Bolts:
   1. Type 316 stainless steel bolts, sized by fabricator, and 1/2 -inch minimum diameter and as specified in Section 05 50 00, Metal Fabrications, unless specified otherwise.
   2. Ferric Chloride Service: Hastelloy C-276 bolt, nuts and washers.

F. Flange and Manway Bolts: Type 316 stainless steel bolts and nuts as specified in Section 05 50 00, Metal Fabrications unless specified otherwise.
   1. Ferric Chloride Service: Hastelloy C-276 bolt, nuts and washers.

2.07 SOURCE QUALITY CONTROL

A. Identify and retain cutouts. Engineer may select certain cutouts for testing for physical properties of laminate.

B. Acoustic Emission Test:
   1. Provide services of acoustic emission test agency to conduct test.
   2. Test completed tank in accordance with ASTM E1067.

C. Factory Test Reports: Certify results, by signature, of the following:
   1. Inspections.
   2. Results of hydrostatic testing.
   3. Test reports of physical properties of standard laminates including Barcol hardness and Acetone sensitivity.
   4. Test results and report for acoustic emission test.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with fabricator’s written instructions.

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

C. Interface with Other Products: Coordinate with mixer and other equipment manufacturers as required for proper mounting of tank mixers, as needed.
3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Construction Contractor to conduct on each tank.
2. Hydrostatic leak test with tank full of clean water. Allow water to stand for 24 hours to verify no leakage.

3.03 MANUFACTURER’S FIELD SERVICES

A. Provide fabricator’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan for installation assistance, inspection and certification of proper installation and startup assistance for specified component, subsystem, equipment, or system.

3.04 SUPPLEMENTS

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

2. User’s Basic Requirements Specification (UBRS) Form, Dechlorination Tank B, CHTR-T-410-B.
4. User’s Basic Requirements Specification (UBRS) Form, Polymer and Coprecip Reaction Tank B, CHTR-T-420-B.
6. User’s Basic Requirements Specification (UBRS) Form, Flocculation Tank B, CHTR-T-430-B.
8. User’s Basic Requirements Specification (UBRS) Form, Sludge Settling Tank B, SLDP-T-700-B.
11. Tank Data Sheets:
   941002-CHEM-T-520.
   941002-CHTR-T-410-A.
   41002-CHTR-T-410-B.
   941002-CHTR-T-420-A.
   941002-CHTR-T-420-B.
   941002-CHTR-T-430-A.
   941002-CHTR-T-430-B.
   941002-SLDP-T-700-A.
   941002-SLDP-T-700-B.
   941002-SLDP-T-700-C.

12. Key Historical Water Quality Data.

13. FRP Tank Schedule.

END OF SECTION
USER’S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No.________________
UBRS Revision No. 0

User Firm Name: ____________________________________________________________

User’s Agent Firm Name: _____________________________________________________

Title of Equipment: Dechlorination Tank A

User’s Designation No.: 941002-CHTR-T-410-A

Installation Location (Name and Address):
Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name: Steve Polson Phone No.: (720)286-5376 Date: ________________

Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):
Dechlorination Tank A is an open top FRP tank 11’-0” D x 16’-0” H with mechanical mixing and
chemical injection. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

☒ Special Requirements:
☒ Acoustic Emission Testing
☐ Inspection or Testing Requirements not Listed in the Standard____________________

____________________________________________________

____________________________________________________

☐ _______________________________________________________________________

☐ _______________________________________________________________________

PW/DEN001/662886 FIBERGLASS REINFORCED
JUNE 30, 2017 PLASTIC TANK
43 40 02 SUPPLEMENT 1 - 1
User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☑ Yes ☐ No

Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

☐ Level 1
☒ Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: No more than 2 per square inch of 1/8” diameter or larger.

☐ Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

3. Material Selection:

3.1 Material Selection by:

☐ Resin Manufacturer (include data per Section 4 of this Document)
☒ Fabricator (include data per Section 4 of this Document)

☐ End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):

☐ Other

3.2 Material of Construction:

Resin: _______________       Catalyst/Cure System: _______________

Veil: _______________ TYPE-C _______________ Barcol Hardness per Para. 6-910(b)(4): __________

☒ Lift Lugs: __ RTP __ Carbon Steel __ Other: ________________________________

☒ Hold-down Lugs: __ RTP __ Carbon Steel __ Other: Stainless Steel

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See Supplement 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Dechlorination of INF achieved by the addition of Sodium bisulfate and mixing. Sulfuric Acid can be added for pH control.
4.2 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent Water (INF)</td>
<td>100 Max. 0 Min.</td>
</tr>
<tr>
<td>Sulfuric Acid (SU)</td>
<td>0.0075 Max. 0 Min.</td>
</tr>
<tr>
<td>Sodium bisulfate (SB)</td>
<td>0.000115 Max. 0.00015 Min.</td>
</tr>
</tbody>
</table>

4.3 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th></th>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>0.0 psig</td>
<td>0.0 psig</td>
</tr>
<tr>
<td>External Pressure</td>
<td>0.09 psig</td>
<td>0.11 psig</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>12.9 ft</td>
<td>16 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements

Snow Load: 10 psf

Ice Load: See Structural General Sheet

Personnel Load: 100 psf

Capacities: Operating 9,163 gal Flooded 11,375 gal

5.2 Mechanical Agitator: ☒ Required ☐ Not Required

Dead Load 400 lb

Static Bending Moment ft-lb

Dynamic Bending Moment ft-lb

Torque 167 ft-lb
Horsepower 3.5 hp

Impeller Speed 56 rpm

Impeller Diameter 40” in

Number of Impellers 1

Foot Bearing: ☑ No

5.3 Heating and Cooling:

☐ Electric Panels

☐ Steam Coil

☐ Steam Sparger

☐ Heat Exchanger

☑ Other None

5.4 Mechanical and Other Forces:

☐ Violent Chemical Reaction

☐ Subsurface Introduction of Gas and Vapor

☐ Subsurface Introduction of Steam

☐ Transmitted Mechanical Load/Force

☐ Impact Due to Introduction of Solids

☐ Vacuum from Pump Down (or Vessel Draining)

☐ Vacuum from Cool Down

☑ Other Tank Baffles, See Additional Requirements

5.5 Corrosion Barrier Excluded from Structural Calculations:

☐ Yes

☑ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):

☐ Yes

☑ No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:

☑ Fabricator’s Quality Control Principal
☐ User’s Representative
☐ Other

Inspector’s Name: __________________________ Telephone: __________
Company: __________________________________________
Address: __________________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name __________________________ Title __________________________
Signature __________________________ Date __________

6.1.2 Authorized Fabricator’s Representative:

Name __________________________ Title __________________________
Signature __________________________ Date __________

Additional Requirements: __________________________________________

Tank Baffles: 1ft W x 8ft H x 8in W See tank datasheet for additional information.

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D. SDS = 0.30g, SD1 = 0.136g,
Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

NOTE: Tank Mixer is not directly attached to tank.

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USER’S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No.________________________

UBRS Revision No.____0____

User Firm Name: ________________________

User’s Agent Firm Name: ________________________

Title of Equipment: Dechlorination Tank B

User’s Designation No.: 941002-CHTR-T-410-B

Installation Location (Name and Address):

Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name: Steve Polson Phone No.: (720)286-5376 Date: _____________

Address:

CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):

Dechlorination Tank B is an open top FRP tank 11’-0” D x 16’-0” H with mechanical mixing and chemical injection. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

☒ Special Requirements:

☒ Acoustic Emission Testing

☐ Inspection or Testing Requirements not Listed in the Standard________________________

________________________________________________________________________

________________________________________________________________________

☐ _________________________________________________________________________

☒ _________________________________________________________________________

☐ _________________________________________________________________________

☒ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No

PW/DEN001/662886 FIBERGLASS REINFORCED
JUNE 30, 2017 PLASTIC TANK
43 40 02 SUPPLEMENT 2 - 1
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

- Level 1
- Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: No more than 2 per square inch of 1/8” diameter or larger.

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

3. Material Selection:

3.1 Material Selection by:

- Resin Manufacturer (include data per Section 4 of this Document)
- Fabricator (include data per Section 4 of this Document)
- End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):
- Other

3.2 Material of Construction:

- Resin:
- Catalyst/Cure System:
- Veil: TYPE-C
- Barcol Hardness per Para. 6-910(b)(4): 32
- Lift Lugs: RTP
- Carbon Steel
- Other:
- Hold-down Lugs: RTP
- Carbon Steel
- Other: Stainless Steel

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Dechlorination of INF achieved by the addition of Sodium bisulfate and mixing. Sulfuric Acid can be added for pH control.
4.4 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Max. %</th>
<th>Min. %</th>
<th>Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent Water (INF)</td>
<td>100</td>
<td>0</td>
<td>Continuous</td>
</tr>
<tr>
<td>Sulfuric Acid (SU)</td>
<td>0.0075</td>
<td>0</td>
<td>Continuous</td>
</tr>
<tr>
<td>Sodium bisulfate (SB)</td>
<td>0.000115</td>
<td>0.00015</td>
<td>Continuous</td>
</tr>
</tbody>
</table>

4.5 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th></th>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>12.9 ft</td>
<td>16 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements)

Snow Load 10 psf

Ice Load: See Structural General Sheet

Personnel Load: 100 psf

Capacities: Operating 9,163 gal Flooded 11,375 gal

5.2 Mechanical Agitator: ☑ Required ☐ Not Required

Dead Load 400 lb

Static Bending Moment ft-lb

Dynamic Bending Moment ft-lb

Torque 167 ft-lb
Horsepower  3.5  hp
Impeller Speed  56  rpm
Impeller Diameter  40”  in
Number of Impellers  1

Foot Bearing:  □ Yes  ☒ No

5.3 Heating and Cooling:

☐ Electric Panels
☐ Steam Coil
☐ Steam Sparger
☐ Heat Exchanger
☒ Other  None

5.4 Mechanical and Other Forces:

☐ Violent Chemical Reaction
☐ Subsurface Introduction of Gas and Vapor
☐ Subsurface Introduction of Steam
☐ Transmitted Mechanical Load/Force
☐ Impact Due to Introduction of Solids
☐ Vacuum from Pump Down (or Vessel Draining)
☐ Vacuum from Cool Down
☒ Other  Tank Baffles, See Additional Requirements

5.5 Corrosion Barrier Excluded from Structural Calculations:

☐ Yes
☒ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):

☐ Yes
☒ No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:

- [ ] Fabricator’s Quality Control Principal
- [ ] User’s Representative
- [ ] Other

Inspector’s Name: ____________________________  Telephone: ________________

Company: ____________________________________________________________

Address: __________________________________________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name: ____________________________  Title: ____________________________

Signature: ____________________________  Date: ________________

6.1.2 Authorized Fabricator’s Representative:

Name: ____________________________  Title: ____________________________

Signature: ____________________________  Date: ________________

Additional Requirements: ____________________________

Tank Baffles: 1ft W x 8ft H x 8in W See tank datasheet for additional information.

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D. SDS = 0.30g, SD1 = 0.136g,

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

NOTE: Tank Mixer is not directly attached to tank.

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USER'S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No.__________________

UBRS Revision No. ______ 0____

User Firm Name: ____________________________

User’s Agent Firm Name: ____________________________

Title of Equipment: Polymer and Coprecip Reaction Tank A

User’s Designation No.: 941002-CHTR-T-420-A

Installation Location (Name and Address):
Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name: Steve Polson Phone No.: (720)286-5376 Date: ____________

Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):
Polymer and Coprecip Reaction Tank A is an open top FRP tank 15'-6" D x 16'-0" H with mechanical mixing and chemical injection. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

☒ Special Requirements:

☒ Acoustic Emission Testing

☐ Inspection or Testing Requirements not Listed in the Standard________________________

______________________________________________________________________________

______________________________________________________________________________

☐ ______________________________________________________________________________

☐ ______________________________________________________________________________

☒ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

- Level 1
- Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: **No more than 2 per square inch of 1/8” diameter or larger.**

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

---

3. Material Selection:

3.1 Material Selection by:

- Resin Manufacturer (include data per Section 4 of this Document)
- Fabricator (include data per Section 4 of this Document)
- End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):
- Other

3.2 Material of Construction:

Resin: _________________ Catalyst/Cure System: ________________
Veil: TYPE-C Barcol Hardness per Para. 6-910(b)(4): 32

- Lift Lugs: RTP Carbon Steel Other:
- Hold-down Lugs: RTP Carbon Steel Other: Stainless Steel

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Organosulfide and Ferric Chloride is added to Dechlorinated Water, Ferric Hydroxide floc is created.

Sulfuric Acid can be added for pH adjustment.
4.6 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
<th>Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dechlorinated Water (DCW)</td>
<td>100%</td>
<td>Continuous</td>
</tr>
<tr>
<td>Sulfuric Acid (SU)</td>
<td>0.0075%</td>
<td>Continuous</td>
</tr>
<tr>
<td>Ferric Chloride (FCL)</td>
<td>0.008%</td>
<td>Continuous</td>
</tr>
<tr>
<td>Organosulfide (OGS)</td>
<td>0.0012%</td>
<td>Continuous</td>
</tr>
</tbody>
</table>

4.7 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.0</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>12.74 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors: N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements

Snow Load 10 psf

Ice Load: See Structural General Sheet

Personnel Load: 100 psf

Capacities: Operating 17,981 gal

Flooded 22,586 gal

5.2 Mechanical Agitator: ☑ Required ☐ Not Required

Dead Load 400 lb

Static Bending Moment ft-lb

Dynamic Bending Moment ft-lb
Torque ________ 167 __________________________ ft-lb
Horsepower ________ 3.5 __________________________ hp
Impeller Speed ________ 56 __________________________ rpm
Impeller Diameter ________ 40” __________________________ in
Number of Impellers 1 __________________________

Foot Bearing: [ ] Yes [x] No

5.3 Heating and Cooling:
[ ] Electric Panels
[ ] Steam Coil
[ ] Steam Sparger
[ ] Heat Exchanger
[ ] Other: None

5.4 Mechanical and Other Forces:
[ ] Violent Chemical Reaction
[ ] Subsurface Introduction of Gas and Vapor
[ ] Subsurface Introduction of Steam
[ ] Transmitted Mechanical Load/Force
[ ] Impact Due to Introduction of Solids
[ ] Vacuum from Pump Down (or Vessel Draining)
[ ] Vacuum from Cool Down
[ ] Other: Tank Baffles, See Additional Requirements

5.5 Corrosion Barrier Excluded from Structural Calculations:
[ ] Yes
[ ] No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):
[ ] Yes
[ ] No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:

☑ Fabricator’s Quality Control Principal

☐ User’s Representative

☐ Other ____________________________

Inspector’s Name: ____________________________ Telephone: _______________

Company: ____________________________________________________________________

Address: ____________________________________________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name ____________________________ Title ____________________________

Signature ____________________________ Date ____________________________

6.1.2 Authorized Fabricator’s Representative:

Name ____________________________ Title ____________________________

Signature ____________________________ Date ____________________________

Additional Requirements: ____________________________________________________________________

Tank Baffles: 1ft W x 8ft H x 8in W See tank datasheet for additional information.

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D, SDS = 0.30g, SD1 = 0.136g,

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

NOTE: Tank Mixer is not directly attached to tank.

GENERAL NOTE: This form may be reproduced and used without written permission from ASME if used for purposes other than republication.
As Required by the Provisions of ASME RTP-1

RTP Edition No.________________

UBRS Revision No. 0

User Firm Name: ____________________________

User’s Agent Firm Name: ____________________________

Title of Equipment: Polymer and Coprecip Reaction Tank B

User’s Designation No.: 941002-CHTR-T-420-B

Installation Location (Name and Address):

Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name: Steve Polson Phone No.: (720)286-5376 Date: __________

Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):

Polymer and Coprecip Reaction Tank B is an open top FRP tank 15'-6" D x 16'-0" H with mechanical mixing and chemical injection. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

☒ Special Requirements:

☒ Acoustic Emission Testing

☐ Inspection or Testing Requirements not Listed in the Standard

☐ ____________________________

☐ ____________________________

☐ ____________________________

☐ ____________________________

☐ ____________________________

☐ ____________________________

☒ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

- Level 1
- Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: No more than 2 per square inch of 1/8” diameter or larger.

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

3. Material Selection:

3.1 Material Selection by:

- Resin Manufacturer (include data per Section 4 of this Document)
- Fabricator (include data per Section 4 of this Document)
- End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):

- Other

3.2 Material of Construction:

- Resin:
- Catalyst/Cure System:
- Veil: TYPE-C
- Barcol Hardness per Para. 6-910(b)(4): 32
- Lift Lugs: RTP
- Carbon Steel
- Other:
- Hold-down Lugs: RTP
- Carbon Steel
- Other: Stainless Steel

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Organosulfide and Ferric Chloride is added to Dechlorinated Water, Ferric Hydroxide floc is created.

Sulfuric Acid can be added for pH adjustment.
4.8 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dechlorinated Water</td>
<td>100 Max. %</td>
</tr>
<tr>
<td>(DCW)</td>
<td>0 Min. %</td>
</tr>
<tr>
<td>Sulfuric Acid (SU)</td>
<td>0.0075 Max. %</td>
</tr>
<tr>
<td>Ferric Chloride (FCL)</td>
<td>0.008 Max. %</td>
</tr>
<tr>
<td>Organosulfide (OGS)</td>
<td>0.0012 Max. %</td>
</tr>
</tbody>
</table>

4.9 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.0</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>12.74 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors: N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements)

Snow Load 10 psf

Ice Load: See Structural General Sheet

Personnel Load: 100 psf

Capacities: Operating 17,981 gal

Flooded 22,586 gal

5.2 Mechanical Agitator: Required Not Required

Dead Load 400 lb

Static Bending Moment ft-lb

Dynamic Bending Moment ft-lb
Torque 167 ft-lb
Horsepower 3.5 hp
Impeller Speed 56 rpm
Impeller Diameter 40” in
Number of Impellers 1

Foot Bearing: ☐ Yes ☒ No

5.3 Heating and Cooling:

☐ Electric Panels
☐ Steam Coil
☐ Steam Sparger
☐ Heat Exchanger
☒ Other None

5.4 Mechanical and Other Forces:

☐ Violent Chemical Reaction
☐ Subsurface Introduction of Gas and Vapor
☐ Subsurface Introduction of Steam
☐ Transmitted Mechanical Load/Force
☐ Impact Due to Introduction of Solids
☐ Vacuum from Pump Down (or Vessel Draining)
☐ Vacuum from Cool Down
☒ Other Tank Baffles, See Additional Requirements

5.5 Corrosion Barrier Excluded from Structural Calculations:

☐ Yes
☒ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):

☐ Yes
☒ No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.)

Inspector shall be:

☑ Fabricator’s Quality Control Principal
☐ User’s Representative
☐ Other ____________________________

Inspector’s Name: ____________________________ Telephone: __________

Company: __________________________________________

Address: __________________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name ____________________________ Title ______________
Signature ____________________________ Date __________

6.1.2 Authorized Fabricator’s Representative:

Name ____________________________ Title ______________
Signature ____________________________ Date __________

Additional Requirements: __________________________________________

Tank Baffles: 1ft W x 8ft H x 8in W See tank datasheet for additional information.

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D. SDS = 0.30g, SD1 = 0.136g, 

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

NOTE: Tank Mixer is not directly attached to tank.

________________________________________

________________________________________

________________________________________

GENERAL NOTE: This form may be reproduced and used without written permission from ASME if used for purposes other than republication.
USER’S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No. __________
UBRS Revision No. 0

User Firm Name: ___________________________________________________________________

User’s Agent Firm Name: ___________________________________________________________________

Title of Equipment: Flocculation Tank A

User’s Designation No.: 941002-CHTR-T-430-A

Installation Location (Name and Address):
Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name:  Steve Polson  Phone No.: (720)286-5376  Date: __________

Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):
Flocculation Tank A is an open top FRP tank 15’-6” D x 16’-0” H with mechanical mixing. See Tank
Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

☒ Special Requirements:

☒ Acoustic Emission Testing
☐ Inspection or Testing Requirements not Listed in the Standard__________________________

☐ Additional Requirements

☒ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

- Level 1
- Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: No more than 2 per square inch of 1/8” diameter or larger.

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

3. Material Selection:

3.1 Material Selection by:

- Resin Manufacturer (include data per Section 4 of this Document)
- Fabricator (include data per Section 4 of this Document)
- End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):
- Other

3.2 Material of Construction:

- Resin: 
- Catalyst/Cure System: 
- Veil: TYPE-C Barcol Hardness per Para. 6-910(b)(4): 32
- Lift Lugs: RTP Carbon Steel Other:
- Hold-down Lugs: RTP Carbon Steel Other: Stainless Steel

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Ferric Hydroxide floc is formed with residence time and mixing.
4.10 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
<th>Max. %</th>
<th>Min. %</th>
<th>Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulated Water (CW)</td>
<td></td>
<td>100</td>
<td>0</td>
<td>Continuous</td>
</tr>
<tr>
<td>Ferric Hydroxide</td>
<td></td>
<td>0.35</td>
<td>0.075</td>
<td>Continuous</td>
</tr>
<tr>
<td>Flocculent Polymer (FLPS)</td>
<td></td>
<td>0.00012</td>
<td>0.00006</td>
<td>Continuous</td>
</tr>
</tbody>
</table>

4.11 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th></th>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>11.58 ft</td>
<td>16 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors: N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements

Snow Load 10 psf

Ice Load: See Structural General Sheet

Personnel Load: 100 psf

Capacities: Operating 17,981 gal

Flooded 22,586 gal

5.2 Mechanical Agitator: ✔ Required ☐ Not Required

Dead Load 400 lb

Static Bending Moment ft-lb

Dynamic Bending Moment ft-lb

Torque 167 ft-lb
Horsepower 3.5
Impeller Speed 56
Impeller Diameter 40”
Number of Impellers 1
Foot Bearing: ☐ Yes ☒ No

5.3 Heating and Cooling:
☐ Electric Panels
☐ Steam Coil
☐ Steam Sparger
☐ Heat Exchanger
☒ Other None

5.4 Mechanical and Other Forces:
☐ Violent Chemical Reaction
☐ Subsurface Introduction of Gas and Vapor
☐ Subsurface Introduction of Steam
☐ Transmitted Mechanical Load/Force
☐ Impact Due to Introduction of Solids
☐ Vacuum from Pump Down (or Vessel Draining)
☐ Vacuum from Cool Down
☒ Other Tank Baffles, See Additional Requirements

5.5 Corrosion Barrier Excluded from Structural Calculations:
☐ Yes
☒ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):
☐ Yes
☒ No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:

- Fabricator’s Quality Control Principal
- User’s Representative
- Other

Inspector’s Name: ____________________________ Telephone: ________________
Company: ____________________________
Address: ________________________________________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name__________________________ Title__________________________
Signature__________________________ Date__________________________

6.1.2 Authorized Fabricator’s Representative:

Name__________________________ Title__________________________
Signature__________________________ Date__________________________

Additional Requirements: ____________________________________________________________

Tank Baffles: 1ft W x 8ft H x 8in W See tank datasheet for additional information.

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D. SDS = 0.30g, SD1 = 0.136g,
Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

NOTE: Tank Mixer is not directly attached to tank.

GENERAL NOTE: This form may be reproduced and used without written permission from ASME if used for purposes other than republication.
1. Equipment Description (equipment sketch and nozzle schedule must be attached):

   Flocculation Tank B is an open top FRP tank 15'-6" D x 16'-0" H with mechanical mixing. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

   ☑ Special Requirements:
   
   ☑ Acoustic Emission Testing
   
   ☐ Inspection or Testing Requirements not Listed in the Standard

   ☑ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☑ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

- Level 1
- Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: **No more than 2 per square inch of 1/8” diameter or larger.**

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

3. Material Selection:

3.1 Material Selection by:

- Resin Manufacturer (include data per Section 4 of this Document)
- **Fabricator** (include data per Section 4 of this Document)
- End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):

3.2 Material of Construction:

- Resin:________________________
- Catalyst/Cure System:________________________
- Veil: TYPE-C
- Barcol Hardness per Para. 6-910(b)(4): 32
- Lift Lugs: **RTP**
- Carbon Steel
- Other:
- Hold-down Lugs: RTP
- Carbon Steel
- **Other: Stainless Steel**

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Ferric Hydroxide floc is formed with residence time and mixing.
4.12 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
<th>Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulated Water (CW)</td>
<td>Max. % 100</td>
<td>Min. % 0</td>
</tr>
<tr>
<td>Ferric Hydroxide</td>
<td>Max. % 0.35</td>
<td>Min. % 0.075</td>
</tr>
<tr>
<td>Flocculent Polymer (FLPS)</td>
<td>Max. % 0.00012</td>
<td>Min. % 0.00006</td>
</tr>
</tbody>
</table>

4.13 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.0</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>11.58 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements

Snow Load 10 psf

Ice Load: See Structural General Sheet

Personnel Load: 100 psf

Capacities: Operating 17,981 gal Flooded 22,586 gal

5.2 Mechanical Agitator: ☑ Required ☐ Not Required

Dead Load 400 lb

Static Bending Moment ft-lb

Dynamic Bending Moment ft-lb

Torque 167 ft-lb
<table>
<thead>
<tr>
<th>Horsepower</th>
<th>3.5 hp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impeller Speed</td>
<td>56 rpm</td>
</tr>
<tr>
<td>Impeller Diameter</td>
<td>40&quot; in</td>
</tr>
<tr>
<td>Number of Impellers</td>
<td>1</td>
</tr>
<tr>
<td>Foot Bearing:</td>
<td>☒ Yes ☐ No</td>
</tr>
</tbody>
</table>

5.3 Heating and Cooling:

- ☐ Electric Panels
- ☐ Steam Coil
- ☐ Steam Sparger
- ☐ Heat Exchanger
- ☒ Other: None

5.4 Mechanical and Other Forces:

- ☐ Violent Chemical Reaction
- ☐ Subsurface Introduction of Gas and Vapor
- ☐ Subsurface Introduction of Steam
- ☐ Transmitted Mechanical Load/Force
- ☐ Impact Due to Introduction of Solids
- ☐ Vacuum from Pump Down (or Vessel Draining)
- ☐ Vacuum from Cool Down
- ☒ Other: Tank Baffles, See Additional Requirements

5.5 Corrosion Barrier Excluded from Structural Calculations:

- ☒ Yes
- ☐ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):

- ☐ Yes
- ☒ No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:

☐ Fabricator’s Quality Control Principal
☐ User’s Representative
☐ Other

Inspector’s Name: ____________________________ Telephone: ________________

Company: ____________________________________________

Address: ____________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name ____________________________ Title ____________________________

Signature ____________________________ Date ____________________________

6.1.2 Authorized Fabricator’s Representative:

Name ____________________________ Title ____________________________

Signature ____________________________ Date ____________________________

Additional Requirements: ____________________________________________

Tank Baffles: 1ft W x 8ft H x 8in W See tank datasheet for additional information.

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D, SDS = 0.30g, SD1 = 0.136g,

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

NOTE: Tank Mixer is not directly attached to tank.
USER’S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No.________________
UBRS Revision No. __ 0 __

User Firm Name: ____________________________

User’s Agent Firm Name: ____________________________

Title of Equipment: Sludge Settling Tank A

User’s Designation No.: 941002-SLD-P-T-700-A

Installation Location (Name and Address):

Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name: Steve Polson  Phone No.: (720)286-5376  Date: _____________

Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):

   Sludge Settling Tank A is a cone bottom elliptical top FRP tank 15’-6” D x 34’-0” H. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

   ☒ Special Requirements:
   ☒ Acoustic Emission Testing
   ☐ Inspection or Testing Requirements not Listed in the Standard

   ☐
   ☐
   ☐

   ☒ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

- Level 1
- Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: No more than 2 per square inch of 1/8” diameter or larger.

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

3. Material Selection:

3.1 Material Selection by:

- Resin Manufacturer (include data per Section 4 of this Document)
- Fabricator (include data per Section 4 of this Document)
- End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):
- Other

3.2 Material of Construction:

Resin: __________________________ Catalyst/Cure System: __________________________

Veil: TYPE-C Barcol Hardness per Para. 6-910(b)(4): 32

- Lift Lugs: RTP Carbon Steel Other: __________________________
- Hold-down Lugs: RTP Carbon Steel Other: Stainless Steel

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Ferric Hydroxide floc is formed with residence time and mixing.

________________________________________________________

________________________________________________________
4.14 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulated Water (CW)</td>
<td>Max. %</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Ferric Hydroxide</td>
<td>5</td>
</tr>
</tbody>
</table>

4.15 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th></th>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17°F to 105°F</td>
<td>-17°F to 105°F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.332</td>
<td>1.332</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>30 ft</td>
<td>34 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed: 120 MPH Classification Category: C Exposure: B

Elevation Above Grade: 850 ft Topographic Factors: N/A

Seismic Zone: C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements)

Snow Load: 10 psf

Ice Load: See Structural General Sheet

Personnel Load: 100 psf

Capacities: Operating 31,876 gal Flooding 36,111 gal

5.2 Mechanical Agitator: ☐ Required ☒ Not Required

Dead Load: N/A lb

Static Bending Moment: N/A ft-lb

Dynamic Bending Moment: N/A ft-lb

Torque: N/A ft-lb

Horsepower: N/A hp
Impeller Speed: N/A rpm

Impeller Diameter: N/A in

Number of Impellers: N/A

Foot Bearing: Yes No

5.3 Heating and Cooling:

- Electric Panels
- Steam Coil
- Steam Sparger
- Heat Exchanger
- Other: None

5.4 Mechanical and Other Forces:

- Violent Chemical Reaction
- Subsurface Introduction of Gas and Vapor
- Subsurface Introduction of Steam
- Transmitted Mechanical Load/Force
- Impact Due to Introduction of Solids
- Vacuum from Pump Down (or Vessel Draining)
- Vacuum from Cool Down
- Other

5.5 Corrosion Barrier Excluded from Structural Calculations:

- Yes
- No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):

- Yes
- No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:

- Fabricator’s Quality Control Principal
- User’s Representative
- Other ____________________________

Inspector’s Name: ____________________________ Telephone: ________________

Company: __________________________________________

Address: __________________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name ____________________________ Title ____________________________

Signature ____________________________ Date ____________________________

6.1.2 Authorized Fabricator’s Representative:

Name ____________________________ Title ____________________________

Signature ____________________________ Date ____________________________

Additional Requirements: __________________________________________

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D, SDS = 0.30g, SD1 = 0.136g,

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

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USER’S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No.__________________
UBRS Revision No.____0____

User Firm Name: ____________________________________________
User’s Agent Firm Name: _______________________________________

Title of Equipment: Sludge Settling Tank B
User’s Designation No.: 941002-SLDP-T-700-B

Installation Location (Name and Address):
Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name: Steve Polson Phone No.: (720)286-5376 Date: ______________
Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):
   Sludge Settling Tank B is a cone bottom elliptical top FRP tank 15’-6” D x 34’-0” H. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:
   ☒ Special Requirements:
     ☒ Acoustic Emission Testing
     ☐ Inspection or Testing Requirements not Listed in the Standard____________________
     ____________________________
     ____________________________
     ____________________________
     ____________________________
     ____________________________
     ☒ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

- Level 1
- Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: No more than 2 per square inch of 1/8” diameter or larger.

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

Material Selection:

3.1 Material Selection by:

- Resin Manufacturer (include data per Section 4 of this Document)
- Fabricator (include data per Section 4 of this Document)
- End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):
- Other

3.2 Material of Construction:

Resin: _______________ Catalyst/Cure System: _______________
Veil: TYPE-C Barcol Hardness per Para. 6-910(b)(4): 32
- Lift Lugs: RTP Carbon Steel Other: _______________
- Hold-down Lugs: RTP Carbon Steel Other: Stainless Steel

Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF 200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Ferric Hydroxide floc is formed with residence time and mixing.
4.16 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
<th></th>
<th></th>
<th>Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulated Water (CW)</td>
<td>100</td>
<td>0</td>
<td></td>
<td>Continuous</td>
</tr>
<tr>
<td>Ferric Hydroxide</td>
<td>5</td>
<td>3</td>
<td></td>
<td>Continuous</td>
</tr>
</tbody>
</table>

4.17 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th></th>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.332</td>
<td>1.332</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>30 ft</td>
<td>34 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements

Snow Load 10 psf

Capacities: Operating 31,876 gal Flooded 36,111 gal

5.2 Mechanical Agitator: ☑ Required ☒ Not Required

Dead Load N/A lb

Static Bending Moment N/A ft-lb

Dynamic Bending Moment N/A ft-lb

Torque N/A ft-lb

Horsepower N/A hp

Impeller Speed N/A rpm

Impeller Diameter N/A in
Number of Impellers: N/A

Foot Bearing: Yes ☐ No ☐

5.3 Heating and Cooling:
- ☐ Electric Panels
- ☐ Steam Coil
- ☐ Steam Sparger
- ☐ Heat Exchanger
- ☒ Other: None

5.4 Mechanical and Other Forces:
- ☐ Violent Chemical Reaction
- ☐ Subsurface Introduction of Gas and Vapor
- ☐ Subsurface Introduction of Steam
- ☐ Transmitted Mechanical Load/Force
- ☐ Impact Due to Introduction of Solids
- ☐ Vacuum from Pump Down (or Vessel Draining)
- ☐ Vacuum from Cool Down
- ☐ Other: None

5.5 Corrosion Barrier Excluded from Structural Calculations:
- ☐ Yes
- ☒ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):
- ☐ Yes
- ☒ No

6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:
6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name_________________________________ Title________________________

Signature________________________________ Date______________________

6.1.2 Authorized Fabricator’s Representative:

Name_________________________________ Title________________________

Signature________________________________ Date______________________

Additional Requirements:

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D, SDS = 0.30g, SD1 = 0.136g,

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

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USER’S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No.________________
UBRS Revision No._____0____

User Firm Name: ________________________________________________

User’s Agent Firm Name: __________________________________________

Title of Equipment: Sludge Settling Tank C

User’s Designation No.: 941002-SLDP-T-700-C

Installation Location (Name and Address):
Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name:__Steve Polson__________Phone No.: (720)286-5376_________Date:________________

Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):

Sludge Settling Tank C is a cone bottom elliptical top FRP tank 15’-6” D x 34’-0” H. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

☒ Special Requirements:

☒ Acoustic Emission Testing

☐ Inspection or Testing Requirements not Listed in the Standard_____________________

☐ _______________________________________________________________________

☐ _______________________________________________________________________

☒ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

☐ Level 1
☒ Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: **No more than 2 per square inch of 1/8” diameter or larger.**

Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

Material Selection:

3.1 Material Selection by:

☐ Resin Manufacturer (include data per Section 4 of this Document)
☒ Fabricator (include data per Section 4 of this Document)
☐ End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):

☐ Other

3.2 Material of Construction:

Resin: ____________________ Catalyst/Cure System: ____________________

Veil: TYPE-C Barcol Hardness per Para. 6-910(b)(4): 32

☐ Lift Lugs: RTP ☐ Carbon Steel ☐ Other: ____________________

☒ Hold-down Lugs: RTP ☐ Carbon Steel ☐ Other: Stainless Steel

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): See SUPPLEMENT 3 OF200 MTF Design Criteria Document DCG-9OF200-D35 Key Historical Water Quality Data.

4.1 Description of Process Function and Process Sequence: Ferric Hydroxide floc is formed with residence time and mixing.
4.18 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulated Water (CW)</td>
<td>100 Max. %</td>
<td>0 Min. %</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Ferric Hydroxide</td>
<td>5 Max. %</td>
<td>3 Min. %</td>
<td>Continuous</td>
<td></td>
</tr>
</tbody>
</table>

4.19 pH Range: 9.0 Max. 6.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>External Pressure</td>
<td>1 atm</td>
</tr>
<tr>
<td>Temperature</td>
<td>-17 F to 105 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.332</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>30 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 850 ft Topographic Factors: N/A

Seismic Zone C Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements

Snow Load 10 psf

Capacities: Operating 31,876 gal Flooded 36,111 gal

5.2 Mechanical Agitator: ☒ Required ☐ Not Required

Dead Load N/A lb

Static Bending Moment N/A ft-lb

Dynamic Bending Moment N/A ft-lb

Torque N/A ft-lb

Horsepower N/A hp

Impeller Speed N/A rpm

Impeller Diameter N/A in
Number of Impellers: N/A

Foot Bearing: □ Yes □ No

5.3 Heating and Cooling:

☐ Electric Panels
☐ Steam Coil
☐ Steam Sparger
☐ Heat Exchanger
☒ Other: None

5.4 Mechanical and Other Forces:

☐ Violent Chemical Reaction
☐ Subsurface Introduction of Gas and Vapor
☐ Subsurface Introduction of Steam
☐ Transmitted Mechanical Load/Force
☐ Impact Due to Introduction of Solids
☐ Vacuum from Pump Down (or Vessel Draining)
☐ Vacuum from Cool Down
☐ Other: None

5.5 Corrosion Barrier Excluded from Structural Calculations:

☐ Yes
☒ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):

☐ Yes
☒ No

6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:
Fabricator’s Quality Control Principal

☐ User’s Representative

☐ Other

Inspector’s Name: ____________________________   Telephone: ________________

Company: _____________________________________________________________________________

Address: ______________________________________________________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name ____________________________   Title ____________________________

Signature ____________________________   Date ________________

6.1.2 Authorized Fabricator’s Representative:

Name ____________________________   Title ____________________________

Signature ____________________________   Date ________________

Additional Requirements: ________________________________________________________________

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D, SDS = 0.30g, SD1 = 0.136g,

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

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USER’S BASIC REQUIREMENTS SPECIFICATION (UBRS)
As Required by the Provisions of ASME RTP-1

RTP Edition No. ________________
UBRS Revision No. ____________ 0

User Firm Name: __________________________________________________________

User’s Agent Firm Name: __________________________________________________

Title of Equipment: Ferric Chloride Tank

User’s Designation No.: 941002-CHEM-T-520

Installation Location (Name and Address):
Outfall 200 Mercury Treatment Facility
Y-12 National Security Complex, Bear Creek Road
Oak Ridge, Tennessee 37830

Name: Steve Polson Phone No.: (720)286-5376 Date: ________________

Address:
CH2M HILL
9191 S. Jamaica St.
Englewood, CO 80112

1. Equipment Description (equipment sketch and nozzle schedule must be attached):

7,125-gallon ferric chloride storage tank with closed top, 10’-6” ID x 12’-0” H side wall with false bottom, and insulated and heated side walls. See Tank Data Sheet for additional details.

2. Additional Fabricator Responsibilities:

☒ Special Requirements:

☒ Acoustic Emission Testing

☐ Inspection or Testing Requirements not Listed in the Standard

☐ User Waives Visual Inspection Prior to Application of Final Exterior Coat: ☐ Yes ☒ No
Visual Inspection Acceptance Level (refer to Table 6-1 of ASME RTP-1):

☐ Level 1
☒ Level 2

Quantity Limitations for Gaseous Air Bubbles or Blisters: No more than 2 per square inch of 1/8”
diameter or larger.

☐ Additional Inspection Aids/Methods (refer to Para. 6-940(c) of ASME RTP-1):

3. Material Selection:

3.1 Material Selection by:

☒ Resin Manufacturer (include data per Section 4 of this Document)
☒ Fabricator (include data per Section 4 of this Document)
☐ End User. Applicable User’s Specifications/Standards, Codes, Ordinances, FDA Requirements, etc. (list and specify; attach copies of local code/ordinance requirements):

☐ Other

3.2 Material of Construction:

Resin:__________________________  Catalyst/Cure System:__________________________
Veil:__________________________  Barcol Hardness per Para. 6-910(b)(4):__________________________

☒ Lift Lugs:  ☒ RTP  ☐ Carbon Steel  ☐ Other:__________________________

☒ Hold-down Lugs:  ☐ RTP  ☐ Carbon Steel  ☒ Other: Epoxy Coated CS

4. Chemical Service Data (must be provided when Fabricator or resin manufacturer is making material selection): 40% Ferric Chloride.

4.1 Description of Process Function and Process Sequence: 40% Ferric Chloride storage tank.
4.20 Contents:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Concentration</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferric Chloride</td>
<td>Max. %</td>
<td>Min. %</td>
<td>Exposure Time</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>35</td>
<td>Continuous</td>
<td></td>
</tr>
</tbody>
</table>

4.21 pH Range: 1.4 Max. 1.0 Min.

5. Design:

5.1 Design Conditions:

<table>
<thead>
<tr>
<th>Operating</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pressure</td>
<td>Atmospheric</td>
</tr>
<tr>
<td>External Pressure</td>
<td>Atmospheric</td>
</tr>
<tr>
<td>Temperature</td>
<td>40 F to 100 F</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.42</td>
</tr>
<tr>
<td>Liquid Level</td>
<td>10.0 ft</td>
</tr>
</tbody>
</table>

Wind/Seismic/Snow Code (include edition or year) ASCE 7-10

Basic Wind Speed 120 MPH Classification Category C Exposure B

Elevation Above Grade 0 ft Topographic Factors: N/A

Seismic Zone C

Site-specific Seismic Information (soil type, ground motion coefficients, etc. See Additional Requirements)

Snow Load None psf

Ice Load None psf

Personnel Load: 100 psf

Capacities: Operating 7,125 gal Flooded 7,775 gal

5.2 Mechanical Agitator: □ Required □ Not Required

Dead Load __________________________ lb

Static Bending Moment __________________________ ft-lb

Dynamic Bending Moment __________________________ ft-lb

Torque __________________________ ft-lb

Horsepower __________________________ hp

Impeller Speed __________________________ rpm
Impeller Diameter ________________________________ in

Number of Impellers ________________________________

Foot Bearing: ☐ Yes ☒ No

5.3 Heating and Cooling:

☒ Electric Panels
☐ Steam Coil
☐ Steam Sparger
☐ Heat Exchanger
☐ Other ________________________________

5.4 Mechanical and Other Forces:

☐ Violent Chemical Reaction
☐ Subsurface Introduction of Gas and Vapor
☐ Subsurface Introduction of Steam
☐ Transmitted Mechanical Load/Force
☐ Impact Due to Introduction of Solids
☐ Vacuum from Pump Down (or Vessel Draining)
☐ Vacuum from Cool Down
☐ Other ________________________________

5.5 Corrosion Barrier Excluded from Structural Calculations:

☐ Yes
☒ No

5.6 Declaration of Critical Service (only by User or User’s Agent; refer to Para. 1-210 of ASME RTP-1):

☐ Yes
☒ No
6. Designation of Inspection (Reviewer Paras. 1-400, 1-430, and 1-440 of ASME RTP-1. It must be recognized that ASME RTP-1 establishes numerous duties for the Inspector, which necessitates that the Inspector be present in the fabrication shop throughout a major portion of the fabrication interval.) Inspector shall be:

☑  Fabricator’s Quality Control Principal

☐  User’s Representative

☐  Other _______________________

Inspector’s Name: __________________________  Telephone: __________

Company: ______________________________________

Address: ______________________________________

6.1 Approval of Inspector Designation:

6.1.1 Authorized User’s Representative:

Name __________________________  Title____________________

Signature __________________________  Date __________

6.1.2 Authorized Fabricator’s Representative:

Name __________________________  Title____________________

Signature __________________________  Date __________

Additional Requirements: ______________________________________

False Bottom: Nominal 6” false bottom sloped at 2% toward the drain invert.

Seismic Loads: SS = 0.375, S1 = 0.121, Site Class Definition = D. SDS = 0.30g, SD1 = 0.136g,

Risk Category = III, Seismic Design Category = C, Importance Factor = 1.25

Handrail: OSHA approved handrail around top of tank with self-closing gate and kickplates.

Fill Dip Tube: 2” flanged dip tube and anti-syphon hole

______________________________________________

GENERAL NOTE: This form may be reproduced and used without written permission from ASME if used for purposes other than republication.
Project: OUTFALL 200 MERCURY TREATMENT FACILITY
Tank Name: FERRIC CHLORIDE TANK
Tag No.: 941002-CHEM-T-520

GENERAL INFORMATION
Service: 40% FERRIC CHLORIDE [SPECIFIC GRAVITY = 1.42]
Capacity: 7,775 GALLONS
Design code: ASTM/ASME RTP-1
Material: FILAMENT-WOUND FRP
Temperature: 40°F TO 100°F

NOZZLE SCHEDULE

<table>
<thead>
<tr>
<th>MK</th>
<th>Size</th>
<th>Type</th>
<th>Service</th>
<th>Projection</th>
<th>Radial CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>2&quot;</td>
<td>FLG</td>
<td>DISCHARGE</td>
<td>9&quot;</td>
<td></td>
</tr>
<tr>
<td>N2</td>
<td>2&quot;</td>
<td>FLG</td>
<td>DRAIN</td>
<td>9&quot;</td>
<td></td>
</tr>
<tr>
<td>N3</td>
<td>4&quot; / 2&quot;</td>
<td>FLG</td>
<td>INLET/FILL WITH 2' DIP TUBE</td>
<td>6&quot;</td>
<td>4'-0&quot;</td>
</tr>
<tr>
<td>N4</td>
<td>6&quot;</td>
<td>FLG</td>
<td>VENT</td>
<td>6&quot;</td>
<td>4'-0&quot;</td>
</tr>
<tr>
<td>N5</td>
<td>4&quot;</td>
<td>FLG</td>
<td>LEVEL TRANSMITTER</td>
<td>6&quot;</td>
<td>4'-0&quot;</td>
</tr>
<tr>
<td>N6</td>
<td>4&quot;</td>
<td>FLG</td>
<td>SPARE</td>
<td>6&quot;</td>
<td>4'-0&quot;</td>
</tr>
<tr>
<td>N7</td>
<td>4&quot;</td>
<td>FLG</td>
<td>SPARE</td>
<td>6&quot;</td>
<td>4'-0&quot;</td>
</tr>
<tr>
<td>N8</td>
<td>24&quot;</td>
<td>FLG</td>
<td>ACCESS HATCH</td>
<td>6&quot;</td>
<td>3'-0&quot;</td>
</tr>
<tr>
<td>N9</td>
<td>30&quot;</td>
<td>FLG</td>
<td>MANWAY</td>
<td>9&quot;</td>
<td></td>
</tr>
<tr>
<td>N10</td>
<td>4&quot;</td>
<td>FLG</td>
<td>OVERFLOW</td>
<td>9&quot;</td>
<td></td>
</tr>
</tbody>
</table>

ACCESSORIES
- X FALSE BOTTOM
- X WALKABLE TOP
- X ANCHOR LUGS
- X HEAT PANELS EQUALLY SPACED
- X INSULATE
- X DIP TUBE
- X HANDRAILS WITH SELF-CLOSING GATE AND TOE BOARDS
- X BLIND FLANGES: PROVIDE BLIND FLANGES WITH BOLTING FOR ALL SPARE NOZZLES

NOTES:
1. INVERT OF NOZZLE N2 SHALL BE FLUSH WITH BOTTOM OF TANK.
2. NOZZLE PROJECTION FROM OD OF TANK WALL. COPE INSULATION BACK AROUND NOZZLES TO PROVIDE ACCESS TO FLANGE BOLTING.
3. TOP OF TANK TO BE UNINSULATED.
4. MANWAY N9 IS TO BE INSULATED. ACCESS HATCH N8 IS TO BE UN-INSULATED.
5. HANDRAIL OPENING WIDTH TO MATCH WALKWAY OPENING WIDTH.
6. PROVIDE 2" DIP TUBE ASSEMBLY CONSISTING OF 4" TANK FLANGE AND 2" PIPE FLANGE. PROVIDE 1/2" ANTI-SYPHON HOLE AT TOP OF DIP TUBE ABOVE OVERFLOW CONNECTION.
7. PROVIDE FALSE BOTTOM SLOPED AT 2% TOWARD DRAIN INVERT.
8. HEAT TRACING TO MAINTAIN TANK CONTENTS AT A MINIMUM TEMPERATURE OF 40°F AND A MAXIMUM TEMPERATURE OF 100°F. TEMPERATURE SHALL BE THERMOSTATICALLY CONTROLLED.
9. DRILL 1/2" HOLE IN TOP OF N3 DIP TUBE LOCATED 3" BELOW TOP OF TANK SIDE WALL FACING CENTER OF TANK.
**General Information**

- **Service**: DECHLORINATED WATER @ 35°-87°F (SG = 1.0)
- **Capacity**: 11,375 GALLONS
- **Design Code**: ASME RTP-1
- **Material**: FILAMENT-WOUND FRP
- **Temperature**: -17° TO 105°F

**Nozzle Schedule**

<table>
<thead>
<tr>
<th>MK</th>
<th>Size</th>
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**Accessories**

- X 18" FRP INT DIP TUBE ON OUTLET
- X EXTERNAL PIPE SUPPORT CLIPS
- X INTERNAL PIPE SUPPORT CLIPS
- X NON-TANK MOUNTED MIXER
- X TANK BAFFLES

**Notes:**

1. 18" FRP DIP TUBE SHALL BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.
2. COORDINATE BAFFLE SIZE AND MOUNTING REQUIREMENTS WITH MIXER MANUFACTURER AND TANK FABRICATOR.
3. BAFFLES NOT SHOWN IN ELEVATION VIEW FOR CLARITY. BAFFLES ARE 1FT WIDE x 8FT TALL. EDGE OF BAFFLES TO BE LOCATED 3IN FROM INSIDE WALL OF TANK. BOTTOM OF BAFFLES TO BE LOCATED 1.5FT ABOVE BOTTOM OF TANK.
PROJECT: OUTFALL 200 MERCURY TREATMENT FACILITY

TANK NAME: DECHLORINATION TANK B

TAG NO.: 941002-CHTR-T-410-B

GENERAL INFORMATION

- **Service:** DECHLORINATED WATER @ 35° - 87°F (SG = 1.0)
- **Capacity:** 11,375 GALLONS
- **Design code:** ASME RTP-1
- **Material:** FILAMENT - WOUND FRP
- **Shell:** VERTICAL CYLINDRICAL
- **Roof:** OPEN TOP
- **Temperature:** -17° TO 105°F
- **Bottom:** FLAT

NOZZLE SCHEDULE

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ACCESSORIES

- X 18" FRP INT DIP TUBE ON OUTLET
- X EXTERNAL PIPE SUPPORT CLIPS
- X INTERNAL PIPE SUPPORT CLIPS
- X NON-TANK MOUNTED MIXER
- X TANK BAFFLES

NOTES:

1. 18" FRP DIP TUBE SHALL BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.
2. COORDINATE BAFFLE SIZE AND MOUNTING REQUIREMENTS WITH MIXER MANUFACTURER AND TANK FABRICATOR.
3. BAFFLES NOT SHOWN IN ELEVATION VIEW FOR CLARITY. BAFFLES ARE 1FT WIDE x 8FT TALL. EDGE OF BAFFLES TO BE LOCATED 3IN FROM INSIDE WALL OF TANK. BOTTOM OF BAFFLES TO BE LOCATED 1.5FT ABOVE BOTTOM OF TANK.
NOTES:

1. **12" DIP TUBE SHALL BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.**

2. **1" FLP INJECTS INTO DIP TUBE THRU WALL OF TANK**

3. **COORDINATE BAFFLE SIZE AND MOUNTING REQUIREMENTS WITH MIXER MANUFACTURER AND TANK FABRICATOR.**

4. **BAFFLES NOT SHOWN IN ELEVATION VIEW FOR CLARITY. BAFFLES ARE 1FT WIDE x 8FT TALL. EDGE OF BAFFLES TO BE LOCATED 3IN FROM INSIDE WALL OF TANK. BOTTOM OF BAFFLES TO BE LOCATED 1.5FT ABOVE BOTTOM OF TANK.**

5. **TANK MANUFACTURER TO PROVIDE PIPE CENTERING DEVICE FOR 1/2" NPS INJECTION QUILL.**
Project: OUTFALL 200 MERCURY TREATMENT FACILITY
Tank Name: POLYMER AND COPRECIP REACTION TANK B
Tag No.: 941002-CHTR-T-420-B

GENERAL INFORMATION
Service: COAGULATED WATER @ 36° - 87°F (SG = 1.03)
Capacity: 22,586 GALLONS
Thickness: 
Design code: ASME RTP-1
Roof: OPEN TOP
Material: FILAMENT-WOUND FRP
Shell: VERTICAL CYLINDRICAL
Temperature: -17° TO 105°F
Bottom: FLAT

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ACCESSORIES
- X 12" FRP INT DIP TUBE ON OUTLET
- X INTERNAL PIPE SUPPORT CLIPS
- X NON-TANK MOUNTED MIXER
- X TANK BAFFFES

NOTES:
1. 12" DIP TUBE SHALL BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.
2. 1" FLP INJECTS INTO DIP TUBE THRU WALL OF TANK
3. COORDINATE BAFFLE SIZE AND MOUNTING REQUIREMENTS WITH MIXER MANUFACTURER AND TANK FABRICATOR.
4. BAFFLES NOT SHOWN IN ELEVATION VIEW FOR CLARITY. BAFFLES ARE 1FT WIDE x 8FT TALL. EDGE OF BAFFLES TO BE LOCATED 3IN FROM INSIDE WALL OF TANK. BOTTOM OF BAFFLES TO BE LOCATED 1.5FT ABOVE BOTTOM OF TANK.
5. TANK MANUFACTURER TO PROVIDE PIPE CENTERING DEVICE FOR 1/2" NPS INJECTION QUILL.
**GENERAL INFORMATION**

- **Service**: COAGULATED WATER @ 36° - 87°F (SG = 1.03)
- **Capacity**: 22,586 GALLONS
- **Design code**: ASME RTP-1
- **Material**: FILAMENT-WOUND FRP
- **Temperature**: -17° TO 105°F

**NOZZLE SCHEDULE**

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**ACCESSORIES**

- X 12" FRP INT DIP TUBE ON OUTLET
- X INTERNAL PIPE SUPPORT CLIPS
- X NON-TANK MOUNTED MIXER
- X TANK BAFFLES

**NOTES:**

1. 12" DIP TUBE SHALL BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.
2. 1" FLG INJECTS INTO DIP TUBE THRU WALL OF TANK
3. COORDINATE BAFFLE SIZE AND MOUNTING REQUIREMENTS WITH MIXER MANUFACTURER AND TANK FABRICATOR.
4. BAFFLES NOT SHOWN IN ELEVATION VIEW FOR CLARITY. BAFFLES ARE 1FT WIDE x 8FT TALL. EDGE OF BAFFLES TO BE LOCATED 3IN FROM INSIDE WALL OF TANK. BOTTOM OF BAFFLES TO BE LOCATED 1.5FT ABOVE BOTTOM OF TANK.
GENERAL INFORMATION

Service: COAGULATED WATER @ 36° - 87°F (SG = 1.03)
Capacity: 22,586 GALLONS
Design code: ASME RTP-1
Material: FILAMENT-WOUND FRP
Temperature: -17° TO 105°F

NOZZLE SCHEDULE

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ACCESSORIES

- X 12" FRP INT DIP TUBE ON OUTLET
- X INTERNAL PIPE SUPPORT CLIPS
- X NON-TANK MOUNTED MIXER
- X TANK BAFFLES

NOTES:

1. 12" DIP TUBE SHALL BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.
2. 1" FLG INJECTS INTO DIP TUBE THRU WALL OF TANK
3. COORDINATE BAFFLE SIZE AND MOUNTING REQUIREMENTS WITH MIXER MANUFACTURER AND TANK FABRICATOR.
4. BAFFLES NOT SHOWN IN ELEVATION VIEW FOR CLARITY, BAFFLES ARE 1FT WIDE x 8FT TALL. EDGE OF BAFFLES TO BE LOCATED 3IN FROM INSIDE WALL OF TANK. BOTTOM OF BAFFLES TO BE LOCATED 1.5FT ABOVE BOTTOM OF TANK.
Project: OUTFALL 200 MERCURY TREATMENT FACILITY
Tank Name: SLUDGE SETTLING TANK A
Tag No.: 941002-SLDP-T-700-A

GENERAL INFORMATION
Service 4% FERRIC HYDROXIDE SLUDGE 35°-87°F (SG = 1.03)
Capacity 33,111 GALLONS
Design code ASME RTP-1
Material FILAMENT-WOUND FRP
Temperature -17° TO 105°F

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ACCESSORIES
- X EXTERNAL PIPE SUPPORT CLIPS
- X EXTERNAL LADDER WITH CAGE AND PLATFORM
- X PERSONNEL TIE OFF SYSTEM
- X TANK SKIRT SUPPORT

NOTES:
1. PROVIDE 36" OPENINGS IN SUPPORT SKIRT TO PERSONNEL ACCESS AT 0°, 90°, 180° AND 270°.
2. TANK SHALL BE DIRECTLY VENTED BY A PERMANENTLY ATTACHED VENT MATCHING TANK MATERIAL AND MAY NOT BE EQUIPPED WITH A FLANGED VENT OR REMOVABLE VENT.
3. PROVIDE AND INSTALL 12" DIAMETER REMOVABLE END CAP ON TANK VENT WITH 1/2" x 1/2" MESH, 16 GA SST BIRD SCREEN.
Project: OUTFALL 200 MERCURY TREATMENT FACILITY
Tank Name: SLUDGE SETTLING TANK B
Tag No.: 941002-SLDP-T-700-B

GENERAL INFORMATION
Service 4% FERRIC HYDROXIDE SLUDGE 36°F - 87°F (SG = 1.03)
Capacity 33,111 GALLONS
Design code ASME RTP-1
Material FILAMENT-WOUND FRP
Temperature -17°F TO 105°F

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<td>FLG</td>
<td>LEVEL ELEMENT</td>
<td>6&quot;</td>
<td></td>
</tr>
</tbody>
</table>

ACCESSORIES
X EXTERNAL PIPE SUPPORT CLIPS
X EXTERNAL LADDER WITH CAGE AND PLATFORM
X PERSONNEL TIE OFF SYSTEM
X TANK SKIRL SUPPORT

NOTES:
1. PROVIDE 36" OPENINGS IN SUPPORT SKIRT TO PERSONNEL ACCESS AT 0°, 90°, 180° AND 270°.
2. TANK SHALL BE DIRECTLY VENTED BY A PERMANENTLY ATTACHED VENT MATCHING TANK MATERIAL AND MAY NOT BE EQUIPPED WITH A FLANGED VENT OR REMOVABLE VENT.
3. PROVIDE AND INSTALL 12" DIAMETER REMOVABLE END CAP ON TANK VENT WITH 1/2" x 1/2" MESH, 16 GA SST BIRD SCREEN.
NOTES:
1. PROVIDE 36" OPENINGS IN SUPPORT SKIRT TO PERSONNEL ACCESS AT 0°, 90°, 180° AND 270°.

2. TANK SHALL BE DIRECTLY VENTED BY A PERMANENTLY ATTACHED VENT MATCHING TANK MATERIAL AND MAY NOT BE EQUIPPED WITH A FLANGED VENT OR REMOVABLE VENT.

3. PROVIDE AND INSTALL 12" DIAMETER REMOVABLE END CAP ON TANK VENT WITH 1/2" x 1/2" MESH, 16 GA S.S. BIRD SCREEN.
KEY HISTORICAL WATER QUALITY DATA
OF200 MTF Design Criteria Document
DCG-9OF200-D35

Table 1. Key historical WQ data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>95th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>gpm</td>
<td>1350</td>
<td>358</td>
<td>12,521</td>
<td>2939</td>
</tr>
<tr>
<td>Mercury</td>
<td>mg/L</td>
<td>2480</td>
<td>232</td>
<td>109,772</td>
<td>6,441</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>22</td>
<td>4</td>
<td>240</td>
<td>87</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mg/L</td>
<td>0.00539</td>
<td>0.0002</td>
<td>0.0167</td>
<td>NA</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>40</td>
<td>15</td>
<td>68</td>
<td>57</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
<td>0.8</td>
<td>0.03</td>
<td>12</td>
<td>4.0</td>
</tr>
<tr>
<td>Lead</td>
<td>mg/L</td>
<td>0.0056</td>
<td>0.0002</td>
<td>0.100</td>
<td>0.015</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>8.7</td>
<td>2.7</td>
<td>17.1</td>
<td>11.9</td>
</tr>
<tr>
<td>Total Residual Chlorine</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Methanol</td>
<td>mg/L</td>
<td>3.71</td>
<td>0.47</td>
<td>5.1</td>
<td>NA</td>
</tr>
<tr>
<td>PCBs</td>
<td>mg/L</td>
<td>0.00116</td>
<td>0.00026</td>
<td>0.023</td>
<td>NA</td>
</tr>
<tr>
<td>Total Nitrates and</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Nitrites</td>
<td>mg/l</td>
<td>6.23695</td>
<td>5.5</td>
<td>24.9</td>
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<tr>
<td>Natural Uranium</td>
<td>mg/L</td>
<td>0.04184</td>
<td>0.003</td>
<td>0.278</td>
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<tr>
<td>BOD</td>
<td>mg/L</td>
<td>12</td>
<td>5</td>
<td>34</td>
<td>27</td>
</tr>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>32</td>
<td>8</td>
<td>75</td>
<td>72</td>
</tr>
<tr>
<td>TDS</td>
<td>mg/L</td>
<td>243</td>
<td>164</td>
<td>546</td>
<td>274</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>mg/L</td>
<td>121</td>
<td>102</td>
<td>140</td>
<td>138</td>
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<tr>
<td>pH</td>
<td>pH</td>
<td>7.7</td>
<td>6.9</td>
<td>9.0</td>
<td>8.1</td>
</tr>
<tr>
<td>Temperature</td>
<td>deg C</td>
<td>21</td>
<td>13</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>Conductivity</td>
<td>μmho</td>
<td>464</td>
<td>38</td>
<td>1210</td>
<td>849</td>
</tr>
<tr>
<td>DO</td>
<td>ppm</td>
<td>8.4</td>
<td>6.2</td>
<td>11.4</td>
<td>10.8</td>
</tr>
</tbody>
</table>

*BOD = biological oxygen demand  PCB = polychlorinated biphenyl
COD = chemical oxygen demand    TDS = total dissolved solids
deg = degree                   TSS = total suspended solids
DO = dissolved oxygen          WQ = water quality
NA = not available
<table>
<thead>
<tr>
<th>Filament-wound or Contact-molded</th>
<th>Maximum Capacity Measured to High Solution Level (gallons)</th>
<th>Installation (Vertical/ Horizontal)</th>
<th>Diameter (feet)</th>
<th>Straight Shell Height (feet)</th>
<th>Support (saddles, flat pad, legs)</th>
<th>Type of Bottom Head</th>
<th>Type of Top Head</th>
<th>Ladder Required (Yes/No)</th>
<th>Tank Location (indoor/ outdoor)</th>
<th>Ambient Temperature Range [degrees F]</th>
<th>Exterior Loading (psf)</th>
<th>Personnel Roof Loads (psf)</th>
<th>Platforms</th>
<th>Mixers</th>
<th>Pipe Supports</th>
<th>Baffles</th>
<th>Dip-Pipes</th>
<th>Operating Contents</th>
<th>Contents Temperature (degrees F, not to exceed 180)</th>
<th>Chemical Composition</th>
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</thead>
<tbody>
<tr>
<td>Filament-wound 9,163</td>
<td>Vertical 11 16</td>
<td>flat pad Flat Open No Outdoor -77 to 105</td>
<td>See Structural General Sheets N/A No Yes Yes Yes INF 36 - 87</td>
<td>See UBRS</td>
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</tr>
<tr>
<td>Filament-wound 17,981</td>
<td>Vertical 15.5 14</td>
<td>flat pad Flat Open No Outdoor -76 to 105</td>
<td>See Structural General Sheets N/A No Yes Yes Yes DCW 36 - 87</td>
<td>See UBRS</td>
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<tr>
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<td>flat pad Flat Open No Outdoor -76 to 105</td>
<td>See Structural General Sheets N/A No Yes Yes Yes DCW 36 - 87</td>
<td>See UBRS</td>
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<tr>
<td>Filament-wound 17,981</td>
<td>Vertical 15.5 14</td>
<td>flat pad Flat Open No Outdoor -76 to 105</td>
<td>See Structural General Sheets N/A No Yes Yes Yes CW 36 - 87</td>
<td>See UBRS</td>
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</tr>
<tr>
<td>Filament-wound 31,876</td>
<td>Vertical 15.5 24</td>
<td>Skirt 45° Cone Elliptical Yes Outdoor -76 to 105</td>
<td>See Structural General Sheets 100 Yes No Yes No No SLW 36 - 87</td>
<td>See UBRS</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Filament-wound 31,876</td>
<td>Vertical 15.5 24</td>
<td>Skirt 45° Cone Elliptical Yes Outdoor -76 to 105</td>
<td>See Structural General Sheets 100 Yes No Yes No No SLW 36 - 87</td>
<td>See UBRS</td>
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</tr>
<tr>
<td>Filament-wound 7,775</td>
<td>Vertical 10.5 12.5</td>
<td>flat pad Sloped Elliptical No Outdoor -77 to 105</td>
<td>See Structural General Sheets 100 Yes No Yes Yes Yes FCL 40-100</td>
<td>See UBRS</td>
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</tr>
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</table>
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Rotary Positive Displacement Blower

### Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

### Document Review & Approval:

**Originator:**
Steven R. Polson, P.E./Lead Process Mechanical

![Signature Image]

**Design Verification Complete:**
Qingshan Wang, P.E./Process Mechanical QC Reviewer

![Signature Image]

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager

![Signature Image]
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).
3. ASTM International (ASTM):
5. American Society of Heating, Refrigerating, and Air-conditioning Engineers:
   a. 52.2-2012.

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. BHP: (Shaft) brake horsepower is the 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 the 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.

G. SCADA: Supervisory Control and Data Acquisition.
1.03 SYSTEM DESCRIPTION

A. Blower system, featuring rotary positive displacement blowers to supply air for the filter backwash process system.

B. 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 room air from a dedicated filter and discharge into a main air discharge header.

D. Intermittent operation in an indoor environment.

E. Each blower shall start no more than two times per hour when operating in intermittent service.

F. Blowers shall meet rated performance and sound level when operating at a maximum gear speed of 3,720 rotations per minute. Operating speed shall not exceed 90 percent of rated speed.

G. Maximum Sound Pressure Level: 90 dBA, factory calculated, with inlet and discharge silencers, measured with a sound enclosure.

H. Performance Requirements:

<table>
<thead>
<tr>
<th>Design Conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Capacity, scfm</td>
<td>1,040</td>
</tr>
<tr>
<td>Maximum Capacity, icfm</td>
<td>1,205</td>
</tr>
<tr>
<td>Altitude, ft</td>
<td>950</td>
</tr>
<tr>
<td>Barometric pressure, psia</td>
<td>14.2</td>
</tr>
<tr>
<td>Inlet air temperature, degrees F (Guarantee Point)</td>
<td>105</td>
</tr>
</tbody>
</table>
### Design Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet air temperature range, degrees F</td>
<td>50 min to 105 max</td>
</tr>
<tr>
<td>Relative humidity, % (Guarantee Point)</td>
<td>40</td>
</tr>
<tr>
<td>Maximum inlet pressure loss, psid</td>
<td>0.95</td>
</tr>
<tr>
<td>Maximum discharge pressure loss, psid</td>
<td>0.16</td>
</tr>
<tr>
<td>Blower discharge pressure required, psid</td>
<td>9.1</td>
</tr>
<tr>
<td>Pressure relief valve setting, psig</td>
<td>11</td>
</tr>
<tr>
<td>Shaft brake horsepower, BHP&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>75</td>
</tr>
</tbody>
</table>

<sup>1</sup>Includes main oil pump, if specified, and all gear and bearing frictional losses.

<sup>2</sup>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. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

l. Sound Enclosure:
   1) Complete description of sound enclosure and accessories.
   2) Calculated noise attenuation.

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. 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.
3. Factory calculated sound levels (dBA) of blower unit and silencers.
4. Factory calculated sound levels (dBA) of blower unit with silencers and sound enclosure.
5. Identification of outside utility requirements for each component such as air, water, power, etc. Include operating parameters for required utilities.
6. Pipe stress analysis for blower discharge piping when proposed piping requires modification to accommodate supplied equipment.
7. Special shipping, storage and protection, and handling instructions.
8. Manufacturer’s written installation instructions.
9. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
10. 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.
11. Routine maintenance requirements prior to plant startup.
12. Test Reports:
   a. Factory test reports for blower and motor.
   b. Field test procedures.
13. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
14. 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 (if required), and materials:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Filters</td>
<td>Enough for two complete changes per unit</td>
</tr>
<tr>
<td>Flexible Coupling</td>
<td>One complete set</td>
</tr>
<tr>
<td>Drive V-Belts</td>
<td>One complete set</td>
</tr>
<tr>
<td>If required, special tools required to</td>
<td>One complete set</td>
</tr>
<tr>
<td>maintain or dismantle</td>
<td></td>
</tr>
</tbody>
</table>

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. Kaeser EB 421 C.
2. Or 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. Each shaft assembly shall be supported by single-row roller bearings sized for a minimum L10 rating of 100,000 hours at design conditions.
   b. Drive end bearings shall be fixed to control axial location of impeller assembly.
   c. Bearings and gears shall be lubricated by a splash type lubrication system on both ends of the rotors.
   d. Provide each bearing with a positive lip type oil seal designed to prevent lubricant from entering air stream 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. Rotors:
   a. Each rotor/shaft assembly 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. Three-lobe rotor type, rotating in opposite directions in a common casing without rubbing, liquid seals, or lubrication.
   c. Positioned by timing gears to maintain proper clearances.

5. Shafts:
   a. Cast iron, integral with rotors.
   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 1.2.
   c. Designed not to exceed allowable overhung load limits of blower and motor.
   d. Provide belt guard.

B. Motor:

1. Squirrel-cage ac induction type, meeting requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
3. Nominal Speed: 3,600 rpm, variable.
4. Rated Voltage: 460 volt, three-phase, 60-Hz.
5. Enclosure Type: ODP as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
6. Inverter duty rated.
   a. Shaft grounding brush on the driven (shaft) end of the motor.
   b. Insulated bearing on the non-driven end of the motor.
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: 1.15 when operated on a sinusoidal source; 1.0 when operated on an ac drive.
10. Thermistors woven into winding, not embedded in windings, are acceptable.

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 shall be 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. Air Inlet Filter:
   1. Provide individual filters for each blower.
   2. Filter efficiency shall meet ASHRAE 52.2 MERV7 50 to 70 percent at 3 to 10 microns.
   3. Factory installed within sound enclosure.
   4. Support leg height shall be field coordinated by Contractor.
   5. Manufacturers:
      a. Universal.
      b. Stoddard.
      c. Or equivalent.

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: 5,500 feet per minute, maximum.
   4. Pressure Loss: .5 psid maximum combined loss, through silencers at design flow rate.
   5. Inlet and outlet flanges shall match the piping size shown on Drawings and blower flanges. Flange drilling shall be 125-pound ANSI standard.
   6. Provide drain coupling and plug.
7. Mount as shown on Drawings.
8. Manufacturers and Products:
   a. Intake Silencer: Universal, Stoddard, or equivalent flanged inlet and discharge, modified as shown.
   b. Discharge Silencer: Universal, Stoddard, or equivalent flanged inlet and discharge, modified as shown complete with support base.

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: 250 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 1025.
      c. Vibraflex; PCS Series.
      d. Or equal.

D. Check Valve:

   1. 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 cast iron or aluminum plates.
   3. Seat: Viton or Silicone for high temperature operation. Elastomeric hinges will not be allowed.
   4. Manufacturer: Techno Corporation; or equivalent.

E. Safety Relief Valve:

   1. Flanged, spring type.
   2. Sized to relieve entire discharge flow without overloading blower.
   3. Furnish one for each blower.
   4. Relief valve shall be factor installed within sound enclosure and vented outside of the enclosure.

F. Temperature Sensor:

   1. Provide HIGH discharge air temperature sensor, rated NEMA 4, for each blower.
   2. Locate sensor directly after blower discharge within sound enclosure.
G. Noise Enclosure:

1. Partial Noise Enclosure: 95 dBA average noise level at 1 meter.

H. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

I. Equipment Identification Plates: Provide 16-gauge 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 die-stamped block type black enamel filled equipment identification number and letters indicated in this Specification.

J. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.04 INSTRUMENTATION AND CONTROLS

A. Instrumentation and controls work of this section shall be in accordance with Section 40 99 90, Package Control Systems. External signal interfaces are required to interface with facility’s supervisory control and data acquisition (SCADA). Provide items not specifically called out which are required to implement functions required for proper system operation.

B. Control Panel:

2. NEMA Rating: 4.
4. Hand Switches:
   a. Disconnect switch.
   b. LOCAL/OFF/REMOTE.
   c. START/STOP.
   d. RESET for blower fail.
5. Indicating Lights:
   a. Blower FAIL.
   b. HIGH differential air pressure.
   c. Amber STOP.
   d. Blower ON.
   e. Blower OFF.
6. Miscellaneous:
   a. RUN time meter.
   b. High inlet vacuum shutdown.
   c. Discharge High Temperature Shutdown: 0 degree to 350-degree range, NEMA 4 mounted, field adjustable, as manufactured by Ashcroft.
d. Discharge High Pressure Shutdown: 5 psig to 15 psig range, NEMA 4 mounted, field adjustable, as manufactured by Ashcroft.

e. Inlet and Discharge Pressure Gauges: Liquid filled, 4.5-inch face, as manufactured by Ashcroft.

f. Inlet and Discharge Temperature Gauges: Minus 20 degrees F to 120 degrees F inlet, 50 degrees F to 400 degrees F discharge, 5-inch-diameter dial every angle, as manufactured by Ashcroft.

C. Control Panel External Interfaces:

1. Discrete Outputs to SCADA:
   a. Dry contacts shall be noble metal or hermetically sealed, and suitable for 5 amps at 120V ac.
   b. REMOTE status.
   c. Common FAIL alarm contact that closes on the occurrence of any of the following conditions (to be used by SCADA):
      1) HIGH differential air pressure.
      2) HIGH discharge temperature.
      3) Motor OVERTEMP.

2. Discrete Outputs to MCC:
   a. Dry contacts rated for 10 amps at 120V ac for use in motor starter circuit.
   b. RUN.

3. Discrete Inputs:
   a. Contact Rating: 5 amps at 120V ac.
   b. Sensing Voltage: 120V ac.
   c. START/STOP from SCADA.
   d. HIGH differential air pressure from field devices.

4. Discrete Inputs from MCC:
   a. Dry contacts rated for 10 amps at 120V ac for use in motor starter circuit.
   b. Sensing Voltage: 120V ac supplied by control panel.
   c. Blower ON.
   d. Motor OVERTEMP.

5. Signals that interface with SCADA shall be wired to a terminal block in each panel.

6. Contacts:
   a. Material: Gold or silver.
   b. Minimum Rating: 5 amps, 28V dc.
   c. Discrete Outputs:
      2) Other: Single-pole, single-throw (SPST) dry type.
   d. Wire each discrete alarm output relay contact to a terminal strip for interfacing to SCADA.
D. System Operation:

1. Functional Requirements: Provide at each panel.
   a. RESET pushbutton and associated logic for the common FAIL alarms. When alarm condition occurs, indicate associated condition at panel. Local indication of alarm condition shall remain until condition has been corrected and RESET pushbutton pressed.
   b. Control logic to monitor operation of blower and provide a contact closure output to motor control center when prestartup or operating conditions are normal. Open contact if a HIGH differential air pressure between blower inlet and outlet condition or HIGH discharge air temperature is detected.
   c. Indicate blower shutdown and problem using latching relays.

E. Shop/Factory Finishing: Prepare and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

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. Perform Slip Test in accordance with manufacturer’s established criteria.
   a. Describe the testing configuration.
   b. Document operating conditions, temperatures, pressures, blower speed, etc.
   c. Complete slip calculations at test conditions.
5. Measure power consumption using a calibrated wattmeter.
6. 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 THE UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

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 the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

END OF SECTION
Weir Plates
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. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

1.02  SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s drawings showing dimensions of the items and accessories being provided.

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  MATERIALS

A. Stainless Steel:

2.02 APPURtenances

A. 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.

B. 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. Install weir plates such that weir crest is level with a maximum variation of 1/16 inch throughout its entire length.

C. 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. Survey and set weir crest elevation before sealant sets up.
   f. Clean all adjacent surfaces of smears or soiling.
3.02 TESTS AND INSPECTION

A. In accordance with the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

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
Vortex Grit Chamber Equipment
PART 1   GENERAL

1.01 REFERENCES

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

1. Hydraulic Institute Standards (HIS).
2. National Electrical Manufacturers’ Association (NEMA): MG 1, Motors and Generators.

1.02 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Remove 95 percent of the grit greater than 50 mesh in size, 85 percent of the grit greater than 70 mesh but less than 50 mesh in size and 65 percent of the grit greater than 100 mesh and less than 70 mesh in size, at the peak wastewater flow rates of 5.8 mgd (peak hydraulic flow for the Base Flow Grit Chamber) and 53 mgd (peak hydraulic flow for the Storm Flow Grit Chamber).
2. Provide manufacturer’s standard influent baffle to enhance hydraulic flow patterns in grit chamber.

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 and Field Painting Systems Proposed: Include Manufacturer’s descriptive technical catalog literature and specifications.

g. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s reference listing of previous installations as specified herein.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
4. Certification that the factory-applied coating system(s) is identical to the requirements specified.
5. Special shipping, storage and protection, and handling instructions.
6. Manufacturer’s written/printed installation instructions.
7. Routine maintenance requirements prior to plant startup.
8. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.
9. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.04 EXTRA MATERIALS

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special tools required to maintain or dismantle unit</td>
<td>One complete set</td>
</tr>
</tbody>
</table>

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. Smith and Loveless.
2. Veolia Water Technologies (John Meunier).
3. Westech.
2.02 FACILITY DESIGN BASIS

A. The facilities and details in this Specification are based on the first-named manufacturer. Other manufacturers shall clearly note in Submittals the differences in their equipment from that defined in this Specification, as well as any changes to the facility configuration and design necessary to accommodate their equipment or allow them to meet the performance requirements specified herein. The Contractor shall be responsible for the cost of any modifications to the facilities necessary for a submitted manufacturer other than the first named manufacturer.

2.03 TAG NUMBERS

A. HDWK-M-101 (Base Flow Grit Chamber Mixer).
B. HDWK-M-201 (Storm Flow Grit Chamber Mixer).

2.04 SUPPLEMENTS

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

2.05 SERVICE CONDITIONS

A. Total Wastewater Flow, Base Flow Grit Chamber:
   1. Minimum: 0.5 mgd.
   2. Average Daily Flow: 1.9 mgd.
   3. Peak Hydraulic Capacity Required: 5.8 mgd.

B. Total Wastewater Flow, Storm Flow Grit Chamber:
   1. May be offline for extended periods of operation during dry weather. The mixer for the Storm Flow Grit Chamber starts when the flow to the storm side (as measured by the upstream Parshall flume) exceeds 1,000 gpm (1.4 mgd), and shuts down when the flow drops below 700 gpm (1.0 mgd).

C. Grit Characteristics:
   1. Type: Typical stormwater grit characteristics and quantities.
   2. Total suspended solids concentration ranges from 4 to 240 mg/L with an average concentration of 22 mg/L.
2.06  EQUIPMENT DESCRIPTION

A.  Grit Collection Mechanism:

1.  Consisting of a vortex type, nonaerated, grit removal mechanism; each complete with drive unit, mechanical gear head, paddle drive tube, and items necessary for a complete grit removal assembly.
2.  Capable of removing grit from stormwater and suitable for installation in a circular concrete basin as shown on Drawings.
3.  Mechanism shall have no moving parts below the water surface which require lubrication or which will be subject to wear or blockage.
4.  Drives, bearings, and support equipment for grit mechanism shall be supported by and readily accessible from a concrete walkway above the water surface as shown on Drawings.
5.  Unless noted elsewhere herein, all material in wetted service shall be Type 304 stainless steel.

B.  Grit chamber hydraulics shall incorporate a toroidal flow path enhanced by a slow vortex. Grit chambers incorporating the gravity principle are not acceptable.

C.  Grit Paddle Mechanism:

1.  Designed to promote removal of grit and assist in sweeping grit to a circular grit wetwell located within center of the basin.
2.  Grit moving across the bottom of the grit chamber shall be hydraulically scoured as the propeller blades pass over the moving grit and cause hydraulic currents to maintain the organics in suspension.

D.  Grit Removal Mechanism:

1.  Axial flow pitch propeller driven by drive tube powered through a helical gear motor.
2.  Helical Gear Motor: Oil lubricated.
   a.  Output Speed: 22 rpm maximum.
3.  Spur-Tooth Bull Gear:
   a.  Enclosed in grease-packed heavy cast iron gear case.
   c.  Mounted on minimum 21-inch diameter turntable bearing.
4.  Bearing Life:
   a.  All Bearings of Drive Unit: B-10 bearing life of 50,000 hours.
   b.  Turntable Bearing Supporting Propeller Assembly: B-10 life of 20 years.
5.  Pinion and Bull Gear Service Factor: Five or greater.
6.  Gear Box: Sealed. Furnish air bell around bottom opening of drive tube to prevent water from entering gear box.
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 die-stamped block type equipment identification number and letters.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.09 PAINTING
A. Factory prepare, prime, and field finish coat with the following systems, as specified in Section 09 90 00, Painting and Coating.

1. System No. 4 for exposed non-stainless steel metal surfaces.

PART 3 EXECUTION

3.01 INSTALLATION
A. In accordance with manufacturer’s written instructions.

B. Anchor Bolts: Accurately place using templates furnished by vortex grit equipment manufacturer and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL
A. Functional Tests: Conduct on each unit.

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.

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. 0.5 person-day for installation assistance and inspection.
2. 0.5 person-day for functional testing and completion of Manufacturer’s Certificate of Proper Installation.
3. 0.5 person-day for prestartup classroom or Site training.
4. 0.5 person-day for facility startup.

B. See Section 01 43 33, Manufacturers’ Field Services.

3.04 SUPPLEMENTS

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

1. Induction Motor Data Sheets.

END OF SECTION
### INDUCTION MOTOR DATA SHEET

**Project:** OF200 Mercury Treatment Facility  
**Owner:** Y-12 National Security Complex  
**Equipment Name:** Base Flow Grit Chamber Mixer  
**Equipment Tag Number(s):** HDWK-M-101

**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:** 1.5  
**Guaranteed Minimum Efficiency at Full Load:** 81.5 percent  
**Voltage:** 460  
**Guaranteed Minimum Power Factor at Full Load:** N/A percent  
**Phase:** 3  
**Service Factor (@ rated max. amb. temp.):** 1.0  
**Frequency:** 60  
**Enclosure Type:** TEFC  
**Synchronous Speed:** 1800 rpm  
**Thermal Protection:** None  
**Multispeed, Two-Speed:** ____ / ____ rpm  
**Winding:** One  
**Winding Type:** Horizontal  
**Mounting Type:** Vertical  
**Space Heater:** 120 volts, single-phase  
**Adjustable Speed Drive:** See Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems.

**Operating Speed Range:** N/A to N/A% of Rated Speed  
**Variable Torque**  
**Constant Torque**

**Additional Motor Requirements:** See Section 26 20 00, Low-Voltage AC Induction Motors.

**Special Features:**

IEEE-841 and UL-listed motor
**INDUCTION MOTOR DATA SHEET**

| Project: OF200 Mercury Treatment Facility |
| Owner: Y-12 National Security Complex |
| Equipment Name: Storm Flow Grit Chamber Mixer |
| Equipment Tag Number(s): HDWK-M-201 |

**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:** 1.5

**Guaranteed Minimum Efficiency at Full Load:** 81.5 percent

**Voltage:** 460

**Guaranteed Minimum Power Factor at Full Load:** N/A percent

**Phase:** 3

**Service Factor (@ rated max. amb. temp.):** 1.0 [X] 1.15

**Frequency:** 60

**Enclosure Type:** TEFC

**Synchronous Speed:** 1800 rpm

**Multispeed, Two-Speed:** [ ] [ ] rpm

**Thermal Protection:** [ ] None

**Winding:** [X] One [ ] Two

**Space Heater:** 120 volts, single-phase

**Mounting Type:** [ ] Horizontal [X] Vertical

**Vertical Shaft:** [X] 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:** N/A to N/A_% of Rated Speed

**Variable Torque**

**Constant Torque**

**Additional Motor Requirements:** [X] See Section 26 20 00, Low-Voltage AC Induction Motors.

**Special Features:**

IEEE-841 and UL-listed motor
Cyclone Separator and Grit Washer

Revision History:

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<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
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<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
</tbody>
</table>

Document Review & Approval:

**Originator:**

Steven R. Polson, P.E./Lead Process Mechanical

**Design Verification Complete:**

Qingshan Wang, P.E./Process Mechanical QC Reviewer

**Approved:**

W. Laird Ellis, Jr. PE/Design Manager
PART 1 GENERAL

1.01 REFERENCES
A. The following is a list of standards which may be referenced in this section:
   2. National Electrical Manufacturers’ Association (NEMA): MG 1, Motors and Generators.

1.02 SYSTEM DESCRIPTION
A. Performance Requirements: Remove 95 percent of the grit having a specific gravity of 2.65 or greater, and 150 mesh or greater from the underflow from the vortex grit collection equipment.

B. Service Conditions:
   2. Inlet Pressure at Cyclone (psig): 11.
   3. Feed Slurry Concentration Range: 0.5 to 2.0 percent solids.

1.03 PERFORMANCE REQUIREMENTS
A. Maximum Water Content in Washed Grit Product at Design Flow: 10 percent.
B. Grit cyclone separator and washer system performance shall meet the USEPA Paint Filter Liquids Test (PFLT, Method 9095B).

1.04 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. Scale drawing showing proposed equipment size and configuration overlaid with the facility drawings to confirm clearance to structures and compliance with the specification requirements herein.

e. External utility requirements such as air, water, power, drain, etc., for each component.

f. Heat tracing and insulation design and details. Detailed calculations for determining insulation requirements and heat tracing design.

g. Power and control wiring diagrams, including terminals and numbers.

h. 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.

i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

2. References of five facilities operating the same equipment for either stormwater or wastewater, which can provide evidence of consistently meeting the EPA PFLT.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

2. Special shipping, storage and protection, and handling instructions.

3. Manufacturer’s written/printed installation instructions.

4. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

5. Certification that factory-applied coating system(s) is identical to requirements specified.

6. Routine maintenance requirements prior to plant startup.

7. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
1.05 EXTRA MATERIALS

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive belts or chains</td>
<td>One complete set</td>
</tr>
<tr>
<td>Lower shaft seals</td>
<td>One complete set</td>
</tr>
<tr>
<td>Adjustable apex liners</td>
<td>One complete set</td>
</tr>
<tr>
<td>Complete set of gaskets</td>
<td>One</td>
</tr>
<tr>
<td>Special tools required to maintain or dismantle</td>
<td>One complete set</td>
</tr>
<tr>
<td>Liners for inlet head, vortex finder, cylinder, and cone</td>
<td>One complete set</td>
</tr>
</tbody>
</table>

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. Smith and Loveless, Model 17 dewatering screw conveyor and Duralyte 500 gpm Concentrator.
2. Or approved equal.

2.02 FACILITY DESIGN BASIS

A. Facility design is based on the named manufacturer. Equipment by proposed alternate manufacturers may require adjustments to the facility design and configuration to accommodate their system and meet the requirements as specified herein. Contractor is responsible for all additional costs to accommodate alternate manufacturer’s system, and shall clearly identify such changes to Engineer in the Submittals for this section.

2.03 TAG NUMBERS

A. HDWK-GC-301 (Cyclone Separator and Grit Washer).
2.04 SUPPLEMENTS

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

2.05 EQUIPMENT

A. General: The complete unit shall consist of a cyclone separator mounted on a grit washing and classification mechanism. Provide structural frames, mounting brackets, and piping transitions for a complete operational unit.

B. Grit Concentrator:

1. Top section of concentrator shall be constructed of Ni-hard with a minimum thickness of 3/4-inch.
2. Bottom cone section shall be constructed of minimum 3/4-inch thick Duralyte polyurethane blend molded with minimum 1/2-inch thick blend of silicon carbide in the bottom portion of the cone. Cone shall be removable by unbolting a flanged connection to the top section.
3. Inlet connection shall be a 4-1/2-inch OD plain end pipe. Underflow outlet (concentrated grit slurry) shall be 3-3/4-inch, and clear water top outlet shall be a 6-inch flanged connection.
4. Less than 5 percent of the influent organic material shall remain in the underflow.

2.06 DEWATERING SCREW CONVEYOR WITH PARALLEL PLATE SEPARATOR

A. General:

1. 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.
2. Capable of removing substantially all 150-mesh grit having a specific gravity of 2.65 or greater from the underflow of the cyclone.

B. Settling Tank:

1. Straight configuration.
4. Screw Speed: 12 rpm maximum.
5. Construct tank of 1/4-inch Type 304 stainless steel plate, reinforced and mounted on stainless steel supports at a slope not more than 3-1/2 inches per foot.
6. Tank shall utilize parallel plate settling technology to effectively capture fine grit.
7. Weir Overflow: Discharge into launder box equipped with a 6-inch flange connection for connection to drain piping.

C. Screw and Trough:

1. Trough:
   a. Trough shall be oriented at a minimum of 22 degrees from horizontal.
   b. Trough length shall be adequate to result in the point of grit discharge to be a minimum of 4 feet 0 inches from the south face of the system equipment pad.
   c. Trough length and angle shall not result in a conflict with the weather cover at the dumpster location.
   d. Type 304 stainless steel construction.

2. Screw:
   a. Heavy-walled, pipe shaft, helicoid screw configuration, Type 304 stainless steel construction.
   b. 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.
   c. Type 304 stainless steel flights shall be continuously seal welded to shaft, and provided with replaceable wear shoes per manufacturer’s standard.
   d. 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.

D. Speed Reducer:

1. Connected to upper end of screw conveyor using flanged, rigid coupling.
2. Torque shall be transmitted by rollers and capable of withstanding shock loadings of 500 percent rated loading.
3. Gearmotor or 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.
E. Pool and trough shall be protected from freezing by an integral insulation and heat tracing system, capable of preventing freezing under a design minimum ambient temperature of minus 17 degrees F. Insulation shall be covered by stainless steel panels to protect it from precipitation and physical damage, and to provide a neat, finished appearance. A single point of power connection shall be provided, and the heat tracing shall be thermostatically controlled so that it operates only when needed. Insulation shall be adequate to limit the heat tracing electrical load to not more than 12 kW under the above design condition.

F. Motor and Reducer Assembly: Pivot at shaft center line so screw assembly can be raised.

G. Removable Solid Cover: Type 304 stainless steel, over full length of screw trough in sections not exceeding 20 pounds each.

2.07 APPURTENANCES

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 die-stamped block type equipment identification number and letters indicated in this Specification.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.08 PAINTING

A. Factory prepare, prime, and finish coat all exposed metalwork surfaces, except stainless steel, in accordance with System No. 5, Section 09 90 00, Painting and Coating.

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 QUALITY CONTROL

A. Functional Tests: Conduct on each cyclone-classifier unit.

B. Performance Tests:

1. Grit samples will be collected by the Owner from the discharge end of the unit twice per day (morning and afternoon) for 5 days, and analyzed in accordance with the EPA Paint Filter Liquids Test (Method 9095B).
2. The timing for initiation of the performance testing, and schedule for sample collection, will be as agreed to by the Contractor, Manufacturer, and Owner.
3. Testing will be conducted in the field at the equipment installation.
   Sample collection and testing will be conducted by the Owner, with the Contractor and/or equipment Manufacturer’s Representative present. An agreement shall be reached among all parties regarding the method of sample collection prior to commencement of the testing.
4. A single sample failure to meet the testing requirements will result in restarting of the testing regimen. The Manufacturer or their Representative will be allowed to make adjustments to the equipment prior to recommencing the sample collection and testing.
5. If 10 successful sequential sample tests are not achieved, following a maximum of three test failures, the equipment shall be deemed to have failed the performance testing. In this event, the grit cyclone separator and grit washer shall be removed and replaced with an acceptable alternate manufacturer’s equipment. The Owner reserves the option to allow additional retesting.

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. 0.5 person-day for installation assistance and inspection.
2. 2 person-days for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
3. 0.5 person-day for prestartup classroom or Site training.
4. 0.5 person-day for facility startup.

B. See Section 01 43 33, Manufacturers’ Field Services.
3.04 SUPPLEMENTS

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

1. Induction Motor Data Sheet.

END OF SECTION
## INDUCTION MOTOR DATA SHEET

**Project:** OF 200 Mercury Treatment Facility  
**Owner:** Y12 National Security Complex  
**Equipment Name:** Cyclone Separator and Grit Washer  
**Equipment Tag Number(s):** HDWK-GC-301  

<table>
<thead>
<tr>
<th>Type</th>
<th>Squirrel-cage induction meeting requirements of NEMA MG 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.</td>
</tr>
</tbody>
</table>

**Hazardous Location:**  
Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

<table>
<thead>
<tr>
<th>Motor Horsepower</th>
<th>3</th>
<th>Guaranteed Minimum Efficiency at Full Load: 80.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>460</td>
<td>Guaranteed Minimum Power Factor at Full Load: n/a%</td>
</tr>
<tr>
<td>Phase</td>
<td>3</td>
<td>Service Factor (@ rated max. amb. temp.): 1.0 / 1.15</td>
</tr>
<tr>
<td>Frequency</td>
<td>60</td>
<td>Enclosure Type:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Synchronous Speed</th>
<th>1200 rpm</th>
<th>Multispeed, Two-Speed: ____ / ____ rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Protection</td>
<td>□</td>
<td>Winding: □ One □ Two</td>
</tr>
<tr>
<td>Space Heater</td>
<td>□ 120 volts, single-phase</td>
<td>Mounting Type: □ Horizontal □ Vertical</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vertical Shaft</th>
<th>□ Solid □ Hollow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Thrust Capacity (lb.)</td>
<td>Up ____ Down ____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjustable Speed Drive</th>
<th>See Section 26 29 23, Low Voltage Adjustable Frequency Drive Systems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Speed Range</td>
<td>____ to ____% of Rated Speed</td>
</tr>
</tbody>
</table>

| □ Variable Torque    | |
| □ Constant Torque    | |

**Additional Motor Requirements:** □ See Section 26 20 00, Low Voltage AC Induction Motors.  
**Special Features:** Motor is to conform to IEEE 841 and be UL listed. Motor shall be suitable for inclined ____ mounting.
Vertical Turbine Pumps

Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
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Document Review & Approval:

**Originator:**
Steven R. Polson, P.E./Lead Process Mechanical

**Design Verification Complete:**
Qingshan Wang, P.E./Process Mechanical QC Reviewer

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager
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.

   a. 610, Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries.
   b. 670, Machinery Protection Systems.

3. ASTM International (ASTM):

4. Hydraulic Institute Standards (HIS):
   a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.

5. Institute of Electrical and Electronics Engineers (IEEE): 841, Standard for Petroleum and Chemical Industry – Petroleum-Efficiency, Severe Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – Up to and Including 370kW (500 hp).

6. National Electrical Manufacturer’s Association (NEMA): MG 1, Motors and Generators.

7. 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. Calculations (where required by Pump Data Sheet):
   a. Torsional analysis for complete rotating assembly. Analysis report shall include the specific items of API 610, Part 2.8, Dynamics.
   b. Lateral vibration analysis for discharge head motor assembly and for column pipe bowl assembly.
5. Pump maximum downthrust or upthrust in pounds.
6. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of components.
7. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, and materials of construction lists.
8. Baseplate drawings with leveling jackscrew details, anchor bolt and sleeve details, and minimum foundation installation and leveling requirements.
9. Power and control wiring diagrams, including terminals and numbers.
10. Complete motor nameplate data, as defined by NEMA, motor manufacturer, including motor modifications.
11. Factory finish system.
12. 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 Functional and Performance Test Reports and Log. 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 01 43 33, Manufacturers’ Field Services.

1.04 EXTRA MATERIALS

A. Furnish for each size of pump:

1. Complete set bowl bearings.

2. Complete set gaskets and O-ring seals.

3. Complete set of shaft sleeves.

4. Complete set keys, dowels, pins, etc.

5. Complete mechanical seal.

6. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. 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.

3. Pump manufacturer shall conduct an analysis of the lateral and torsional vibration of pump and motor assembly.
   a. Excitation frequency range of the analysis shall include, but not be limited to, number of motor poles and number of impeller vanes.
   b. Perform detailed stress analysis for pump, coupling, motor system at each critical speed, and steady-state operating condition.
   c. Stress analysis shall demonstrate that in no case shall maximum stress on pump, coupling and motor component exceed endurance limits of pump, coupling and motor assembly components materials of construction.
2.02 TAG NUMBERS

A. Headworks:
   1. HDWK-P-100-A, -B and -C (Base Flow Pumps A, B and C).
   2. HDWK-P-200-A, -B and -C (Storm Flow Pumps A, B and C.)

2.03 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.04 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. Arrangement shall allow removal of seal without disturbing pump or driver.
   4. 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.
   5. Design such that dynamic O-ring moves towards a clean surface as face wears and springs are not in pumped fluid.
   6. Stationary seal face shall be spring loaded to provide self-aligning despite stuffing box misalignment.
   7. 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.
   8. 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 Eligiloy, or other alloy that is not vulnerable to chloride stress corrosion.
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.

9. Seal Environmental Controls:
   a. Pipe seal flush port drain to wetwell 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.
      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.

2.05 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, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.06 FACTORY FINISHING

A. Prepare and prime, and finish coat nonrotating pump components below the sole plate in accordance with System No. 1, as specified in Section 09 90 00, Painting and Coating. Nonrotating pump components above the sole plate (including the sole plate) shall be prepared, primed and finish coated in accordance with System No. 5, color as selected by the Engineer. Motor shall
be finish coated in accordance with Section 26 20 00, Low-Voltage AC Induction Motors.

2.07 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test all equipment actually furnished.

B. Factory Test Report: Include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.

C. Functional Test: Perform manufacturer’s standard test on equipment. Include vibration test, as follows:

1. Dynamically balance rotating parts of each pump and its driving unit before final assembly.
2. Limits:
   a. Driving Unit Alone: Less than 80 percent of NEMA MG 1 limits.
   b. Complete Rotating Assembly Including Coupling, and Motor:
      Less than 90 percent of limits established in the Hydraulic Institute Standards.

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. Touch up any damaged coatings using the original coating material and 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, or storage volumes where flow measurement is not available.
4. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
5. Test for continuous 3-hour period.

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, for each set of pumps:

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 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 an accepted detailed lesson plan for each training activity has been reviewed by Engineer.

B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

3.05 SUPPLEMENTS

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

1. Pump Data Sheets.

END OF SECTION
VERTICAL TURBINE PUMP DATA SHEET, 44 42 56.03-01

Tag Numbers: HDWK-P-100-A through -C

Pump Name: BASE FLOW PUMPS

Manufacturers and Product: (1) Flowserve, Model 14ENL, three stages (2) Or equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): __________ Stormwater (degritted)

Pumping Temperature (Fahrenheit): Normal __70____ Max __82____ Min __55____

Specific Gravity at 60 Degrees F: ___1.0___ Viscosity Range: 1.00 mPa-s (68 deg F)____

Vapor Pressure at 60 Degrees F: 0.258 psia pH: 7.0

Abrasive (Y/N): ____N___ Caused by: __________

Possible Scale Buildup (Y/N): ____N___ Caused by: _______________________

Corrosive (Y/N): ____N______ Caused by: _____________________________

Min. NPSH Available (Ft. Absolute): ______

Altitude (Feet above Mean Sea Level): ______ 940

Location: Indoor (Y/N): ____N_______ Outdoor (Y/N): Y_______

Total Installation Height, Pump Discharge Centerline to Wet Well Bottom (Ft): 19.5

PERFORMANCE REQUIREMENTS


(Note: Rated capacity is based on two pumps operating in parallel delivering a total flow of 3,500 gpm.)

Total Dynamic Head (Ft): Rated: __75.0____ Secondary: 47.9; Tertiary: 48.2

(Note: TDH values at points other than rated are to establish potential range of operation.)

Static Head: Maximum: 45.7  Minimum: 31.5

BHP at Rated Point: 40.6 Secondary: 11.7; Tertiary: 36.3
Maximum BHP Over Pump Range: 43.6
Shutoff Head (Ft): 153
Minimum Pump Output at 100 Percent Speed: 660 gpm
Min. Pump Hydraulic Efficiency at Rated Capacity (%): 81.6
Max. NPSH Required at Rated Capacity (Ft. Absolute): 7.1
Max. Pump Speed at Rated Capacity (rpm): 1185
Constant (Y/N): No
Adjustable (Y/N): Yes
Reverse Rotation: Pump shall be capable of operating at runaway speed in reverse rotation without damage

DESIGN AND MATERIALS

Pump Type: Open Line Shaft (Y/N) Y Enclosed Line Shaft (Y/N) N
Bowl: Cast Iron A48 CL30
Bowl and Suction Bell Maximum Diameter (inches): 17.5 inches
Bowl Bearings: Bronze C84400 Column: Steel A53 Type E GrB
Line Shafting: Carbon steel Max. Bearing Span (Feet): (per Manufacturer)
Line Shaft Bearings: Fluted synthetic rubber with bronze, ASTM B584 C90500, shells
Discharge Head:
   Type: Above grade
   Material: Cast Iron A48 CL30
Discharge Nozzle Size (inches): 8 Flange Standard/Class: 125 lb FF ANSI
Impeller:
   Type: Enclosed
   Material: Bronze
Shaft Sealing: Packing (Y/N) N Mechanical (Y/N) Y Type: Cartridge
Seal Lubrication: Pumped liquid

Coupling:

Manufacturer Standard (Y/N) Y

Baseplate Material: Steel

Sole Plate (Y/N) Y Material Steel Soleplate: Provide for support of pump assembly, including thrust and dynamic loads, as indicated. Top of soleplate shall be faced, drilled, and tapped for pump baseplate

Motor Base Material: Steel

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 50 Voltage: 460 Phase: 3

Synchronous Speed (rpm): 1200

Service Factor: 1.0 when operated on an ac drive

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP EXP ODP TEFC IEEE 841 TEWAC WPI WPII

Mounting Type: Vertical Hollow Shaft X Nonreverse Ratchet (Y/N) Y

ABMA 9 and ABMA 11, B-10 Motor Bearing Life (hrs): 125,000

Adjustable Speed Drive Range: 50% min to 105% max. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems.

REMARKS (1) Provide motor space heaters, (2) provide shaft grounding brush on the driven (shaft) end of the motor, and (3) provide insulated bearing on the non-driven end of the motor.

Provide manufacturer’s standard vortex suppressor with each pump. Contractor shall permanently mount vortex suppressor to floor, centered below pump inlet, as recommended by the manufacturer.
VERTICAL TURBINE PUMP DATA SHEET, 44 42 56.03-02

Tag Numbers: HDWK-P-200-A through -C

Pump Name: STORM FLOW PUMPS

Manufacturers and Product: (1) Flowserve 32 SNM, two stages
(2) Or equal

SERVICE CONDITIONS

- Liquid Pumped (Material and Percent): Stormwater (degritted)
- Pumping Temperature (Fahrenheit): Normal 70 Max 82 Min 55
- Specific Gravity at 60 Degrees F: 1.0
- Viscosity Range: 1.00 mPa-s (68 deg F)
- Vapor Pressure at 60 Degrees F: 0.258 psia
- pH: 7.0
- Abrasive (Y/N): N
- Possible Scale Buildup (Y/N): N
- Corrosive (Y/N): N
- Altitude (Feet above Mean Sea Level): 940
- Location: Indoor (Y/N): N Outdoor (Y/N): Y
- Total Installation Height, Pump Base to Wet Well Bottom (Ft): 32.0 (based on first listed pump)

PERFORMANCE REQUIREMENTS

- Capacity (US gpm): Rated: 13,000 Secondary: 15700; Tertiary: 6000
  (Note: Rated capacity is based on three pumps operating in parallel delivering a total flow of 39,000 gpm.)
- Total Dynamic Head (Ft): Rated: 102.0 (78.0 at minimum static) Secondary: 73.8; Tertiary: 94.0
  (Note: TDH values at points other than rated are to establish potential range of operation.)
- Static Head: Maximum: 91.5 Minimum: 67.2
- BHP at Rated Point: 382
Shutoff Head, min (Ft): 168

Minimum Pump Output at 100 Percent Speed: 5600 gpm

Min. Pump Hydraulic Efficiency at Rated Capacity (%): 87.5

Max. Pump Speed at Rated Capacity (rpm): 710

Constant (Y/N): _______ N Adjustable (Y/N): Y

Reverse Rotation: Pump shall be capable of operating at runaway speed in reverse rotation without damage.

DESIGN AND MATERIALS

Pump Type: Open Line Shaft (Y/N)  Y  Enclosed Line Shaft (Y/N)  N

Bowl: Cast Iron A48 CL30

Bowl and Suction Bell Maximum Diameter (inches): 37.5 inches

Bowl Bearings: Bronze C84400

Column: Steel A53 Type E GrB

Line Shafting: 416 stainless steel Max. Bearing Span (Feet): (per manufacturer)

Line Shaft Bearings: Fluted synthetic rubber with bronze, ASTM B584 C90500, shells

Discharge Head:

Type: Above grade

Material: Fabricated Steel, ASTM A36/A36M

Discharge Nozzle Size (inches): 24  Flange Standard/Class: 150 lb ANSI

Impeller:

Type: Semi-open

Material: Bronze

Shaft Sealing: Packing (Y/N)  N  Mechanical (Y/N)  Y

Type: Cartridge

Seal Lubrication: Pumped fluid
Coupling: Manufacturer Standard (Y/N) Y

Baseplate Material: Steel Sole Plate (Y/N) Y Material Steel

Soleplate: Provide for support of pump assembly, including thrust and dynamic loads, as indicated. Top of soleplate shall be faced, drilled, and tapped for pump baseplate.

Motor Base Material: Fabricated steel

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 450 Voltage: 460 Phase: 3

Synchronous Speed (rpm): 720

Service Factor: 1.0 when operated on an ac drive

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP EXP ODP TEFC IEEE 841 X TEWAC WPI WPII

Mounting Type: Vertical Hollow Shaft X Nonreverse Ratchet (Y/N) Y

ABMA 9 and ABMA 11, B-10 Motor Bearing Life (hrs): 125,000

Adjustable Speed Drive Range: 50% min to 105% max. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems.

**REMARKS** Provide for this pump a torsional analysis for complete rotating assembly and lateral vibration analysis for discharge head motor assembly and for column pipe bowl assembly, as specified herein. (1) Provide motor space heaters, (2) Provide shaft grounding brush on the driven (shaft) end of the motor, (3) Provide insulated bearing on the non-driven end of the motor.

Provide manufacturer’s standard vortex suppressor with each pump. Contractor shall permanently mount vortex suppressor to floor, centered below pump inlet, as recommended by the manufacturer.
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Submersible Pumps

Revision History:

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Document Review & Approval:

Originator:

Steven R. Polson, P.E./Lead Process Mechanical

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Design Verification Complete:

Qingshan Wang, P.E./Process Mechanical QC Reviewer

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Approved:

W. Laird Ellis, Jr. PE/Design Manager

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Digitally signed by Qingshan Wang
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Digitally signed by Steven R. Polson
Date: 2017.06.13 15:34:46-07'00'
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):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Rating and Fatigue Life for Roller Bearings.
3. ASTM International (ASTM):
4. Hydraulic Institute Standards (HIS):
   a. 11.6, Submersible Pump Test.
   a. 70, National Electrical Code.
   b. 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.
7. Underwriters Laboratories, Inc. (UL):
   a. 508A, Standard for Industrial Control Panels.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of 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, including cable seal details.
3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower
demand, overall efficiency, and minimum submergence required at guarantee point.
4. For variable speed motors, provide variable speed curves for every 50 rpm over the operational range.
5. Power and control wiring diagrams, including terminals and numbers.
6. Motor data, in accordance with the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
7. Adjustable frequency drive data, in accordance with the requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
8. Factory-finish system.
9. L-10 bearing life calculations per ABMA.
10. If required, wiring for motor protection module.
11. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 00, Anchorage and Bracing.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer’s printed installation instructions.
4. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system meets requirements specified herein.
5. Suggested spare parts list to maintain equipment in service for period of 5 years. Include 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 each set of pumps:

1. One set mechanical seals.
2. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Submersible, vertical shaft, centrifugal nonclog type, for pumping wastewater and floor drainage.
B. Designed for continuous operation under submerged or partially submerged conditions, and intermittent operation when totally dry without damage to pump or motor.

C. Pump and Electrical Driver: Meet requirements for class, group, and division location in accordance with NFPA 70.

D. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 TAG NUMBERS

A. Headworks:
   1. HDWK-P-210-A and –B (Storm Wet Well Sump Pumps A and B).
   2. HDWK-P-310-A and –B (Grit Pump Room Sump Pumps A and B).

B. Mercury Treatment Facility:
   1. SPD-P-720-A and –B (Filtrate Wet Well Pumps A and B).
   2. FLTR-P-600-A and B (Backwash Supply Pump A and B).
   3. FLTR-P-610-A and B (Backwash Waste Pump A and B).

2.03 SUPPLEMENTS

A. Specific requirements are attached to this section as supplements.

2.04 COMPONENTS

A. Equipment consists of pump complete with motor, control system (where required), guide rail, anchoring brackets, base elbow, power cable, and pump lifting cable, and control panel and level switches (where required).

B. Characteristics:
   1. Motor and rotating parts shall be removable from motor end of pump.
   2. Mating surfaces to be watertight and fitted with nitrile O-rings.
   3. Pumps fitted with dynamically balanced nonclog impellers designed to pass coarse solids and stringy materials.

C. Lifting Arrangement:
   1. Stainless steel chain, 2 feet minimum, and one “grip-eye.”
   2. Attach chain permanently to pump and access platform with stainless steel wire rope.
   3. “Grip-eye” capable of being threaded over and engaging links of stainless steel chain so pump and motor may be lifted with “grip-eye” and independent hoist.
D. Sliding Guide Bracket:

1. Integral part of pump unit.
2. Pump unit to be guided by no less than two guide bars, or equivalent cable system, and pressed tightly against discharge connection elbow with metal-to-metal contact or through use of profile-type gasket, provided gasket is attached to pump’s flange and can be easily accessed for inspection when pump is lifted out of wetwell.

E. Guide Rails:

1. Type 304 stainless steel.
2. Coordinate with pump manufacturer for required guide rail size and length.

F. Motor nameplate horsepower not to be exceeded at head-capacity point on pump curve.

G. Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NFPA 70 specifications for pump motors. Cables shall be of sufficient length to reach junction boxes without strain or splicing.

H. Motor Protection Module: If required, provide pump with a motor protection module for remote mounting. Contract Drawings are based on first named submersible pump manufacturer and motor protection module. If pump and motor protection module other than first named manufacturer is provided, provide revised wiring for the motor protection module.

1. Provide the motor protection module and auxiliary components in a common enclosure.
2. Certification: UL508.
3. Enclosure: NEMA Type 4X stainless steel, with device mounting back panel and hinged cover with clamp-type fasteners.
4. Power supply: 120V, 60-Hz ac power will be provided to the motor protection module. If a different supply voltage is required, provide the appropriate power supply conversion device(s).
5. Control Devices:
   a. On the door of the motor protection module enclosure door, provide the following NEMA Type 4X control devices:
      1) “RESET” pushbutton.
      2) Amber LED push-to-test indicating lights to indicate individual motor faults.
I. Cable Entry System:

1. Junction chamber and motor separated by stator lead sealing gland or terminal board that prevents foreign material entering through pump top.
2. Utilize cable with factory-installed sealing gland with nonshrink epoxy seal system.
3. O-ring compression seal between sealing gland and cable entry point will also be acceptable.

2.05 CONTROL PANEL (GRIT PUMP ROOM SUMP ONLY)

A. NEMA 4X enclosure.

B. Refer to Section 40 99 90, Package Control Systems, for additional panel requirements.

C. Wall mounted.

D. Features:

1. Main circuit breaker disconnect interlocked with panel door.
2. Combination circuit breaker type, NEMA rated motor starters.
3. Fused control power transformer, 120V ac.
4. Alternator and pump lead-lag controls.
5. ON/OFF/AUTO switches.
6. Running lights.
7. High level indication.
8. Normally closed, dry, 5 amps at 120V ac contacts for remote indication of:
   a. High level alarm.
   b. Pump failure (temperature or moisture alarm).
9. Terminal strip for interfacing with external wiring.
11. Moisture alarm indication.
12. Alarm (high temperature, moisture, or high level) beacon located on top of panel.
13. Lightning protection.
15. Alarm silence button.
16. Document pocket located inside panel with pump and panel operation and maintenance manual, and separate laminated pump curve.
17. 110-volt, duplex GFI outlet, weather-protected, and accessible from outside of panel.
18. Run hour meter.
19. 100 watts minimum, condensation heater with thermostat.
20. UL listing mark.

E. Prewired and factory tested.
F. Mount control switches, indicating lights, and switches on hinged front panel.
G. Single Feed: 480 volts, three-phase.

2.06 ACCESSORIES

A. Level Switches (where required): In accordance with Section 40 90 00, Instrumentation and Controls for Process Systems, component L8, and for:
   1. LOW LOW Level: Pumps off.
   2. LOW Level: First pump on.
   3. HIGH Level: Second pump on.
   4. HIGH HIGH Level: Alarm.

B. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.07 FACTORY FINISHING

A. Manufacturer’s standard epoxy system for continuous submersion in corrosive water.

2.08 SOURCE QUALITY CONTROL

A. Control Panel:
   1. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
   2. Factory Tests and Adjustments: Test control panel actually furnished.

B. Pump:
   1. Factory Performance Test:
      a. In accordance with HIS 11.6, Level B for submersible pump tests.
      b. Include test data sheets curve test results, and performance test logs.
   2. Conduct on each pump.
3. Perform under actual or approved simulated operating conditions.
   a. Throttle discharge valve to obtain pump data points on curve at
      2/3, 1/3, and shutoff conditions.

C. Submersible Motor Functional Test: In accordance with HIS 11.6.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s printed instructions.

B. Mount the discharge elbow to the floor of the wetwell floor with stainless
   steel anchor bolts.

C. Connect piping without imposing strain to flanges.

D. No portion of pump shall bear directly on floor of sump.

3.02 FIELD FINISHING

A. Touch up damaged areas of factory paint using paint provided by the factory
   matching that applied in the factory.

3.03 FIELD QUALITY CONTROL

A. Functional Test: Conduct on each pump.

   1. Alignment: Test complete assemblies for correct rotation, proper
      alignment and connection, and quiet operation.
   2. Flow Output: Measured by plant instrumentation or storage volumes.
   3. Test for three pump cycles (full to empty sump).
   4. Test Report Requirements: In accordance with Hydraulic Institute
      Standards for submersible pump tests HIS 14.6 and 11.6.
   5. Routine Production Tests:
      a. Check impeller, motor rating and electrical connections for
         compliance to specification.
      b. Test motor and cable insulation for moisture content and
         insulation defects.
      c. Prior to submergence, run pump dry to establish correct rotation
         and mechanical integrity.
      d. Conduct abbreviated three-point operational performance test.
      e. After operational performance test, perform insulation test again.
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, for each set of pumps:

1. 1 person-day for installation assistance, inspection and functional testing, and completion of Manufacturer’s Certificate of Proper Installation.
2. 1 person-day for post-startup training of Owner’s personnel. A single training session shall be provided for all pumps furnished under this section. Training shall not commence until accepted detailed lesson plan for training has been reviewed by Engineer.

B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

3.05 SUPPLEMENTS

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

1. Data Sheets.

END OF SECTION
**SUBMERSIBLE PUMP DATA SHEET, 44 42 56.04-01**

Tag Numbers: ___ HDWK-P-210-A and -B ________________________________

Pump Name: ___ Storm Wet Well Sump Pumps A & B ________________________________

Manufacturer and Model Number: (1) Grundfos, SLV.30.A30.30.4.61 R.C

(2) Or equal ________________________________

**SERVICE CONDITIONS**

Liquid Pumped (Material and Percent Solids): Water with less than 0.1 percent solids

Pumping Temperature (Fahrenheit): Normal: 70 Max 82 Min 55

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1 cP

pH: 5.0 to 8.0

Abrasive (Y/N) Y Possible Scale Buildup (Y/N): N ________________________________

Maximum diameter solid pump can pass (inches): 3.125

Min. NPSH Available (Ft. Absolute): 33

**PERFORMANCE REQUIREMENTS**

Capacity (US gpm): Rated: 145 gpm ________________________________

Total Dynamic Head (Ft): Rated: 35.9 ________________________________

Minimum Shutoff Head (Ft): 48.0 ________________________________

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 41.0 ________________________________

Max. Pump Speed at Rated Capacity (rpm): Constant (N): ________________________________

Adjustable (Y): 1770

**DESIGN AND MATERIALS**

Pump Type: Heavy-Duty Nonclog (Y) Other: ________________________________

Volute Material: Stainless steel ________________________________

Pump Casing Material: Stainless steel ________________________________

Motor Housing Material: Cast Iron ASTM A48 (With Coal-Tar Epoxy or High Build Epoxy – 2 Coats, 16 MDFT) ________________________________
Wear Rings Case (Y/N): N  
Material: 

Wear Ring Impeller (Y/N): N  
Material: 

Elastomers: Nitrile Rubber 

Fasteners: Stainless Steel 

Impeller: Type: Double-Shrouded Non-Clog (Y/N): N   
Other: Super Vortex  
Material: Stainless Steel 

Shaft Material: Stainless Steel 

Base Elbow: Stainless Steel 

Double Mechanical Seal (Y/N): Y   
Bearing Life (Hrs): 

**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors) 

Horsepower: 3  
Voltage: 460  
Phase: 3  
Synchronous Speed (rpm): 1800  
Enclosure: Submersible 

**CONTROLS** 

Pump controls shall be provided under Section 40 90 01, Instrumentation and Controls for Process Systems. 

Moisture Detection Switches (Y/N): N  

Thermal Protection Embedded in Windings (Y/N): N  

**REMARKS:** Rail guided installation 

_________________________________________ 

_________________________________________ 

_________________________________________ 

_________________________________________
SUBMERSIBLE PUMP DATA SHEET, 44 42 56.04-02

Tag Numbers: HDWK-P-310-A and -B

Pump Name: Grit Pump Room Sump Pumps A & B

Manufacturer and Model Number: (1) Grundfos SL1.20.A30.30.2.61R.C
(2) Or equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Water and grit (less than 0.5 percent solids)

Pumping Temperature (Fahrenheit): Normal: 70 Max 82 Min 55

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1 cP

pH: 5.0 to 8.0

Abrasive (Y/N) Y Possible Scale Buildup (Y/N): N

Maximum diameter solid pump can pass (inches) 3.125

Min. NPSH Available (Ft. Absolute): 33

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 90.0

Total Dynamic Head (Ft): Rated: 52.5

Minimum Shutoff Pressure (Ft): 66

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 41.0

Max. Pump Speed at Rated Capacity (rpm): Constant (N): 1760

DESIGN AND MATERIALS

Pump Type: Heavy-Duty Nonclog (Y/N) Y Other:  

Volute Material: Stainless steel

Pump Casing Material: Stainless steel
Motor Housing Material: Cast Iron ASTM A48 (With Coal-Tar Epoxy or High Build Epoxy – 2 Coats, 16 MDFT)

Wear Rings Case (Y/N): N Material:                                    
Wear Ring Impeller (Y/N): N Material:                                    
Elastomers: Nitrile Rubber                                             
Fasteners: Stainless Steel                                            
Impeller: Type: Double-Shrouded Non-Clog (Y/N): N Other: Super Vortex, Material: Stainless Steel
Shaft Material: Stainless Steel.
Base Elbow: Stainless Steel                                             
Double Mechanical Seal (Y/N): Y Bearing Life (Hrs): ____________

**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: ___3___ Voltage: ____460___ Phase: 3 Synchronous Speed (rpm): 1800
Enclosure: Submersible

**CONTROLS**

Provide control panel including motor starters as specified herein. Provide complete control system including level floats set at the following depths (from sump bottom):

1. LOW (HDWK-LSL-310): 2.2 ft (shut down pump(s))
2. HIGH (HDWK-LSH-1-310): 3.7 ft (start lead pump)
3. HIGH HIGH (HDWK-LSH-2-310): 4.2 ft (start lag pump)
4. HIGH HIGH HIGH (HDWK-LSHH-310): 4.5 ft

Provide alarm output for HIGH HIGH level condition.

**REMARKS:** Rail guided installation.
SUBMERSIBLE PUMP DATA SHEET, 44 42 56.04-03

Tag Numbers: SPD-P-720-A and -B

Pump Name: Filtrate Wet Well Pumps A & B

Manufacturer and Model Number: (1) Grundfos SL1.30.A40.55.4.61J.C
(2) Or equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Water with chemical sludge (less than 1 percent solids)

Pumping Temperature (Fahrenheit): Normal: 70 Max 82 Min 55

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1 cP

pH: 5.0 to 8.0

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Maximum diameter solid pump can pass (inches) 3.125

Min. NPSH Available (Ft. Absolute): 33

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 350

Total Dynamic Head (Ft): Rated: 36.6

Minimum Shutoff Pressure (Ft): 62

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 61.0

Max. Pump Speed at Rated Capacity (rpm): Constant (Y): 1764 Adjustable (N):

DESIGN AND MATERIALS

Pump Type: Heavy-Duty Nonclog (Y/N) Y Other: 

Volute Material: Stainless steel

Pump Casing Material: Stainless steel
Motor Housing Material: Cast Iron ASTM A48 (With Coal-Tar Epoxy or High Build Epoxy – 2 Coats, 16 MDFT)

Wear Rings Case (Y/N): N __________ Material: _____________________________

Wear Ring Impeller (Y/N): N __________ Material: _____________________________

Elastomers: Nitrile Rubber

Fasteners: Stainless Steel

Impeller: Type: Double-Shrouded Non-Clog (Y/N): N __________ Other: S-Tube_____ Material: Stainless Steel

Shaft Material: Stainless Steel.

Base Elbow: Cast Iron ASTM A48

Double Mechanical Seal (Y/N): Y __________ Bearing Life (Hrs): __________

**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: ____7.5____ Voltage: ____460____ Phase: ____3____ Synchronous Speed (rpm): ____1800____

Enclosure: Submersible

**CONTROLS**

Pump controls shall be provided under Section 40 90 01, Instrumentation and Controls for Process Systems.

**REMARKS:** Rail guided installation.
SUBMERSIBLE PUMP DATA SHEET, 44 42 56.04-04

Tag Numbers: FLTR-P-600-A & B

Pump Name: Backwash Supply Pump A & B

Manufacturer and Model Number: (1) Grundfos S2.45.A100.760.8.66H.S.465.G.N.D

(2) Or equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Water with less than 0.1 percent solids

Pumping Temperature (Fahrenheit): Normal: 70 Max 82 Min 55

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1 cP

pH: 5.0 to 8.0

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Maximum diameter solid pump can pass (inches): 1.0

Min. NPSH Available (Ft. Absolute): 33

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 4680

Total Dynamic Head (Ft): Rated: 41.0

Minimum Shutoff Head (Ft): 51.6

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 68

Max. Pump Speed at Rated Capacity (rpm): Constant (N): 1170

Adjustable (Y): 1170

DESIGN AND MATERIALS

Pump Type: Heavy-Duty Nonclog (Y) Other:

Volute Material: Stainless steel

Pump Casing Material: Stainless steel

Motor Housing Material: Cast Iron ASTM A48 (With Coal-Tar Epoxy or High Build Epoxy – 2 Coats, 16 MDFT)
Wear Rings Case (Y/N): Y Material: Nitrile Rubber
Wear Ring Impeller (Y/N): Y Material: Stainless Steel
Elastomers: Nitrile Rubber
Fasteners: Stainless Steel
Impeller: Type: Double-Shrouded Non-Clog (Y/N): N Other: Super Vortex Material: Stainless Steel
Shaft Material: Stainless Steel
Base Elbow: Stainless Steel
Double Mechanical Seal (Y/N): Y Bearing Life (Hrs): 50,000

**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 75 Voltage: 460 Phase: 3 Synchronous Speed (rpm): 876

Enclosure: Submersible

**CONTROLS**

Pump controls shall be provided under Section 40 90 01, Instrumentation and Controls for Process Systems.

Moisture Detection Switches (Y/N): Y

Thermal Protection Embedded in Windings (Y/N): Y

**REMARKS:** Rail guided installation.
SUBMERSIBLE PUMP DATA SHEET, 44 42 56.04-05

Tag Numbers: FLTR-P-610-A & B

Pump Name: Backwash Waste Pump A & B

Manufacturer and Model Number: (1) SL1.35.A60.245.4.52H.S.N.61G

(2) Or equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Water with less than 1 percent solids

Pumping Temperature (Fahrenheit): Normal: 70 Max 82 Min 55

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1 cP

pH: 5.0 to 8.0

Abrasive (Y/N) Y Possible Scale Buildup (Y/N): Y

Maximum diameter solid pump can pass (inches): 3.125

Min. NPSH Available (Ft. Absolute): 33

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 900 gpm

Total Dynamic Head (Ft): Rated: 70.0

Minimum Shutoff Head (Ft): 80.0

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 68

Max. Pump Speed at Rated Capacity (rpm): Constant (Y): 1755

Adjustable (N):

DESIGN AND MATERIALS

Pump Type: Heavy-Duty Nonclog (Y) Other: 

Volute Material: Stainless steel

Pump Casing Material: Stainless steel

Motor Housing Material: Cast Iron ASTM A48 (With Coal-Tar Epoxy or High Build Epoxy – 2 Coats, 16 MDFT)
Wear Rings Case (Y/N): Y Material: 
Wear Ring Impeller (Y/N): Y Material: 
Elastomers: Nitrile Rubber
Fasteners: Stainless Steel
Impeller: Type: Double-Shrouded Non-Clog (Y/N): N Other: Super Vortex Material: Stainless Steel
Shaft Material: Stainless Steel
Base Elbow: Stainless Steel
Double Mechanical Seal (Y/N): Y Bearing Life (Hrs): 50,000

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)
Horsepower: 25 Voltage: 460 Phase: 3 Synchronous Speed (rpm): 1783
Enclosure: Submersible

CONTROLS
Pump controls shall be provided under Section 40 90 01, Instrumentation and Controls for Process Systems.
Moisture Detection Switches (Y/N): Y
Thermal Protection Embedded in Windings (Y/N): Y

REMARKS: Rail guided installation
Induced Flow (Recessed Impeller) 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).
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 curves showing head, capacity, horsepower demand, 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 guarantee point.
   d. Pump maximum downthrust or upthrust in pounds.
   e. Detailed structural, mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
   f. Power and control wiring diagrams, including terminals and numbers.
   g. Motor information as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
   h. Factory finish system.
B. Informational Submittals:

1. Manufacturer’s Certification of Compliance that factory finish system is identical to the requirements specified herein.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer’s printed installation instructions.
5. Suggested spare parts list to maintain the 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.
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 Each Pump:

1. Complete set bearings.
2. Complete set gaskets and O-ring seals.
3. Complete set of shaft sleeves.
4. Complete set of keys, dowels, pins, etc.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 TAG NUMBERS

A. Headworks:

1. HDWK-P-300-A (Storm Flow Grit Pump).
2. HDWK-P-300-B (Base Flow Grit Pump).
3. HDWK-P-300-C (Standby Grit Pump).
2.03 SUPPLEMENT

A. Specific requirements are attached to this Section as supplement.

2.04 SHAFT SEAL

A. A single cartridge mechanical seal requiring no external flushing shall be furnished in the pump. Pumps requiring external flushing will not be accepted. The seal shall utilize a rotational sealing ring mounted in an elastomer cup with an O-ring mounted stationary ring loaded by a non-fouling, conical spring encapsulated in Viton. Installation of the seal shall require no measurements or scribe marks on the shaft.

B. The rotation seal ring shall be made of tungsten carbide Grade VC805, the surface of which shall be lapped to a flatness not to exceed three helium light bands. The seal ring shall be bonded inside a Viton cup that shall have three integrally molded anti-rotational lugs to prevent the rotary seal face from turning within the rotary body. The rotary body shall have three 1/8-inch solid stainless steel pins to prevent the rotary seal face from turning within the rotary body.

C. The stationary seal ring shall be constructed of alpha-sintered type silicon carbide. The surface shall be lapped to a flatness not to exceed three helium light bands. The stationary ring shall have a slot milled on the side opposite of the mating side that engages an anti-rotation pin. Stationary seal rings of converted carbon or other surface-only treatments are not acceptable.

D. The spring that loads the rotational seal ring shall be a cone-type, non-fouling design and shall run in the pumped product without fouling or hang-up. The spring metal material shall be SAE1095 Carbon steel, ASTM A682 heat-treated to a Rockwell C hardness of 45-50 and totally encapsulated in Viton. The product side of the spring shall have a minimum 1/4-inch thick Viton rubber covering. Seals using single coil, multiple coil, bellows and rubber-in-shear designs are not acceptable.

E. To minimize the number of points where the slurry must be sealed, the mechanical seal assembly shall have no more than three O-rings: one shaft sleeve O-ring, one stationary face O-ring, one retainer O-ring. O-rings shall be made of Viton.

F. All metal components not encapsulated in Viton shall be constructed of abrasion-resistant CD4Mcu ASTM A743. Surface finish shall be a maximum of 64 RMS.
G. The seal shall be capable of running with up to plus or minus 0.025-inch radial shaft deflection and plus or minus 0.040-inch axial shaft deflection without leakage or damage.

H. The seal chamber shall be high chrome iron, ASTM A532, minimum 600 Brinell. The chamber shall provide a reservoir of adequate volume for the pumped product to contact and lubricate the seal faces. The seal shall be installed in the seal chamber from the impeller side of the pump.

2.05 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.

2.06 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.07 SOURCE QUALITY CONTROL

A. Factory Test Report: Include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.

B. Functional Test: Perform manufacturer’s standard test on equipment.

C. Factory Performance Test:

1. Conduct on each pump.
2. Perform under simulated operating conditions.
3. Conduct in accordance with Hydraulic Institute Standards.
4. Test for a continuous 3-hour period without malfunction.
5. Test Log: Record the following:
   a. Total head.
   b. Capacity.
   c. Horsepower requirements.
   d. Flow measured by factory instrumentation and storage volumes.
6. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

D. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
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 the pump and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the 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 the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the 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.

G.  Pipe pump drain(s) to scupper.

3.02 FIELD FINISHING

A.  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 with actual building structures and foundations provided shall not develop vibration exceeding the limits specified in HIS 9.6.4.
b. If units exhibit vibration in excess of the limits modify as necessary.

3. Flow Output: Measured by plant instrumentation and storage volumes.

B. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

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 prestartup classroom or Site training.
4. 1 person-day for facility startup.
5. 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 Engineer.

B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

3.05 SUPPLEMENT

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

1. Grit Pump Data Sheet.

END OF SECTION
GRIT PUMP DATA SHEET

Tag Numbers: HDWK-P-300-A through -C

Pump Name: Grit Pump

Manufacturer and Model Number: Wemco Model C
Or equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Grit Slurry (water and grit mixture)

Pumping Temperature (Fahrenheit): Normal: 60 Max 85 Min 40

Specific Gravity at 60 Degrees F: Varies Viscosity Range: Varies

pH: 4.5 to 8.0

Corrosive (Y/N) N Nature of Corrosive Conditions:

Abrasive (Y/N) Y Nature of Abrasive Conditions: Grit Slurry

Possible Scale Buildup (Y/N): N

Min. NPSH Available (Ft. Absolute): 35
Altitude (Feet above Mean Sea Level): 907

Area Classification: See Project Drawings

Ambient Temperature (degrees F.): 70

Location: Indoor (Y/N): Y Outdoor (Y/N): N

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 500 gpm; Secondary: 500 gpm

Total Dynamic Head (Ft): Rated: 72 feet; Secondary: 60.0 feet

BHP at Rated Point: 27 hp

Min. Pump Hydraulic Efficiency at Rated Capacity (%): 34.0%
Max. Pump Speed at Rated Capacity (rpm): 1200 rpm
  Constant (Y/N): Y  
  Adjustable (Y/N): N

**DESIGN AND MATERIALS**

- **Pump Type:** Horizontal (Y/N) N  
  Frame-Mounted (Y/N) Y  
  Vertical (Y/N) Y – Vertical discharge Other

- **Fully-Recessed Impeller Type:** Cupped Design  
  Material: 650 Brinell Hi-Chrome Iron

- **Removable Suction Flange/Wear Plate (Y/N):** Y  
  Material: 650 Brinell Hi-Chrome Iron

- **Removable Radial Wear Plate (Y/N):** Y  
  Material: 650 Brinell Hi-Chrome Iron

- **Removable Wear Plate w/Pump-out Vanes behind Impeller (Y/N):** Y
  
  **Material:** Brinell Hi-Chrome Iron

- **Primary Wear Surface Minimum Brinell Hardness:** 650

- **Primary Wear Surface Minimum Thickness (in.):** 0.75

- **Casing Type:** Two-piece radially split  
  Min Thickness (in.) 0.75

- **Casing Material:** 650 minimum Brinell Chrome Iron, ASTM A532 Cast-on Feet

- **Shaft Material:** Steel, ASTM A108, Grade 1141

- **Shaft Sleeve Material:** Stainless Steel, ASTM A582 Type 416 or ASTM A743 Grade CA-40, or ASTM A2746

- **Shaft Seal:** Packing (Y/N) N  
  Mechanical (Y/N) Y  
  Type: Flushless, as described in the specification.

- **ABMA B-10 Bearing Life (hrs):** 100,000 hrs  
  Lubrication: Oil Bath

**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors.)

- **Horsepower:** 40  
  **Voltage:** 460  
  **Phase:** 3  
  **Synchronous Speed (rpm):** 1,200

- **Service Factor:** 1.0 when operated on an ac drive  
  Inverter Duty: Yes

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.
Enclosure: DIP _____ EXP _____ ODP _____ TEFC Yes CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive Range: __50%___ min to ____100%__ max. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems.

**REMARKS** Provide pump arrangement/layout per Drawings. Provide motor shaft

grounding brush at the driven (shaft) end. Motor horsepower selected to accommodate

runout at full speed.
Progressing Cavity Pumps

Revision History:

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Document Review & Approval:

Originator:

Steven R. Polson, P.E./Lead Process Mechanical

Design Verification Complete:

Qingshan Wang, P.E./Process Mechanical QC Reviewer

Approved:

W. Laird Ellis, Jr. PE/Design Manager
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).
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 curves showing head, capacity, horsepower demand, 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 guarantee point.
   d. Detailed mechanical, and electrical drawings showing the 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, and including any motor modifications.
   g. Factory finish system.
   h. 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. Factory Functional and Performance Test Reports.
3. 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 1 year and 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 each set of pumps:

1. Complete set packing.
2. Complete set gaskets and O-ring seals.
3. Complete set rod washers.
4. Complete set keys, dowels, pins, etc.
5. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.03 ACCESSORIES

A. Stator Thermal Protection: Provide for pumps where indicated in supplements and as specified below:
1. Stator thermal protection (run dry protection) shall shut pump down before stator damage occurs.
2. Provide thermowell drilled and tapped into stator and thermocouple for measurement of temperature at pump stator to rotor interface.
3. Provide temperature controller in NEMA 4X enclosure, with dual display for stator temperature and alarm set-point with adjustable hysteresis to prevent on/off cycling of pump when coming off an alarm.
4. Provide thermocouple cable between thermocouple and temperature controller.

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: Equipment weighing over 100 pounds.

D. 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 FACTORY FINISHING

A. Manufacturer’s standard baked enamel finish.

2.05 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

C. Factory Test Report: Include test data sheets, curve test results, and performance test logs.

D. Functional Test: Perform manufacturer’s standard test on equipment.

E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

F. Performance Test:
   1. Conduct on each pump.
   2. Conduct in accordance with Hydraulic Institute Standards.
   3. Perform under simulated operating conditions.
   4. Test for a continuous 3-hour period without malfunction.
   5. Test Log: Record the following:
      a. Total head.
      b. Capacity.
c. Horsepower requirements.
d. Driving motor voltage and amperage measured for each phase.

6. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

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 the 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 the proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, non-shrink grout of the proper category, as specified in Section 03 62 00, Non-shrink 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.

G. Pipe pump drain(s) to hub drain.

3.02 FIELD FINISHING

A. 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. Flow Output: Measured by plant instrumentation and storage volumes.
3. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

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. 1/2 person-day for installation assistance and inspection.
2. 1/2 person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
3. 1 person-day for prestart up classroom or Site training and facility startup.

B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

END OF SECTION
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Lobe 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).
4. ASTM International (ASTM):
6. National Electrical Manufacturers’ Association (NEMA): MG 1, Motors and Generators.

1.02  DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to 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, and including motor modifications.
g. Factory finish system.
h. 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. Factory Functional and Performance Test Reports and Logs.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer’s printed installation instructions.
5. Suggested spare parts list to maintain equipment in service for a period of 5 years. Include 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 QUALITY ASSURANCE

A. Rotary lobe pump manufacturer shall be ISO 9001 certified.

1.05 EXTRA MATERIALS

A. Furnish for each pump:

1. Complete set of bearings.
2. Complete set gaskets and O-ring seals.
3. Two shaft sleeves if used.
5. Two complete mechanical seals.
6. One set wear plates.
7. One set housing segments or radial liners.
8. One pair rotors or rotor tips for two rotors.
9. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:
2.02 ROTARY LOBE POSITIVE DISPLACEMENT PUMP

A. General:

1. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.
2. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.
3. Pumping units required under this section shall be complete.

B. Tag Numbers:

1. 941002-CHTR-P-400-A Equalization Tank Discharge Pump A.
2. 941002-CHTR-P-400-B Equalization Tank Discharge Pump B.
3. 941002-CHTR-P-400-C Equalization Tank Discharge Pump C.
4. 941002-SLDP-P-700-A Recycle Sludge Pump A.
5. 941002-SLDP-P-700-B Recycle Sludge Pump B.
6. 941002-SLDP-P-700-C Recycle Sludge Pump C.
7. 941002-SLDP-P-710-A Sludge Waste Pump A.
8. 941002-SLDP-P-710-B Sludge Waste Pump B.
9. 941002-SLDP-P-710-C Sludge Waste Pump C.
10. 941002-SLDP-P-718-A Filter Press Feed Pump A.
11. 941002-SLDP-P-718-B Filter Press Feed Pump B.

C. Pump Design:

1. Some specific requirements are attached to this section as supplements.
2. Designed and fabricated for 24-hour continuous duty at any and all points within specified range of operation, without overheating and without excessive vibration or strain.
3. Parts shall be designed and proportioned to have liberal strength, stability, and stiffness and to be especially adapted for service to be performed. Provide space for inspection, repairs, and adjustment.
4. Working parts of pumps and motors, such as bearings, wearing rings, shaft, sleeves shall be interchangeable between like units and such that Owner may, at any time in future, obtain replacement and repair parts for those furnished in original equipment.
5. Nameplate ratings of motors shall not be exceeded, nor shall design service factor be reduced when pump is operating at point on its characteristic curve up to maximum flow specified herein.
6. Provide mechanical equipment, including drives and electric motors in accordance with applicable OSHA regulations. Unless otherwise specified, provide rigid painted steel or stainless steel guards on rotating assemblies. Guards shall be removable only by use of a tool.
7. Noise level of pump system, unless otherwise noted, shall not exceed limits established by HI 3.1-3.5-2008 paragraph 3.3.17.3.
8. Lubrication fitting shall be brought to outside of equipment so they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
9. Mechanical seals, wear plates and rotors shall be replaceable by removing front cover of rotor housing without disassembly of pump unit or pipe system.

D. Pump Casings:
   2. Pump Rotor Housing: Multi-piece to allow adjustment of rotor running clearance at least twice or shall include radial liners that can be replaced to restore running clearances.

E. Wear Plates:
   1. Where Process Fluid is Water: Rear of pump rotor casing and front cover shall be protected with replaceable Type 316 Stainless Steel wear plates having a minimum Brinell hardness of 500.
   2. Where Process Fluid is Sludge: Rear of pump rotor casing and front cover shall be protected with replaceable tungsten carbide wear plates having a minimum Brinell hardness of 1400.
   3. Front cover wear plate shall be reversible.
   4. Wear Plate Bolts: Bolts that secure wear plates to castings inside pump assembly shall be stainless steel, hex head type.

F. Rotors:
   1. Driven through positive timing gears running in oil.
   2. Solid steel rotor cores shall be covered with a layer of Buna-N at an average durometer hardness of 70 as per ASTM D2240. Alternatively, pump may utilize rotors with replaceable Buna-N 70 durometer tips.
   3. Geometry:
      a. Rotor core shall be same as that of finished rotor.
      b. Helical with a minimum of three lobes to provide a near pulseless flow.
   4. Designed for pumping water and ferric hydroxide sludge containing solids, small particles, and grit.

G. Shafts:
   1. Fabricated of alloy steel AISI A4140.
   2. Fabricated from stainless steel with ceramic coated stainless steel sleeves through seal area.
H. Mechanical Seals:

1. Mechanical style with tungsten carbide seal faces. Cartridge style or component type mechanical seals that use bushings to permanently place seals are acceptable.
2. Seal Holders: Fabricated of materials that are suitable for prolonged corrosion and chemical resistance.
3. Pumps that utilize packing glands or require external flushing for lubrication and cooling are not acceptable.

I. Quench/Blocking Chamber:

1. Oil-filled quench/blocking chamber located behind mechanical seal, and in front of bearing housing lip seal shall be molded into casting of pump.
2. Chamber shall be suitable for fill, from side of pump, through nipples and have an external sight glass or oil bottle for visual inspection of status of mechanical seal operation.
3. Oil shall provide lubrication and cooling of seals.

J. Flanges:

1. Port Connection: ANSI 125-pound or 150-pound rated or greater.
2. Inlet and outlet ports shall be constructed of stainless steel, fittings and flanges bolted to rectangular ports on pump casting.
3. Ports shall be oriented horizontally without offset unless otherwise shown on Drawings.

K. Pump Front Cover:

1. Provide access to pump chamber without disconnecting pipe work or bearings.
2. When opened shall provide unhindered access to rotors, wear plate, and mechanical seals.

L. Bearings:

1. Sized to withstand maximum radial or axial load carried by shafts for continuous duty.
2. Minimum ABMA L10 Bearing Life:
   a. Running at Steady or Constant Speed, Load, Pressure and Temperature: 100,000 hours.
   b. Operated with Variable Frequency Drive: 50,000 hours.
M. Timing Gears and Gear Housing:
   1. Meet AGMA Class 9 quality minimum.
   2. Keyed and timed to prevent contact between rotors and provide smooth and quiet transmission of load.
   3. Located in separate oil-filled, cast-iron gear box fitted with built-in sight glass to monitor oil level.

N. Gear Reducer:
   1. In-line gear reducer designated for continuous duty at moderate shock load.
   2. Meet AGMA Class II, with service factor of 1.4 minimum for pump applications with moderate shock, continuous duty and AGMA Class III, with service factor of 2.0 minimum for heavy shock, continuous duty operation.
   3. C-face, mounted with C-face drive motor to form integral gearmotor combination.

O. Structural Base: Rotary lobe pump, gear reducer, motor or gearmotor shall be mounted on a structural steel baseplate, with structural channel supports as necessary, complete with couplings, guards, and mounting hardware.

2.03 ACCESSORIES

A. Equipment Identification Plate:
   1. 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location giving name of manufacturer, rated capacity, head, speed and other pertinent data. Attach to each pump, motor, and gear reducer.
   2. Additionally, pump serial number, model, gear reduction and motor horsepower shall be cut or stamped into steel plate and welded to skid for permanent identification.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. 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. Coat in accordance with Section 09 90 00, Painting and Coating.

2.04 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating where applicable.
2.05 MANUFACTURER’S STANDARD BAKED ENAMEL FINISH. SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

C. Functional Test: Perform manufacturer’s standard, motor test on equipment. Include vibration test, as follows:

1. Dynamically balance rotating parts of each pump and its driving unit before final assembly.
2. Limits:
   a. Driving Unit Alone: Less than 80 percent of NEMA MG 1 limits.
   b. Complete Rotating Assembly Including Coupling, Drive Unit, and Motor: Less than 90 percent of limits established in Hydraulic Institute Standards.

D. Performance Test:

1. Conduct on each pump.
2. Perform under simulated operating conditions.
3. Test for a continuous 3-hour period for maximum and minimum expected flow rates 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. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
   f. Calculated velocity head at the discharge flange.
   g. Field head.
   h. Driving motor voltage and amperage measured for each phase.
5. Performance Test Logs Certified correct by a registered professional engineer registered in the State of Tennessee.
6. 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. Factory Test Report: Include test data sheets and curve test results.
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 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 so 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 leveling wedges after grout is set and pack void left 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.

G. Pipe pump drain 12 inches above finished concrete, if needed.

3.02 FIELD FINISHING

A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests:

1. Conduct on each pump.
2. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
3. 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 units exhibit vibration in excess of limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced by manufacture.


B. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

C. 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. 5 person-days for installation assistance and inspection.
2. 5 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. 3 person-days for facility startup.
5. 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 and Engineer.

B. See Section 01 43 33, Manufacturers’ Field Services.

3.05 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. Pump Data Sheet.

END OF SECTION
PUMP DATA SHEET
EQUALIZATION TANK DISCHARGE PUMP A, B C

<table>
<thead>
<tr>
<th>Pump Name</th>
<th>Tag Numbers</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equalization Tank Discharge Pump A</td>
<td>941002-CHTR-P-400-A</td>
<td>1) LobePro</td>
</tr>
<tr>
<td>Equalization Tank Discharge Pump B</td>
<td>941002-CHTR-P-400-B</td>
<td>2) Vogelsang</td>
</tr>
<tr>
<td>Equalization Tank Discharge Pump C</td>
<td>941002-CHTR-P-400-C</td>
<td>3) Boerger</td>
</tr>
</tbody>
</table>

**SERVICE CONDITIONS**

| Liquid Pumped: | Water |
| Solids Content: | Less than 0.02% |
| Solids Size: | 1/16” to 3/4” |
| Specific Gravity @ 60 Degrees F: | 1 |
| Vapor Pressure @ 60 Degrees F: | 0.258 psia |
| Viscosity Range: | 1 cP |
| Abrasive (Y/N): | No |
| Maximum Total Suspended Solids: | 200 mg/L |
| Suction Pressure (psig): | Max: 17.3, Min: -1.1 |
| Altitude (ft msl): | 930 |
| Area Classification: | Non-Hazardous |
| Location (indoor/outdoor): | Outdoor |

| High Pressure Discharge Pressure Switch Setting: | MFG Determined |

| PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT |
| Rated Capacity (US gpm): | 1675 |
| Max Discharge Head Required (psig): | 12.37 |
| Maximum Shutoff Pressure (psig): | 25 |
| Maximum Pump Speed at Design Point (rpm): | 500 |
| Minimum Continuous Flow (US gpm): | 250 |
| Discharge Head @ Min Flow (psig): | 10.43 |

| DESIGN AND MATERIALS |
| Minimum Displacement(per/100 r): | 350 gal |
| Foot Mounted (Y/N): | Y |
| Bracket Mounted (Y/N): | 3 |
| Min # of Lobes: | 3 |
| Helical Lobe Material: | Buna-N Coated Steel |
| Timing Gear Material: | AGMA Class 9 |
| Shaft Sleeve Material: | Ceramic Coated SS |
| Coupling: | MFG Standard |
| Flange Class: | ANSI 150# |
| Inline Case (Y/N): | |
| Suction Orientation: | In-Line |
| Rotation (from end of coupling): | |
| Near Centerline Case (Y/N): | 316 SS |
| Casing Materials: | |
| Shaft Size: | 1.5” min |
| Shaft Material: | A4140 |
| Shaft Seals: | Mech |
| Wear Plate Material: | 316 SS |
| Flange Size: | 10” |
# PUMP DATA SHEET

## EQUALIZATION TANK DISCHARGE PUMP A, B C

<table>
<thead>
<tr>
<th>Motor Size (HP):</th>
<th>50</th>
<th>Voltage:</th>
<th>460</th>
<th>Phase:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (Hz):</td>
<td>60</td>
<td>Synchronous Speed (rpm): 1800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Factor:</td>
<td>1.15</td>
<td>Inverter Duty: Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosure:</td>
<td>TEFC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pump Speed Control:** Adjustable Speed Drive  
(See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.)

## REMARKS
# PUMP DATA SHEET
## RECYCLE SLUDGE PUMP A, B C

<table>
<thead>
<tr>
<th>Pump Name:</th>
<th>Tag Numbers:</th>
<th>Manufacturers:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycle Sludge Pump A</td>
<td>941002-SLDP-P-700-A</td>
<td>1) LobePro</td>
</tr>
<tr>
<td>Recycle Sludge Pump B</td>
<td>941002-SLDP-P-700-B</td>
<td>2) Vogelsang</td>
</tr>
<tr>
<td>Recycle Sludge Pump C</td>
<td>941002-SLDP-P-700-C</td>
<td>3) Boerger</td>
</tr>
</tbody>
</table>

### SERVICE CONDITIONS

<table>
<thead>
<tr>
<th>Liquid Pumped:</th>
<th>4% Ferric Hydroxide Sludge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids Content:</td>
<td>4%</td>
</tr>
<tr>
<td>Solids Size:</td>
<td>1/16” to 3/4”</td>
</tr>
<tr>
<td>Specific Gravity @ 60 Degrees F:</td>
<td>1.03</td>
</tr>
<tr>
<td>Vapor Pressure @ 60 Degrees F:</td>
<td>0.258 psia</td>
</tr>
<tr>
<td>Abrasive (Y/N):</td>
<td>Yes</td>
</tr>
<tr>
<td>Maximum Total Suspended Solids:</td>
<td>13.3 mg/L</td>
</tr>
<tr>
<td>Suction Pressure (psig):</td>
<td>Max: 13.3</td>
</tr>
<tr>
<td></td>
<td>Min: 13.0</td>
</tr>
<tr>
<td>High Pressure Discharge Pressure Switch Setting:</td>
<td>MFG Determined</td>
</tr>
<tr>
<td>Viscosity Range:</td>
<td>7.0 - 8.0 cP</td>
</tr>
<tr>
<td>Liquid pH:</td>
<td>6.4</td>
</tr>
<tr>
<td>Possible Scale Buildup (Y/N):</td>
<td>Y</td>
</tr>
<tr>
<td>Altitude (ft msl):</td>
<td>930</td>
</tr>
<tr>
<td>Area Classification:</td>
<td>Non-Hazardous</td>
</tr>
<tr>
<td>Location (indoor/outdoor):</td>
<td>Outdoor</td>
</tr>
</tbody>
</table>

### PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

| Rated Capacity (US gpm): | 225                    |
| Max Discharge Head Required (psig): | 35              |
| Maximum Shutoff Pressure (psig): | 50                |
| Maximum Pump Speed at Design Point (rpm): | 500          |
| Minimum Continuous Flow (US gpm): | 20                 |
| Discharge Head @ Min Flow (psig):   | 15.4               |

### DESIGN AND MATERIALS

| Minimum Displacement(per/100 re) | 100 gal |
| Foot Mounted (Y/N):              | Y       |
| Bracket Mounted (Y/N):           |         |
| Min # of Lobes:                  | 3       |
| Helical Lobe Material:           | Buna-N Coated Steel |
| Gear Reducer:                    | Y       |
| Timing Gear Material:            |AGMA Class 9 |
| Shaft Sleeve Material:           | Ceramic Coated SS |
| Coupling:                        | MFG Standard |
| Flange Class:                    | ANSI 150# |
| Inline Case (Y/N):               | In-Line |
| Suction Orientation:             |         |
| Rotation (from end of coupling): |         |
| Near Centerline Case (Y/N):      |         |
| Casing Materials:                | 316 SS   |
| Shaft Size:                      | 1.5" min |
| Shaft Material:                  | A4140    |
| Shaft Seals:                     | Mech     |
| Wear Plate Material:             | Tungsten Carbide |
| Flange Size:                     | 6"      |
# PUMP DATA SHEET

**RECYCLE SLUDGE PUMP A, B C**

<table>
<thead>
<tr>
<th>Motor Size (HP)</th>
<th>Voltage</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>460</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Synchronous Speed (rpm)</th>
<th>Inverter Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>1800</td>
<td>Y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service Factor</th>
<th>Enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.15</td>
<td>TEFC</td>
</tr>
</tbody>
</table>

**Pump Speed Control:** Adjustable Speed Drive

(See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.)

---

**REMARKS**
# PUMP DATA SHEET
## WASTE SLUDGE PUMP A, B C

<table>
<thead>
<tr>
<th>Pump Name</th>
<th>Tag Numbers</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge Waste Pump A</td>
<td>941002-SLDP-P-710-A</td>
<td>1) LobePro</td>
</tr>
<tr>
<td>Sludge Waste Pump B</td>
<td>941002-SLDP-P-710-B</td>
<td>2) Vogelsang</td>
</tr>
<tr>
<td>Sludge Waste Pump C</td>
<td>941002-SLDP-P-710-C</td>
<td>3) Boerger</td>
</tr>
</tbody>
</table>

## SERVICE CONDITIONS

<table>
<thead>
<tr>
<th>Liquid Pumped</th>
<th>4% Ferric Hydroxide Sludge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids Content</td>
<td>4%</td>
</tr>
<tr>
<td>Solids Size</td>
<td>1/16” to 3/4”</td>
</tr>
<tr>
<td>Specific Gravity @ 60 Degrees F</td>
<td>1.03</td>
</tr>
<tr>
<td>Vapor Pressure @ 60 Degrees F</td>
<td>0.258 psia</td>
</tr>
<tr>
<td>Abrasive (Y/N)</td>
<td>Yes</td>
</tr>
<tr>
<td>Maximum Total Suspended Solids</td>
<td>mg/L</td>
</tr>
<tr>
<td>Suction Pressure (psig):</td>
<td></td>
</tr>
<tr>
<td>Max:</td>
<td>24.1</td>
</tr>
<tr>
<td>Min:</td>
<td>15.0</td>
</tr>
<tr>
<td>High Pressure Discharge Pressure Switch Setting:</td>
<td>MFG Determined</td>
</tr>
<tr>
<td>Pumping Temperature (Fahrenheit):</td>
<td>Normal: 56</td>
</tr>
<tr>
<td></td>
<td>Max: 77</td>
</tr>
<tr>
<td></td>
<td>Min: 52</td>
</tr>
<tr>
<td>Viscosity Range:</td>
<td>7.0 - 8.0 cP</td>
</tr>
<tr>
<td>Liquid pH:</td>
<td>6.4</td>
</tr>
<tr>
<td>Possible Scale Buildup (Y/N):</td>
<td>Y</td>
</tr>
<tr>
<td>Altitude (ft msl):</td>
<td>930</td>
</tr>
<tr>
<td>Area Classification:</td>
<td>Non-Hazardous</td>
</tr>
<tr>
<td>Location (indoor/outdoor):</td>
<td>Outdoor</td>
</tr>
</tbody>
</table>

## PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

| Rated Capacity (US gpm):        | 20                          |
| Max Discharge Head Required (psig): | 20                  |
| Maximum Shutoff Pressure (psig): | 50                          |
| Maximum Pump Speed at Design Point (rpm): | 300               |
| Minimum Continuous Flow (US gpm): | 0.7                        |
| Discharge Head @ Min Flow (psig): | 20                         |

## DESIGN AND MATERIALS

| Minimum Displacement(per/100 rev) | 8 gal |
| Foot Mounted (Y/N):               | Y     |
| Bracket Mounted (Y/N):            |       |
| Min # of Lobes:                   | 3     |
| Helical Lobe Material:            | Buna-N Coated Steel          |
| Gear Reducer:                     | Y     |
| Timing Gear Material:             | AGMA Class 9                  |
| Shaft Sleeve Material:            | Ceramic Coated SS             |
| Coupling:                         | MFG Standard                  |
| Flange Class:                     | ANSI 150#                      |
| Inline Case (Y/N):                |       |
| Suction Orientation:              | In-Line                        |
| Rotation (from end of coupling):  |       |
| Near Centerline Case (Y/N):       |       |
| Casing Materials:                 | 316 SS                         |
| Shaft Size:                       | 1.5" min                       |
| Shaft Material:                   | A4140                          |
| Shaft Seals:                      | Mech                           |
| Wear Plate Material:              | Tungsten Carbide               |
| Flange Size:                      | 2"                             |

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LOBE PUMPS
44 42 56.14 SUPPLEMENT - 5
## PUMP DATA SHEET

### WASTE SLUDGE PUMP A, B C

<table>
<thead>
<tr>
<th>Motor Size (HP):</th>
<th>3</th>
<th>Voltage:</th>
<th>460</th>
<th>Phase:</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (Hz):</td>
<td>60</td>
<td>Synchronous Speed (rpm):</td>
<td>1800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Factor:</td>
<td>1.15</td>
<td>Inverter Duty:</td>
<td>Y</td>
<td>Enclosure:</td>
<td>TEFC</td>
</tr>
</tbody>
</table>

**Pump Speed Control:** Adjustable Speed Drive

(See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.)

---

**REMARKS**
# PUMP DATA SHEET
## FILTER PRESS FEED PUMP A, B

<table>
<thead>
<tr>
<th>Pump Name</th>
<th>Tag Numbers</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter Press Feed Pump A</td>
<td>941002-SLDP-P-718-A</td>
<td>1) LobePro</td>
</tr>
<tr>
<td>Filter Press Feed Pump B</td>
<td>941002-SLDP-P-718-B</td>
<td>2) Vogelsang</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Boerger</td>
</tr>
</tbody>
</table>

## SERVICE CONDITIONS

<table>
<thead>
<tr>
<th>Liquid Pumped</th>
<th>4% Ferric Hydroxide Sludge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids Content</td>
<td>4%</td>
</tr>
<tr>
<td>Solids Size</td>
<td>1/16” to 3/4”</td>
</tr>
<tr>
<td>Specific Gravity @ 60 Degrees F</td>
<td>1.03</td>
</tr>
<tr>
<td>Vapor Pressure @ 60 Degrees F</td>
<td>0.258 psia</td>
</tr>
<tr>
<td>Abrasive (Y/N)</td>
<td>Yes</td>
</tr>
<tr>
<td>Maximum Total Suspended Solids</td>
<td>mg/L</td>
</tr>
<tr>
<td>Suction Pressure (psig):</td>
<td></td>
</tr>
<tr>
<td>Max:</td>
<td>16.0</td>
</tr>
<tr>
<td>Min:</td>
<td>-0.3</td>
</tr>
<tr>
<td>High Pressure Discharge Pressure Switch Setting</td>
<td>MFG Determined</td>
</tr>
<tr>
<td>Pumping Temperature (Fahrenheit):</td>
<td></td>
</tr>
<tr>
<td>Normal:</td>
<td>56</td>
</tr>
<tr>
<td>Max:</td>
<td>77</td>
</tr>
<tr>
<td>Min:</td>
<td>52</td>
</tr>
<tr>
<td>Viscosity Range:</td>
<td>7.0 - 8.0 cP</td>
</tr>
<tr>
<td>Liquid pH:</td>
<td>6.4</td>
</tr>
<tr>
<td>Possible Scale Buildup (Y/N):</td>
<td>Y</td>
</tr>
<tr>
<td>Altitude (ft msl):</td>
<td>930</td>
</tr>
<tr>
<td>Area Classification:</td>
<td>Non-Hazardous</td>
</tr>
<tr>
<td>Location (indoor/outdoor):</td>
<td>Outdoor</td>
</tr>
</tbody>
</table>

## PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

<table>
<thead>
<tr>
<th>Rated Capacity (US gpm):</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Discharge Head Required (psig):</td>
<td>17</td>
</tr>
<tr>
<td>Maximum Shutoff Pressure (psig):</td>
<td>120</td>
</tr>
<tr>
<td>Maximum Pump Speed at Design Point (rpm):</td>
<td>300</td>
</tr>
<tr>
<td>Minimum Continuous Flow (US gpm):</td>
<td>6</td>
</tr>
<tr>
<td>Discharge Head @ Min Flow (psig):</td>
<td>107</td>
</tr>
</tbody>
</table>

## DESIGN AND MATERIALS

<table>
<thead>
<tr>
<th>Minimum Displacement(per/100 rev):</th>
<th>100 gal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot Mounted (Y/N):</td>
<td>Y</td>
</tr>
<tr>
<td>Bracket Mounted (Y/N):</td>
<td></td>
</tr>
<tr>
<td>Min # of Lobes:</td>
<td>3</td>
</tr>
<tr>
<td>Helical Lobe Material:</td>
<td>Buna-N Coated Steel</td>
</tr>
<tr>
<td>Gear Reducer:</td>
<td>Y</td>
</tr>
<tr>
<td>Timing Gear Material:</td>
<td>AGMA Class 9</td>
</tr>
<tr>
<td>Shaft Sleeve Material:</td>
<td>Ceramic Coated SS</td>
</tr>
<tr>
<td>Coupling:</td>
<td>MFG Standard</td>
</tr>
<tr>
<td>Flange Class:</td>
<td>ANSI 150#</td>
</tr>
<tr>
<td>Inline Case (Y/N):</td>
<td></td>
</tr>
<tr>
<td>Suction Orientation:</td>
<td>In-Line</td>
</tr>
<tr>
<td>Rotation (from end of coupling):</td>
<td></td>
</tr>
<tr>
<td>Near Centerline Case (Y/N):</td>
<td></td>
</tr>
<tr>
<td>Casing Materials:</td>
<td>316 SS</td>
</tr>
<tr>
<td>Shaft Size:</td>
<td>1.5&quot; min</td>
</tr>
<tr>
<td>Shaft Material:</td>
<td>A4140</td>
</tr>
<tr>
<td>Shaft Seals:</td>
<td>Mech</td>
</tr>
<tr>
<td>Wear Plate Material:</td>
<td>Tungsten Carbide</td>
</tr>
<tr>
<td>Flange Size:</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Motor Size (HP):</td>
<td>10</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Frequency (Hz):</td>
<td>60</td>
</tr>
<tr>
<td>Service Factor:</td>
<td>1.15</td>
</tr>
<tr>
<td>Pump Speed Control:</td>
<td>Adjustable Speed Drive</td>
</tr>
</tbody>
</table>

**REMARKS**
Peristaltic Hose Pump
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).
5. Hydraulic Institute Standards.
6. 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. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   b. Detailed mechanical and electrical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
   c. Make, model, weight, and horsepower of each equipment assembly.
   d. Performance data curves showing head, capacity, and horsepower demand over entire operating range of pump, from shutoff to maximum capacity. Indicate head, capacity, and horsepower demand required at guarantee point.
   e. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
   f. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
   g. Power and control wiring diagrams, including terminals and numbers.
   h. Listing of extra materials supplied for this section.
   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. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, signed by an authorized representative of manufacturer that equipment and factory-applied coating system(s) meet requirements specified herein.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Factory test reports.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer’s printed installation instructions.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup, and for future maintenance.
7. 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.
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 01 43 33, Manufacturers’ Field Services.

1.04 EXTRA MATERIALS

A. No spare parts or tools required.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with motor manufacturer and be responsible for pumps and motors.

B. Where adjustable speed drives are required, furnish and be responsible for a coordinated operating system complete with pump, motor, and adjustable speed drive.

C. Design Requirements: In accordance with Section 01 61 00, Common Product Requirements.

2.02 SUPPLEMENTS

A. Specific product requirements are attached to this section as supplements.
2.03 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 and control panel in a readily visible location. Plate shall bear 3/8-inch high die-stamped block type black enamel filled equipment identification number and letters indicated in this Specification.

C. 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. Coat in accordance with Section 09 90 00, Painting and Coating.

D. Leak Detection Switch:
   1. Locate near top of pump to detect leakage of pumped product into pump housing.
   2. Mount sensor on rear of pump housing.
   3. Supply sensor Normally Closed with ability for field adjustment to Normally Open.
   4. Float Switch Rating: Vmax = 240V AC, Imax = 1 amp, Pmax = 50VA.

E. Revolution Sensor:
   1. Provide inductive type revolution sensor located to detect rotor revolutions.
   2. Pump manufacturer to supply and mount sensor and triggering device.
   3. Inductive Sensor Rating: Vmax = 30V dc, Imax = 150 mA, Pmax = 4.5 VA.

F. Inlet Pulsation Accumulators and Discharge Pulsation Dampeners:
   1. Inlet size same as pump connecting pipe size. Provide ANSI Class 150 flanged inlet.
   2. Housing: Epoxy coated steel.
   4. Accessories: Pressure gauge, air fill valve, and cap.
   5. Fasteners: Stainless steel.
   7. Manufacturer and Product: Blacoh Fluid Control; Sentry Series.

2.04 FACTORY FINISHING

A. Prepare, prime and finish coat in accordance with Section 09 90 00, Painting and Coating using Manufacturer’s standard industrial protective coatings.
2.05 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Pumps: Assemble, check, and shim all pumps for the specific application prior to shipment.

2. Control Panels:
   a. Inspect control panels for required construction, electrical connection, and intended function.
   b. Test all control panels furnished.

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.

1. Wedge taper not greater than 1/4 inch per foot.
2. Use double wedges to provide a level bearing surface for pump and driver base.
3. 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. Touch up manufacturer’s finish using manufacturer’s recommended coating repair system.
3.03 FIELD QUALITY CONTROL

A. Perform pre-operational checks per manufacturer’s printed instructions.

B. Functional Tests:

1. Conduct on Each Pump: Test complete assemblies for correct rotation, proper connections, and normal operational characteristics.

C. Performance Tests:

1. Conduct on Each Pump:
   a. Perform under simulated or actual operating conditions.
   b. Test for a continuous 30-minute period for each pump.
   c. Test and Test Log: Record the following:
      1) Pump suction head relative to suction flange centerline.
      2) Pump discharge head relative to pump discharge flange centerline.
      3) Pump flow using pump rpm and gallons per revolution.
      4) Pump flow using plant flowmeter instrumentation, if available.
      5) Motor voltage and amperage measured for each phase.

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, inspection, startup, functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
2. 1 person-day for prestartup classroom or Site training, and post-startup training Owner’s personnel.

B. See Section 01 43 33, Manufacturers’ Field Services.

3.05 SUPPLEMENTS

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

1. Peristaltic Hose Pump Data Sheet.

END OF SECTION
PERISTALTIC HOSE PUMP DATA SHEET 44 42 56.16-1

Tag Numbers: 941002-CHEM-P-513C, 941002-CHEM-P-513D

Pump Name: Thickening Aid Polymer Solution Pump C / D.

Manufacturer and Model Number:  
(1) Watson Marlow/Bredel Pumps  
(2) Verderflex  
(3) Proiment DulcoFlex

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): BASF Zetag 8844FS, 0.5% solution

Pumping Temperature (Fahrenheit): Normal: 70_____ Max 85_____ Min 60_____  
Specific Gravity @ 60 Degrees F: 600 cP__________ Viscosity Range: 200 – 1200  
pH: 4.0________________________________________

Abrasive (Y/N): N__________________ Possible Scale Buildup (Y/N): N____

Inlet Pressure at Pump (psig): -3 psig________________________

Min. Net Positive Inlet Pressure Available (psia): 10____________________

Area Classification: None________________________________________

PERFORMANCE REQUIREMENTS

Rated Capacity (gpm): 7.5_________ Rated Differential Pressure (psi): 70_________

Maximum Pump Speed at Rated Condition (rpm): __________________________

Constant Speed (Y/N): N______________ Adjustable Speed (Y/N): Y______________

Speed Range: 10___% to 110% of Rated Speed: __________________________

DESIGN AND MATERIALS

Pump Type: Heavy-duty, horizontal, peristaltic hose pump

Pump Configuration: Direct or close-coupled

Pump Housing Material: Cast, ASTM A48/A48M, Class 25

Cover Material: Carbon steel or cast iron, with inspection window

Cover Seal Material: Buna N (NBR)
Rotor Material: Cast iron

Rotor Shoes: Stainless Steel

No. of Rotor Shoes (Minimum): 2

Rotor Shoe Shim Material: Type 316 stainless steel

Hose Size, Millimeters: 40

Maximum Number of Hose Occlusions per 100 Gallons Pumped: 570

Hose Material: Buna-N (NBR)

Hose Pressure Rating (psig): 200

Hose Inserts Material: Type 316 stainless steel

Hose Lubricant: Manufacturer’s standard

Flange Rating and Material: ANSI Class 125/150 Type 316 stainless steel

Bearing Housing Material: Cast iron

Bearing Type: Ball bearings, permanently lubricated

Bearing Life (ABMA L-10) (hrs): 100,000

Gear Drive: Planetary type, AGMA Class II

Baseplate: Factory-coated steel

High Level Leak Detector (Y/N): Y

Pump Speed Sensor (Y/N): Y

Revolution Sensor (Y/N): Y

Suction Pulsation Dampener (Y/N): Yes, if recommended by pump manufacturer

Discharge Pulsation Dampener (Y/N): Y

**DRIVE MOTOR** (see Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 3
Voltage: 480
Phase: 3
Synchronous Speed (rpm): 1800

Service Factor: 1.15
Inverter Duty (Y/N): Y

Enclosure: TEFC
Adjustable Speed Drive Range: ______ min to _______ max, see Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems.

REMARKS


Filter Press Equipment

## Revision History:

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
<th>Affected Pages</th>
</tr>
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<tr>
<td>0</td>
<td>Issue for Construction</td>
<td>June 16, 2017</td>
<td>All</td>
</tr>
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</table>

## Document Review & Approval:

**Originator:**
Karen M. Leber, PE/ Process Lead Engineer

**Design Verification Complete:**
Mark Davis/Senior Technical Consultant

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager
PART 1            GENERAL

1.01 GENERAL

A. Section includes the requirements necessary to furnish and install a filter press system. The filter press and other related appurtenances and accessories are hereinafter referred to as the system.

B. Equipment and appurtenances for the filter press dewatering system to be provided under this section include the following key components and/or subsystems:

1. Fabricated steel filter press frame, 100 psig operational.
2. Polypropylene, non-gasketed, recess chamber filter plates with filter clothes, 1200 mm by 1200 mm.
3. Automatic hydraulic power pack for press opening and closing systems (one per press).
4. Sludge feed piping with double-end feed capability, valves and appurtenances.
5. Filtrate removal piping, valves and appurtenances.
6. Filter plate core blow system.
7. Safety light curtain on both sides of each press for personnel protection (two per press).
8. Electrical components, controls and appurtenances.
9. Filter press motor starter/drive panel (one per press)
10. Filter press control panel (one per press).

C. Related Sections:

1. Section 01 43 33, Manufacturers Field Services.
2. Section 01 61 00, Common Product Requirements.
3. Section 01 78 23, Operation and Maintenance Data.
4. Section 01 88 15, Anchorage and Bracing.
5. Section 05 12 00, Structural Steel Framing.
6. Section 09 90 00, Painting and Coating.
7. Section 26 05 04, Basic Electrical Materials and Methods.
8. Section 26 20 00, Low-Voltage AC Induction Motors.
10. Section 40 99 90, Package Control Systems.
1.02 SYSTEM DESCRIPTION

A. Design and Performance Requirements:

1. Design and performance requirements are shown in Section 44 43 23.01, Filter Press Equipment, Datasheet.
2. The filter press system shall receive the sludge specified in the data sheet, dewater it, efficiently release the dewatered cake from the filter cloths with a minimum of operator assistance, and neatly discharge the dewatered sludge cake solids storage container directly under the filter press.
3. Design the system to accommodate the initial capacities indicated in the data sheet, with capability to expand the system to the build-out capacities indicated with future addition of plates.
4. The filter press system shall perform the required dewatering operations without side extrusion of sludge between filter plates or spillage or leakage of sludge.

1.03 SUBMITTALS

A. Action Submittals:

1. Process and Instrument Diagram of the complete system.
2. Utility summary for the system.
3. Schematics showing all elements of the complete system including all specialized devices fully labeled showing manufacturer and part identification.
4. Dimensioned overall plan and elevation of the system and appurtenant devices. Show arrangement of the equipment, interfaces with other systems and site components, and loads imposed on site support structures.
5. Shop drawings of each individually fabricated component showing design data including dimensions, materials, construction features, and capacities.
6. Size and weights for filter press equipment and major components, including shipping weight and operating weight distribution on base plates, weight of heaviest component, and weight of heaviest component assembly to be lifted during installation.
7. Structural foundation plan with dimensions and vertical and horizontal load distribution for filter press equipment.
8. Description of the hydraulic system, hydraulic cylinders, and hydraulic power pack including schematics, schematic legend, hydraulic components, motors, pumps, valves, piping, and control devices.
9. Number of recessed chambers or plates, total effective filtration area, chamber thickness, and effective filtration volume provided per press.
10. Details of filter plates including size, tensile strength, compression strength, design differential pressure, materials of construction, carriage
assembly details, location and size of sludge feed opening, filtrate opening, stay bosses and vent connections.

11. Details of filter cloth including materials of construction, weaving pattern, size, reinforcing details, weight, and method of attachment to the plate.

12. Details of plate shifter including chains, hooks, plate shifting speed, and location on filter press.

13. Details of filter press piping including materials of construction, dimensions, sizes, locations, pressure rating, flange type, pipe supports, design calculations, and plan and section views of piping. Including details of swivel joints and flexible hoses.

14. Equipment installation details of all equipment including foundation details, structural modifications, anchor details, anchor bolt placement drawings, loading on building structural members and details of all structural penetrations.

15. Details of the filter press frame including materials of construction, structural design criteria, dimensions and thickness of structural components, design closing force, and follower plate carriage details.

16. Details of discharge chute including materials of construction, structural design criteria, dimensions and thickness of structure components, and details of structural attachments.

17. Confirmation that the process and instrument air quantities, pressures, and qualities as listed in Section 43 12 01, Compressed Air Systems, are acceptable for correct filter press and instrumentation operation. If the air requirements differ, clearly quantify air quantities, pressures, and quality in the submittal to allow the Engineer to coordinate requirements with the compressed air system supplier.

18. A complete set of electrical drawings including control schematics detailing all control components, electrical point-to-point wiring and piping. Electrical drawings shall include wiring schematics, interconnecting diagrams, panel layouts, electrical power requirements, bill of materials and enclosure door layout. Clearly delineate factory from field assembly.

19. Define interface points for electric, control wiring, water, sludge and filtrate connections.

20. Control sequence describing sludge pump control and press fill/dewatering cycle, including pump speeds and pressure set points, as well as other information needed to understand how the pumps and press operation will be controlled, and the ability of the operator to adjust these parameters.

21. A detailed proposed factory test procedure in writing to the Engineer at least 8 weeks prior to the test, for review, comment and approval. The procedure shall describe testing methods and data to be recorded during the test.

22. Record drawings to the Owner showing “as-built” conditions, including any field revisions.
B. Informational Submittals:

1. Installation List: The manufacturer shall submit a list of filter press systems installed within the last 5 years.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
4. Certification that the factory-applied coating system(s) is identical to the requirements specified in Section 09 90 00, Painting and Coating. Include painting schedule showing the surface preparation, paint type, coating thickness, and color for each component of the filter press equipment.
5. Special shipping, storage and protection, and handling instructions.
6. List of spare parts and special tools furnished with the equipment.
7. List of materials and supplies furnished with the equipment.
8. Qualifications of engineer designing the Filter Press Raised Platform. The design will not be reviewed for accuracy or approval but rather to demonstrate that the platform was designed and stamped by the professional engineer.
9. Product data sheets/individual catalog cuts for all purchased equipment of standard manufacture.
10. Manufacturer’s written/printed installation instructions to enable the Contractor to install the equipment furnished (including lifting points). It is understood that the Owner has the right to copy and distribute additional copies of the installation instructions.
11. Routine maintenance requirements prior to plant startup.
12. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
13. Recommended spare parts and cost information. Include name, address, and telephone number of filter press manufacturer’s nearest spare parts inventory location.
14. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.
15. Proposed field test procedures for all equipment.
16. Manufacturer to provide report to the Engineer containing the certified test results within two weeks after test completion. The report shall document any problems encountered during the tests, document corrective action to be taken, and contain the detailed results of each test. A separate report shall be submitted for the filter press and for the filter plates. The filter plate test report shall include graphical plots of pressure versus deflection for each test point of each plate, and shall include a scale drawing of filter plate showing test point locations.
17. List of exceptions to the requirements of the contract including equipment locations changes, piping alterations, and electrical and control changes.
18. Quality control information shall be available upon request.

1.04 QUALITY ASSURANCE

A. All filter press equipment shall be furnished by a single manufacturer who is fully experienced for a minimum of 10 years, reputable, and qualified in the manufacture of the equipment to be furnished. All equipment shall be in accordance with specifications herein. Acceptable manufacturers are:

1. Evoqua Water Technologies.
2. Ascension Industries Inc. Durco Filtration Division (formerly FSD)/Aquacare Systems, Inc.
3. Andritz Group.
4. FLSmidth Minerals.

B. Where equipment offered for approval varies from the description and requirements of this Section, such equipment will be considered only if the full intent of the design, including performance and long term reliability is clearly demonstrated to the complete satisfaction of the Owner and Engineer.

C. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s services.

D. Equipment shall comply with the most recent safety standards of the Federal Occupational Safety Health Act and all other applicable state, local and federal codes.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Conform to the requirements of Section 01 61 00, Common Product Requirements.

B. Prior to shipment, remove dirt and extraneous materials from the filter interior. Remove exterior surface markings, coatings, or contaminants prior to shipment.

C. Box, crate, or otherwise protect equipment from damage and moisture during shipment, handling and storage. Protect equipment from exposure to corrosive fumes and keep equipment thoroughly dry during shipping. For extended storage periods, avoid use of plastic equipment wrappers which could cause accumulation of condensate in gears and bearings.

D. Tag each component to identify its location, tag number and function in the system. Prominently display equipment identification on the outside of
packages. Provide a permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with tag number, as given in the Drawings or as provided by the Engineer during the submittal process, on each piece of equipment supplied.

1.06 EXTRA MATERIALS

A. Furnish the following spare parts, tagged and boxed for storage:
   1. One complete set of hydraulic cylinder packing and O-rings.
   2. One complete set of filter cloths for an entire press.
   3. Two filter plates.
   4. One complete set of filter cloth fasteners.
   5. Provide one spare fuse for each fused terminal block.

PART 2 PRODUCTS

2.01 GENERAL

A. Tag Numbers:
   1. SLDP-FP-718-A.
   2. SLDP-FP-718-B.

B. Construct the system and filter frame of steel capable of absorbing static forces, operating loads, and moments which could arise.

C. Include recessed filter plates with electro-hydraulic closure.

D. Provide the system automated throughout load, squeezing, plate-shifting, and disposal cycles, with capability for manual initiation of automatic cycles.

E. Provide a double-air blowdown manifold, factory piped and wired and consisting of the necessary piping and valves to join the four filtrate discharge ports into a common discharge pipe. Include an air regulator and pressure gauge to control and monitor the air blowdown.

F. Provide a fabricated steel cabinet to protect the closure system and components.

G. Coat non-stainless steel metallic surfaces for corrosion resistance. Paint equipment and piping in compliance with Section 09 90 00, Painting and Coating, System No. 4.
H. Filter Frame:

1. Provide overhead or sidebar plate suspension.
2. Size the filter frame to provide a filter volume and system expansion capacity as specified on the data sheet.
3. Design the system based on the following minimum structural design criteria:
   a. Minimum distributed load of the specified feed pressure over the entire filtration area, including fittings and manifolds.
   b. Design filter press to support its own weight and the filter plates completely filled with filter cake when the plate set has been fully expanded and when the follower plate is in both the open and closed positions.
   c. Provide a pre-stressed beam assembly to limit deflection.
4. Provide Feed End: Interface connection ports for the filter press on the feed end. Provide a central feed inlet port to connect the feed into adjacent chambers of the filter pack. Provide four ports at each corner of the feed end to allow for filtrate discharge.
5. Moving End: The moving end and plate pack are driven up to the feed end and held under pressure by the hydraulic closure cylinder.

I. Filter Press Raised Platform:

1. Provide a raised platform structure that supports the filter presses, personnel, and associated maintenance equipment.
2. Raised platform shall be designed and stamped by a structural engineer registered in the state of Tennessee.
3. Construct the platform using structural steel framing as identified in Section 05 12 00, Structural Steel Framing, and coated in accordance with Section 09 90 00, Painting and Coating.
4. Handrails: Stainless steel or FRP.
5. Fasteners: Stainless steel.
6. No aluminum shall be used in the area due to potential contact with mercury contained in sludge material.
7. Provide stair access to the raised platform with walkable grated surface with minimum 4-foot clearance around filter press equipment as shown on Drawings. Grating shall be fiber reinforced plastic. Design platform to meet minimum and/or maximum dimensions and clearances as shown on Drawings.

J. Filter Plates:

1. Mold plates from pigmented polypropylene with no fillers. Plates shall have a drainage surface design that provides adequate support for filter cloths and have integrally molded stay boss supports equally spaced on the drain field. Machine plate sealing surfaces to a maximum parallel
plate tolerance of 0.3 mm. Chamber recess depth dimensions shall have a tolerance not to exceed 0.5 mm.

2. Provide plates complete with filter cloths.
3. Filter plates to have center feed with alternating corner discharge design with fixed volume and recessed, non-gasketed design.
4. Provide the end filter plates installed on the head stand and on the movable follower plate with sludge cake recesses only on the side facing the adjacent filter plate.
5. In order to process less than a full load, provide the system with a blank backup plate, capable of being inserted, along with the tail filter plate, at any point in the press plate stack.

K. Filter Cloth:

1. Provide a polypropylene filter cloth for each filter plate.
2. Design the filter cloth to cover the filter area of each plate on both sides and include plate fasteners required for attachment of the filter cloth to the plate.

L. Electric/Hydraulic Closure System:

1. Include one hydraulic cylinder, mounted at the center of the follower plate, and one hydraulic power pack to open and close the filter and to maintain the closing force throughout the process cycle.
2. Hydraulic power pack:
   a. Includes an electric motor and hydraulic driven pump along with safety relief valve and pressure switch arrangement mounted to an integral oil reservoir.
   b. Clamp the press by pressurizing the hydraulic system after the plate pack is fully closed.
   c. To minimize the use of hydraulic pumping module, cycle the pump off when the hydraulic unit is fully pressurized and restart if the hydraulic pressure falls below a preset value.
   d. Mount the power pack independent of the hydraulic cylinder mount and provide easy access for maintenance.
3. Allow sufficient movement of the pistons to permit operation and sludge removal at maximum and minimum dewatering capacity.
4. Provide system hydraulics completely assembled prior to shipment, including mounting and connection of the hydraulic piping from the oil supply and return connections on the power pack to the hydraulic cylinders.
5. Include the following accessories with the hydraulic oil reservoirs:
   a. Oil level sight gauge.
   b. Breather fill cap.
c. Filters on supply and return lines.
d. Drain line with valve.

M. Automatic Plates Shifting/Separation System: Provide an electrically powered, chain driven, fully automatic plate separator, which facilitates cake removal from the plates.

N. Sludge Feed Piping, Filtrate Removal Piping, Valves, and Appurtenances:

1. Provide feed and discharge piping manifolds and other specialty items. Fabricate piping of Type 316 stainless steel, Schedule 40. Provide flanged connections outside of the stationary head plate for the center feed slurry port and the corner filtrate discharge ports.
2. Provide core blow down valving and piping. Design the core blow to remove the wet center feed eye core of the filter pack after filtration is complete.
3. Provide air blow down valving and piping to remove additional water from the dewatered sludge once the press is full through the use of compressed air injected into the press.
4. Use automatic, pneumatically-actuated valves to control dewatering process, air blow down, and core blow down.
   a. Sludge Valves: Type 316 stainless steel flanged plug valves.
   b. Filtrate Valves: Type 316 stainless steel flanged butterfly valves
   c. Compressed Air Valves: Type 316 stainless steel full-port ball valves.
   d. Automatic valves actuators: single acting spring return actuators arranged to fail safe if air pressure is lost. Provide open/close limit switches giving visual indicator of valve state and electrical indication to the controlling PLC.

O. Safety Light Curtain:

1. Provide with each unit two light curtains contained within a heavy-duty NEMA 4X enclosure. The purpose of the light curtains shall be to stop all automatic movements of the filter press should any of the light curtain beams be interrupted by an obstruction. Locate the light curtains on both the operator and non-operator side of the filter press.
2. Utilize solid state microprocessor based construction with fail safe self-checking circuitry design. The light shall operate in the invisible infrared light range and meet the requirements for presence sensing devices when correctly installed and regularly maintained. Each transmitter and receiver, diode/transistor pair shall operate sequentially for a period of 15 milliseconds each.
P. Motor Controllers

1. Provide 480V motor starter/drive panel.
   a. Enclosure: NEMA 4X, Type 316 stainless steel.
   b. Power Supply (by Others): One feeder, 480V, 60-Hz, with capacity and overload protection as identified by filter press manufacturer. Provide main disconnecting means.
   c. Control Voltage: 120V ac, derived from the incoming 480V feeder. Provide a fused 120V circuit to the filter press control system.
      1) Hydraulic systems (ratings by filter press manufacturer).
      2) Other motor-driven equipment as necessary to operate the filter press.

Q. Controls and Instrumentation:

1. General: Provide field panels and instrumentation for a complete functional system. These components and the system construction shall comply with the requirements of Section 409990, Package Control Systems.
2. Field Panels and Instrumentation: Provide field panel(s) and instruments. Construct field panels in accordance with Package Control System and as follows
   a. Field Panels:

<table>
<thead>
<tr>
<th>Tag Number</th>
<th>Name</th>
<th>NEMA Rating</th>
<th>Enclosure Materials</th>
<th>Power Supply</th>
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<tbody>
<tr>
<td>941002-LCP-718-A</td>
<td>Filter Press A Control Panel</td>
<td>4X</td>
<td>316 SST</td>
<td>120</td>
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<tr>
<td>941002-LCP-718-B</td>
<td>Filter Press B Control Panel</td>
<td>4X</td>
<td>316 SST</td>
<td>120</td>
</tr>
<tr>
<td>941002-LCP-718AB</td>
<td>Filter Press A Starter Panel</td>
<td>4X</td>
<td>316 SST</td>
<td>480V ac</td>
</tr>
<tr>
<td>941002-LCP-718BB</td>
<td>Filter Press B Starter Panel</td>
<td>4X</td>
<td>316 SST</td>
<td>480V ac</td>
</tr>
</tbody>
</table>

3. Instrumentation: All field instruments shall be rated NEMA 4. Specific manufacturer and model are the vendor’s choice, unless noted below or if noted in Section 409990, Package Control Systems.
4. Operator Interface Devices: Provide Local OIT (Operator Interface Terminal) which will communicate with the associated control panel via Ethernet. The following minimum operator interface functions shall be provided on the local OIT.
a. Alarm ACKNOWLEDGE.
b. Alarm TEST
c. Alarm RESET.
d. EMERGENCY STOP pushbutton. Push to STOP. Pull to reset.
e. Filtration cycle stop.
f. Sludge inlet valve OPEN/CLOSED indicators.
g. FILTRATION CYCLE START.
h. FILTRATION CYCLE COMPLETE indication.
i. Core blow inlet valve OPEN/CLOSE/AUTO selection.
j. Core blow inlet valve OPEN/CLOSED indication.
k. Core blow return valve OPEN/CLOSE/AUTO selection.
l. Core blow outlet valve OPEN/CLOSED indication.
m. CORE BLOW COMPLETE indication.
n. CLOSE COMPLETE indication.
o. PRESS CLOSE selection.
p. AUTO/MANUAL filter press mode selection.
q. ON/OFF fill cycle selection.
r. HAND/OFF/AUTO hydraulic system selection.
s. LOW FLOW alarm.
t. PRESS HIGH PRESSURE alarm.
u. PRESS OPEN selection.
v. OPEN COMPLETE indication.
w. SHIFT COMPLETE indication.
x. HAND/OFF/AUTO plate shifter selection.
y. PLATE SHIFT START.
z. CORE BLOW START.

aa. External inputs provided to the filter press control system include, but are not limited to the following. Display these operator interfaces along with the other interfaces listed above.

1) Sludge feed pressure.
2) Sludge flow rate.
3) Sludge feed pump HAND/OFF/AUTO switch position.
4) Sludge feed pump ON indication.

5. External Interfaces (Interface with plant SCADA via Ethernet):
a. Discrete Outputs: (From Filter Press PLC to Plant SCADA)
   1) Common Alarm: To include automatic trip notification, loss of process sensor, automatic transfer of control loop from automatic mode to manual.
   2) Current Op Mode:
      a) Closing.
      b) Filling.
      c) Filtering.
      d) Core Blow.
      e) Open.
      f) Plate Shift.
3) Ready.
4) Trip channel failure.
b. Discrete Inputs: (From Plant SCADA to Filter Press PLC)
   1) Enable.
   2) Cycle.
   3) Sludge pump ON status (two pumps).
   4) Sludge pump FAIL status (two pumps).
   5) Sludge pump HOA position (two pumps).
   6) Filtrate Wet Well status (OK to feed - no LSHH, at least one pump ready)
   7) Sludge tank available to feed (at least one tank available with sufficient sludge).
c. Analog Inputs: (From Plant SCADA to Filter Press PLC)
   1) Sludge pump speeds.
   2) Sludge Flow into Filter press.
   3) Sludge Storage Tank levels.
   4) Sludge pump discharge pressure.
d. Analog Output:
   1) Sludge flow rate setpoint.
6. Functional Requirements:
   a. Provide protection and safety interlocking functions for the press in both LOCAL and REMOTE modes.
   b. Provide automated control of the press including hydraulic system, feed pumps, control and isolating valves and cake discharge doors.
   c. Provide automatic sequencing through the filtration cycle after operator-initiated staring of the filter press sequence. Provide for a pause of the cycle before proceeding to the Open Step. Resumption of automatic sequence and cycle initiation shall resume after an operator actuation of the RESUME Button.
      1) REMOTE Mode: New cycles to be initiated only when the CYCLE input is present. Cycles to be terminated should the ENABLE signal not be present.
      2) LOCAL Mode: Cycles to be initiated as requested locally. Cycle initiation to be prevented and cycles to be terminated should the ENABLE signal not be present. Cycles may be terminated based on low-low sludge tank level, high-high filtrate tank level, or sludge pump failure.
   d. Disable process equipment on various abnormal conditions. Re-enable the equipment by pressing the Reset pushbutton.
R. Accessories: Provide an initial charge of lubricants and hydraulic fluid for the initial startup and testing.
2.02 FACTORY FINISHING
   A. Prepare, and prime and finish coat in accordance with Section 09 90 00, Painting and Coating, System No. 4.

2.03 SOURCE QUALITY CONTROL
   A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
   B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Installation shall be done by the Contractor with installation assistance provided by the manufacturer’s representatives as specified herein.

3.02 FIELD FINISHING
   A. Equipment that did not receive a factory finish shall be field finished in accordance with Section 09 90 00, Painting and Coating. Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material and shall be primed and top coated with material meeting requirement of Section 09 90 00, Painting and Coating.

3.03 FUNCTIONAL TESTS
   A. The Manufacturer in coordination with the Contractor shall provide functional testing of all equipment to ensure safe and satisfactory operation, as witnessed and approved by the Owner and Engineer. Prior to start-up, all equipment shall be inspected by the manufacturer for proper alignment, quiet operation, proper connection and satisfactory performance.

3.04 INSTALLATION ASSISTANCE, STARTUP, AND TRAINING
   A. General: The Manufacturer shall furnish the services of authorized factory representatives to advise on installation and startup of all equipment, to make any necessary adjustments, and to instruct operating personnel in maintenance and operation. The operations personnel’s normal work schedules will be accommodated in the training, with the factory representative instruction every shift during their normal working hours.
   B. Operator training shall include a minimum of two classroom sessions and two hands-on training sessions. Training shall be accomplished during site visits as described below.
C. The Manufacturer and Owner shall conduct an additional inspection of equipment at the end of 11 months of operation and the Manufacturer shall submit a report to the Owner including the findings and observations from the inspection, and details of proper operation, maintenance, and care of the equipment. At this inspection, the equipment shall be carefully examined by the Manufacturer’s representative. A written evaluation of material and manufacturing workmanship shall be prepared during the inspection. Any equipment listed as defective shall be replaced or repaired under the terms of the warranty.

D. The manufacturer shall submit to the owner a Certificate of Proper Installation as found in Section 01 43 33, Manufactures’ Field Services, that the equipment has been installed properly prior to start up and is operating properly as soon as possible after startup.

3.05 PERFORMANCE TEST

A. Following submittal of Certificate of Completion, completion of the Functional Test, and calibration of all instruments, the Equipment Supplier, in conjunction with the Owner’s operations, shall conduct performance testing of all filter presses.

B. Provide a test report within 7 days of the functional test and no later than 30 days after the performance test.

C. To perform the test, the Owner’s operation staff will operate the system with supervision assistance from the Manufacturer over a 3-day test period to demonstrate that the equipment meets the performance requirements in this Specification. The following data shall be recorded on Test Log Sheets:

1. Feed Flow Rates.
2. Feed Pressure.
4. Press Filtrate Discharge (Visual) total suspended solids.
5. Dewater solids moisture content.

D. Test samples shall be split with the Owner for independent test analysis.

E. Manufacturer shall submit a proposed schedule for the testing no less than 30 days prior to the proposed start of testing. If the Owner does not agree with the start date, an alternate date will be proposed by the Owner. The Owner, Contractor, and Manufacturer the equipment fails to meet the requirements, the Manufacturer shall provide a written plan to meet the performance and will have the option of repeating the tests with appropriate modifications subject to Owner’s approval.
F. Testing results shall confirm compliance with the performance requirements as defined in the Data Sheet attached to this Specification. If the equipment fails to meet the required performance criteria, the manufacturer shall make adjustments to the equipment and/or chemical dosages as needed and the testing shall be repeated. This cycle of adjustment and retesting is allowed for two additional cycles (three tests total), after which time the equipment will be considered to be non-compliant with the Specification if it has not met the performance requirements. At this point, the equipment shall be removed and replaced with another manufacturer’s equipment at the Contractor’s expense, including complete submittals and performance testing on the replacement equipment as specified.

3.06 MANUFACTURER’S SERVICES

A. The Manufacturer shall allow for a minimum of three separate round trips to the jobsite for a minimum of 3 person days each (excluding travel time) for site visits. Fourteen days prior to each site visit, the supplier shall submit through the Contractor a plan of activities to be accomplished during the site visit for the Engineer’s information. After each site visit, a trip report shall be submitted within 14 days of the trip. The report shall include the name of the filter press manufacturer’s representatives who participated, services performed on specific dates, and remaining tasks and trips. The following tasks shall be accomplished during the site visits. Tasks for each site visit shall be grouped and sequenced in a logical manner depending on the status of construction and installation.

1. Inspection and inventory of the equipment shipments and observing equipment unloading at the jobsite.
2. Inspection, installation assistance, installation, meetings, and certification of the installation before testing.
3. Functional testing, performance testing and startup
4. Pre-startup classroom and onsite equipment instruction on operation, maintenance, and troubleshooting.
5. Post-startup maintenance assistance, classroom and onsite system instruction, troubleshooting, and/or other follow-up services requested by Owner.

3.07 SUPPLEMENTS

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

1. Filter Press Equipment Data Sheet.

END OF SECTION
### SECTION 44 43 23.01
FILTER PRESS EQUIPMENT, Datasheet

| Tag Number(s)                  | 941002-SLDP-FP-718-A  
<table>
<thead>
<tr>
<th></th>
<th>941002-SLDP-FP-718-B</th>
</tr>
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<tr>
<td>Quantity</td>
<td>2</td>
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<tr>
<td>Equipment Name</td>
<td>Filter Press</td>
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#### PERFORMANCE CRITERIA

**PROCESS INFORMATION**

- **Feed Slurry Composition**: Ferric Hydroxide and suspended solids from source water
- **Maximum Feed Wet Slurry Flowrate (gpm)**: 60 gpm
- **Feed Slurry pH**: 6.9
- **Feed Slurry Specific Gravity**: 1.03
- **Feed Slurry Temperature**: Min: 36 Max: 87
- **Feed Slurry Total Volume (gallons/day)**: 15,340 (at 3% solids)
- **Feed Slurry Solids Concentration (%)**: 3%-4%
- **Required Dry Cake Solids (%)**: 30%-50%
- **Specific Gravity of Wet Filter Cake**: 1.12
- **Initial Filter Press Volume (ft³)**: 60
- **Future Expansion Volume to (ft³)**: 125
- **Minimum Slurry Feed Pressure (psig)**: 10 psig
- **Maximum Slurry Feed Pressure (psig)**: 100 psig
- **Minimum Filtrate Discharge Pressure (psig)**: 10 psig
- **Available Air Pressure/Flow (psig / scfm)**: Min 100 PSI, max 120 PSI, 8 SCFM

#### DETAILED CRITERIA

**GENERAL**

- **Location**: Indoors
- **Electrical Power Available (Volts/Phase/Hertz)**: 460/3/60, high-resistance grounded
- **Operating Hours/Day**: 8 hours/day
### SECTION 44 43 23.01
FILTER PRESS EQUIPMENT, DATASHEET

#### EQUIPMENT REQUIREMENTS

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<th>Description</th>
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</thead>
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<tr>
<td>Plate Type</td>
<td>Plate Frame</td>
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<tr>
<td>Plate Style</td>
<td>Non Gasketed (NG)</td>
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<tr>
<td>Manifold Piping Material</td>
<td>316 SS</td>
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<td>Gasket Material</td>
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<tr>
<td>Valves</td>
<td>Pneumatic Operated</td>
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<tr>
<td>Plate Shifter Control</td>
<td>Fully Automatic with: Trip Wire Interrupter</td>
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<tr>
<td>Closure</td>
<td>Electro/Hydraulic</td>
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<tr>
<td>Filter Cloth Material</td>
<td>Polypropylene with latex edge</td>
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<tr>
<td>Discharge Chute (Material/Color/Maximum</td>
<td>304SS</td>
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<td>Dimensions)</td>
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#### ACCESSORIES

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<td>Waste Dumpster (Y/N)</td>
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<tr>
<td>Waste Dumpster Capacity (yd)</td>
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<tr>
<td>Light Curtains (Y/N)</td>
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<tr>
<td>Light Curtain Quantity</td>
<td>2, one on each side of press</td>
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<tr>
<td>Zone of Protection</td>
<td>Waste Dumpster Envelope</td>
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<tr>
<td>Safety Splash Screen/Curtains (Y/N)</td>
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<td>Piece for Expansion (ft)</td>
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<td>Drip Trays (Y/N)</td>
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<td>Slurry Feed Pump (Y/N)</td>
<td>By Others (Controlled by filter press PLC)</td>
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<td>Squeeze Water Pump (Y/N)</td>
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<tr>
<td>Slurry Conditioning System (Y/N)</td>
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<tr>
<td>Polymer System (Y/N)</td>
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<tr>
<td>Raised Platform (Y/N)</td>
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#### REMARKS

1) Filter Press Feed Pumps are Rotary Lobe Positive Displacement Pumps, see Section 44 42 56.14, Lobe Pumps, for details.

END OF SECTION
Filter Media

Revision History:

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<td>June 16, 2017</td>
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Document Review & Approval:

Originator: Karen M. Leber, PE/Process Lead Engineer

[Signature]

Design Verification Complete: Mark Davis/ Senior Technical Consultant

[Signature]

Approved: W. Laird Ellis, Jr. PE/Design Manager

[Signature]

Digitally signed by W. Laird Ellis, Jr.

Date: 2017.06.16 10:49:44 -06'00'
PART 1   GENERAL

1.01 REFERENCES

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


1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit not less than 30 days prior to shipment manufacturer’s product information, including grain size ranges for each fine media layer specified. Fine media sizes shall be in millimeters. Data on flowrate versus expansion of the media during fluidization backwashing at 1, 10, and 20 degrees C shall be provided.
2. Samples: Submit two 10-pound samples of fine media material during loading of shipment.

B. Informational Submittals: Submit gradation test results of fine media, including sieve analysis, hardness, acid solubility, and specific gravity prior to loading and shipment.

PART 2   PRODUCTS

2.01 GENERAL

A. Filter media to be placed in the following (Equipment Tag Numbers):

1. FLTR-MM-610-A.
2. FLTR-MM-610-B.
3. FLTR-MM-610-C.
4. FLTR-MM-610-D.
5. FLTR-MM-610-E.
6. FLTR-MM-610-F.
2.02 MANUFACTURERS

A. Fine Media (Mixed):
   1. Unifilt Corp.
   2. F.B. Leopold Co.

2.03 MIXED MULTI MEDIA FILTERS

A. Fine Media:
   1. Mixed multimedia bed meeting the following criteria:
      a. Relative size of particles shall be such that hydraulic grading of
         material during backwash will result in a filter bed graded
         progressively from coarse to fine in the direction of filtration
         (downward).
      b. Anthracite coal of specific gravity greater than or equal to 1.55.
      c. Silica sand of specific gravity greater than or equal to 2.6.
      d. Garnet sand of specific gravity greater than or equal to 4.0, plus or
         minus 0.2.
   2. Anthracite Media:
      a. The anthracite media shall be anthracite coal in accordance with
         ASTM D388.
      b. The anthracite media shall consist of a 48-inch deep layer of
         graded material placed upon the silica sand, measured after all
         necessary washing and scraping has been completed.
      c. The anthracite coal source material shall be clean, virgin, of deep
         open pit mine origin and shall not contain dredged or bank
         material. The source material shall be free of visible extraneous
         material that is not easily separable (i.e. through normal
         backwashing) including wood fibers and plant materials. The
         anthracite shall be free from any significant amounts of iron
         sulfides, clay, shale, dust, wood debris or other foreign matter.
      d. All test procedures shall be in accordance with the applicable
         portion of ANSI/AWWA Standard B100:
            1) The anthracite shall have a Mohs hardness greater than 2.7
               and acid solubility less than 5 percent.
            2) The anthracite shall have an apparent specific gravity
               of 1.55.
            3) The anthracite shall have effective size of 0.90 mm to
               1.10 mm, and uniformity coefficient of 1.4 or less.
   3. Silica Sand Media:
      a. The silica sand media shall consist of a 24-inch deep layer of
         material placed upon the garnet, measured after all necessary
         washing and scraping has been completed.
b. The silica sand shall be visibly free of clay, dust, and micaceous and organic matter.
c. All test procedures shall be in accordance with the applicable portion of ANSI/AWWA Standard B100:
   1) The silica sand shall have an acid solubility less than 5 percent.
   2) The silica sand shall have an apparent specific gravity of 2.6.
   3) The silica sand shall have effective size of 0.5 mm to 0.55 mm, and uniformity coefficient of 1.4 or less.

4. Garnet Media:
   a. The garnet media shall consist of a 6-inch deep layer of material placed upon the filter underdrain, measured after all necessary washing and scraping has been completed.
   b. The garnet shall be visibly free of foreign material.
   c. All test procedures shall be in accordance with the following:
      1) The garnet shall have an apparent specific gravity of 4.
      2) The garnet shall have effective size of 0.5 mm, and uniformity coefficient of 1.4 or less.

2.04 SOURCE QUALITY CONTROL

A. Sampling:
   1. Owner will test Samples in accordance with procedures specified in AWWA B100a.
   2. The media supplier shall perform sieve analysis and determination of specific gravity on the media prior to shipment.

B. Testing:
   1. The pre-shipment media testing shall be performed by an independent test laboratory retained by the filter media supplier.
   2. Sieve analysis shall be performed in accordance with AWWA B100. Test reports shall include raw data, graphical results, computation of effective size, and uniformity coefficient.
   3. The specific gravity shall be determined for each samples. Testing shall be in accordance with AWWA B100 and ASTM C128.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver media in heavy-duty woven polypropylene, semibulk containers (sacks) treated with UV light inhibitors. The containers shall have lifting sleeves for forklift use capable of supporting the entire weight of the full container and shall have a bottom discharge spout.
B. If material cannot be placed immediately into filter cell, the containers shall be stored on pallets. Materials shipped in semibulk containers (sacks) shall be covered with a durable opaque material to block sunlight and provide protection from weather.

C. Any filter media that becomes contaminated by contact with dirt or any other foreign substance shall be removed and replaced with new clean media.

3.02 INSTALLATION

A. General:

1. Media shall be placed in accordance with AWWA B100 standards and all additional requirements included herein.
2. Prior to placement of media, the Contractor shall determine that the underdrain system is properly installed, clean, and free from debris and any foreign substance.
3. Do not permit workers to walk or stand directly on materials that are less than 1/2 inch in diameter.
4. Before fine media is placed, mark top of all layers on side of filter.
5. The filters shall be washed and tested one at a time.
6. Notify Owner 3 days prior to testing of each filter.

B. Fine Media Placement:

1. Transport and place fine media carefully to prevent contamination of any sort.
2. Any filter media which becomes contaminated or dirty (i.e. contains more than 0.5 percent of foreign material by weight) whether before or after it has been placed in the filters, shall be removed and replaced with clean media.
3. Level fine media by hand to within plus or minus 6 inches of the appropriate mark prior to backwashing.
4. The backwash water shall be applied at a rate not to exceed 5.0 gallons per minute per square foot of filter area at the start of the washing, and shall be gradually increased to a maximum rate of 17.5 gallons per minute per square foot. The backwash water flow rate shall not be increased above the starting rate until the media is submerged.
5. Install in following sequence:
   a. Place 6 inches of garnet sand and level.
   b. Backwash bed a minimum of three times and remove surface fines by scraping after each washing.
   c. Replace scrapings with new material after each washing to obtain required depth.
   d. Place 24 inches of silica sand and level.
   e. Backwash bed a minimum of three times, and remove surface fines by scraping after each washing.
f. Replace scrapings with new material after each washing to obtain the required depth.
g. Place 48 inches of anthracite coal and finish off smooth to proper elevation.
h. Backwash bed three times, and remove minimum of 1/2 inch of surface fines by scraping after each washing.
i. Replace scraping with new material after each washing to obtain the required depth.
j. Backwash and remove surface fines until gradation is in accordance with specified bed design.

6. Final depth of fine media after washing and scraping shall be 78 inches.

END OF SECTION
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Backwash Troughs

### Revision History:

<table>
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### Document Review & Approval:

**Orinogtor:**
Karen M. Leber, PE/Process Lead Engineer

**Design Verification Complete:**
Mark Davis/Senior Technical Consultant

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager
SECTION 44 43 32
BACKWASH TROUGHS

PART 1  GENERAL

1.01  WORK OF THIS SECTION

A. This section includes providing the backwash troughs and all appurtenant work for six mixed media filters consisting of 48 inches of anthracite on top of 24 inches of silica sand on top of 6 inches of garnet. Each filter has an area of 260 square feet and dimensions of approximately 20 feet by 13 feet.

B. General Requirement: 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 Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install and test (if applicable) the equipment to provide a complete and operable backwash trough system.

1.02  SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s catalog cuts, sales literature, and technical literature describing the backwash troughs, and identifying all components of the troughs.
   b. Complete scaled and dimensioned construction drawings indicating dimension, material specifications, and proposed layout within the filter boxes.
   c. Detailed installation requirements including required block-outs and anchorage.
   d. Detailed drawings and description of the leveling mechanism.
   e. Structural calculations for load bearing and deflection, as described herein, stamped by a registered professional engineer licensed in the State of Tennessee.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer’s Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturer’s Field Services. Provide a separate Certificate for each filter (six total).
3. Manufacturer’s warranty.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
1.03 PRODUCT DELIVERY AND UNLOADING

A. Product delivery and unloading at the jobsite shall comply with Section 01 61 00, Common Product Requirements.

B. Fabricated parts when delivered to the site shall be stored off the ground and protected from weather and damage.

PART 2 PRODUCTS

2.01 GENERAL

A. Filter media to be placed in the following (Equipment Tag Numbers):

1. FLTR-MM-610-A.
2. FLTR-MM-610-B.
3. FLTR-MM-610-C.
4. FLTR-MM-610-D.
5. FLTR-MM-610-E.
6. FLTR-MM-610-F.

2.02 MANUFACTURERS

A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features, and materials of construction as specified herein.

B. Materials, equipment, components, and accessories specified in this Section for backwash troughs shall be products of:

1. WesTech Engineering, Inc.
2. F.B. Leopold Co., Inc.

2.03 GENERAL REQUIREMENTS

A. Nameplates: Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer’s name, model, serial number, size, characteristics, and appropriate data describing the equipment performance ratings.
2.04 BACKWASH TROUGH PERFORMANCE AND FUNCTIONAL REQUIREMENTS

A. The Contractor shall furnish and install two backwash troughs in each of the filter cells as shown on the Drawings. The backwash troughs within each filter cell shall have a total capacity of 4,680 gallons per minute (2,340 gpm for each trough) with a freeboard of at least 2 inches. Minimum dimensions of the troughs shall be 18 inches wide by 22 inches deep.

B. Spacing between the troughs shall be as shown on the Drawings, not to exceed 6.5 feet centerline to centerline.

C. The backwash troughs shall be compatible with the filter media as described in Section 44 43 30, Filter Media.

D. The backwash troughs shall perform under the following conditions: drain water in filter box to 6 inches above top of media, air wash at 4 scfm/sf, water only backwash of 4,680 gpm, followed by water only backwash of 3,000 gpm, and a rinse of 1,500 gpm while overflowing the trough.

E. Each trough shall have straight vertical sides, and a rounded bottom. The length of each trough shall be adequate to span the filter, and penetrate the gullet wall as shown on the Drawings. Troughs with alternate shapes shall not be acceptable.

F. Top edges (weirs) of each trough shall be level and straight and shall not have more than 1/8 inch deviation from a true plane to provide even flow distribution into the trough.

G. No part of the troughs, weirs or components shall extend above the filtration operation liquid level during normal filter operation (not backwashing). The troughs shall be designed such that the liquid level in the troughs is always at least 2 inches below the weirs during backwash at the maximum backwash rate.

H. The troughs shall have one closed end for attaching to the filter wall, designed to allow elevation adjustments. The other end shall be open to allow flow to exit the filter.

I. The troughs and support connections shall be designed to withstand all loading conditions that will be experienced during filtration and backwashing operations including gravity load, buoyant load, lateral load, and backwashing load. Design calculations shall be submitted with the shop drawings.

J. Maximum vertical deflection under full buoyant load or full gravity load shall not exceed L/1,000, where "L" is the unsupported trough length in inches, including the weight of water filling the trough. Deflection shall be measured
at midpoint between trough supports. Maximum trough sidewall horizontal deflection shall not exceed D/100, where “D” is the inside trough depth. The trough system shall be designed and constructed to prevent oscillations caused by the flow of water over the trough edges or by operation of the air and water backwash system.

2.05 BACKWASH TROUGHS

A. Troughs: The troughs shall be constructed of molded densely laminated fiberglass-reinforced plastic (FRP) or minimum 10-gauge, Type 316L stainless steel. All exposed metallic surfaces, bolts, anchors, anchor bolts, etc., shall be Type 316 stainless steel and provided by the manufacturer.

B. End Supports: The closed end of the trough shall be supported by end supports consisting of a stainless steel angle with wall concrete anchors and support rods. All materials shall be Type 316 stainless steel.

C. Other Supports: Intermediate trough supports shall be designed and provided by manufacturer where required to provide stability and meet deflection criteria. All exposed metallic surfaces, brackets, beams, stabilizers, bolts, anchors, anchor bolts, etc., shall be Type 316 stainless steel.

D. Water Stop: An integral water stop seal shall be provided on the trough whenever the trough is grouted into and/or passes through a wall.

E. All miscellaneous hardware shall be Type 316 stainless steel.

F. All welded components shall be low carbon grade, Type 316L stainless steel.

2.06 SOURCE QUALITY CONTROL

A. Factory or Shop Inspections and Tests: Perform manufacturer’s recommended standard inspections and testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s printed instructions.

B. No field welding shall be required or allowed for installation of the troughs.
3.02 MANUFACTURERS' SERVICES

A. Manufacturer's Services and Certificate of Proper Installation: Provide manufacturer's services and Manufacturer's Certificate of Proper Installation for each filter (six total). Manufacturer’s representation shall provide supervision of equipment installations, field inspection of equipment before startup and the executed copies of Certificate of Proper Installation. Certificate of Proper Installation will be signed prior to operation of the filter.

B. Provide a minimum of 4 person days and two trips for Contractor assistance for installation assistance, startup assistance, functional and/or performance testing, and completion of Manufacturer’s Certificate of Proper Installation.

END OF SECTION
W. Laird Ellis, Jr.

Digitally signed by W. Laird Ellis, Jr.
Date: 2017.06.16 10:53:25 -06'00'

UCOR-FM-001, REV. 0 - SPECIFICATION COVER SHEET

Specification Document Control No.: 44 43 34
Revision No.: 0

Project: Outfall 200 Mercury Treatment Facility

Engineering Discipline: Process

Specification Division: 44 - Pollution Control Equipment
Date: 6/16/2017

Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)

Filler Underdrain System

Revision History:

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Document Review & Approval:

Originator:
Karen M. Leber, PE/Process Lead Engineer

Signature

Date: 6/15/17

Design Verification Complete:
Mark Davis/Senior Technical Consultant

Signature

Date: 6/15/17

Approved:
W. Laird Ellis, Jr. PE/Design Manager

Signature

Digitally signed by W. Laird Ellis, Jr.
Date: 2017.06.16 10:53:25 -06'00'

Signature

Date
PART 1 GENERAL

1.01 GENERAL

A. This section includes providing the filter underdrain system and all appurtenant work for the six gravity filter boxes each composed of one filter bay 20 feet long and 13 feet wide.

B. The Drawings show only the general arrangement for the filter underdrains system and do not show complete details to properly interface the filter underdrain system with the filter structures. Such details shall be designed by the responsible filter underdrain system manufacture.

C. The Contractor shall provide all labor, materials, equipment and incidentals as shown, and specified that are required to furnish, install and test the equipment and to provide a complete and operable filter underdrain system.

1.02 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):

2. ASTM International (ASTM):
   c. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
1.03 SYSTEM DESCRIPTION

A. Design and Performance Requirements:

1. Design filter underdrain system, including, but not limited to, the underdrain laterals and riser pipes, and integral support cap air scour header.

2. Compatible with filter media being supplied; refer to Section 44 43 30, Filter Media.

3. The filter underdrain system shall be designed and installed to ensure long term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects which would in time cause loss of efficiency or effectiveness in its operation.

4. Flow:
   a. The underdrain system is intended to allow for the uniform collection of filtered water and uniform distribution of backwash water and air over the total area of the filter floor.
   b. The backwash system shall allow for separate air scouring and water backwashing and for the simultaneous use of air and water at the specified rates.
   c. Flow uniformity per square foot of filter underdrain area shall be as required to permit efficient and effective operation during filtration and backwashing.
   d. There shall be no localized areas with excessive flow (maldistribution) which cause mounding, lateral displacement, or other deleterious disturbances in filter media.
   e. Size air scour header and risers to produce uniform air flows throughout filter bay.
   f. When subjected to a flow rate of 20 gpm/sf (48.9 m/h) of filter area the headloss through an underdrain lateral 32 feet (9.75 m) long shall not exceed 45 inches (1140 mm) water column.
   g. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches (510 mm) water column at a backwash flow rate of 20 gpm/sf (48.9 m/h) of filter area.

5. System shall ensure operating characteristics have long-term stability and resistance to the following:
   a. Corrosion.
   b. Changes in head loss.
   c. Changes in flow uniformity.
   d. Other effects which would over time cause loss of efficiency or effectiveness of operation.
6. System Design Loads:
   a. The filter underdrain system, including anchorage and supports shall be designed to safely withstand loadings for the specified conditions.
   b. The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 1400 psf (67 kPa) or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of gravel or filter media.
   c. The filter underdrain system shall also be designed to withstand a net downward loading of not less than 2,800 psf (134 kPa).
   d. Withstand specified loadings, including anchorages and supports.
   e. Address loads incurred during shipment, delivery, storage, handling, installation, and operation.

7. Support and Restraint:
   a. The underdrain system shall have an integral grout pocket designed to provide uplift resistance as a result of internal pressurization of 30 psi (2.068 Bar) without any external mechanical anchors. Underdrain blocks that do not have a grout pocket shall have external anchor rods embedded into the filter floor and shall extend above the underdrain and hold the underdrain down from the top. The external anchor system shall be designed for a minimum allowable load of 30 psi hold down across the filter. All anchors shall be tested prior to the placement of the underdrain block to 130 percent of the allowable load. All anchors shall be Type 316 stainless steel.
   b. Underdrain laterals shall not require support or restraint to resist specified burst pressure.
   c. Safety Factor: 2.0, minimum, to account for transient pressures which may occur during initiation and termination of air and water flows during backwash.
   d. Filter air scour header assemblies shall be designed to be supported inside flume.

8. The filter underdrain system, as installed, shall satisfy the following criteria for minimum acceptable flow uniformity. Maldistribution of air and water flows during backwash, for all indicated flow conditions, shall not exceed:
   a. Water: The maldistribution in a lateral 32 feet long or less, including the flume, shall not exceed plus or minus 5 percent of the average gpm/sf of filter for a backwash rate of 20 gpm/sf.
   b. Air: Plus or minus 10 percent of average scfm per square foot of filter underdrain area. Visually, the air should show a uniform pattern.

9. Evenly distribute air, water, and combined air/water flows and perform satisfactorily when operated under the following conditions:
a. Filtration (Downflow) Mode: Water (filtrate) at rates up to 10 gpm per square foot of filter underdrain area.
b. Backwash (Upflow) Mode:
   1) Air Rate:
      a) 2 to 5 scfm per square foot of filter underdrain area
         for air wash only.
      b) 4 scfm per square foot concurrent with water at rates
         of 5 gpm per square foot while overflowing backwash
         troughs.
   2) Water Rates: Up to 25 gpm per square foot of filter
      underdrain area.

10. Water flow head losses across underdrain system shall include losses
    associated with underdrain and equalizing or secondary flume inside
    filter bay.
    a. Head losses shall include all losses from just upstream of the
       lower gullet wall opening to just upstream of (above) the integral
       support cap or cover screen on top of underdrain.
    b. Head losses exclude static head of water above integral support
       cap or cover screen as well as losses through media.

11. Air flow head loss across filter air scour header and riser pipes, and
    underdrain laterals shall not exceed the following:
    a. 12 inches WC of head loss when supplied with concurrent air and
       water flows of up to 3.0 scfm per square foot of air flow in
       backwash mode.

12. Air flow head losses across filter air scour header, riser pipes, and
    underdrains shall include losses associated with air scour header
    assemblies and underdrain.
    a. Head losses shall include losses from upstream flange on air scour
       header within filter basin to just downstream of (above)
       distribution orifices in top of underdrain.
    b. Head losses exclude static head of water above underdrain.

13. Media-retaining, integral support cap system shall:
    a. Be compatible with filter underdrain system and with filter media.
       Refer to Section 44 43 30, Filter Media.
    b. Retain filter media.
    c. Be appropriate for combined air/water backwash.

1.04 SUBMITTALS

A. Action Submittals:
   1. Manufacturer’s catalog cuts and technical literature describing proposed
      filter underdrain system.
   2. Shop Drawings: Scaled and dimensioned drawings showing layout,
      configuration, and installation details for the filter underdrain system.
3. Written interface requirements, installation details, and recommendations as are necessary to properly interface filter underdrain system with surrounding structures and provide a complete, functional and operating air scouring filter underdrain system. Provide guidance in order for filter structure to be modified to accommodate underdrain system if needed. These interface requirements shall be approved by the Engineer.

4. Details of design and operating characteristics of proposed filter underdrain system. Address full range of flow conditions. Indicate pertinent physical relationships (location, relative size) among various air and water orifices, including those in lower gullet walls.

5. Include the following:
   b. Head loss data for air, water, and combined air/water flows.
   c. Maximum percentage of flow maldistribution within filter for air, water, and combined air/water flows.
   d. Cross-sectional areas for flow of air and water and resulting velocities at pertinent points (e.g., gullet, lateral, orifices) throughout underdrain system (i.e., from inside lower gullet to just above media support cap).
   e. Relative magnitudes of entrance, transport, metering, and discharge losses.
   f. Other data necessary to demonstrate conformance with requirements of Contract Documents.

B. Informational Submittals:

1. Delivery, storage, handling, installation, field testing, operating and maintenance instructions, including installation details, leveling requirements and a statement of any project-specific requirements and instructions for the filter underdrain system.

2. Written confirmation that filter media (which is to be supplied by others) is compatible with underdrain system.

3. Test reports showing conformity with hydraulic and pneumatic flow. Address full range of flow conditions.

4. Certification that filter underdrain system will satisfy specified hydraulic and pneumatic conditions and provide even distribution of air water, and combined air/water flow at specified flow rates as fed in arrangement shown on Drawings.

5. Design calculations showing structural design requirements, including anchor bolt sizing. Structural calculations shall be stamped and signed by structural engineer registered in state of the Project.

6. Proposed method of testing installed system.

7. Field Test Reports: Describe units tested, type of test, test set ups, procedures, instrumentation, flow rates, pressures, levels, and other data
and results as required to demonstrate items tested meet specified requirements.

8. Certificate of factory tests and test results prior to delivery of underdrain system components.

9. Written interface requirements, installation details, and recommendations as necessary to properly interface filter underdrain system with surrounding structures.

10. Manufacturer’s installation instructions and details.

11. Manufacturer’s written confirmation filters have been satisfactorily prepared for installation of filter underdrain system.

12. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

13. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer shall have, as a minimum, 15 successful installations in the United States of a complete underdrain system.

2. Manufacturer’s representative for field services shall be a direct employee of filter underdrain system manufacturer and shall have minimum of 5 years’ experience installing type of underdrain system specified herein.

3. The underdrain system shall be a standard product of a filter manufacturer who has been actively providing dual-parallel lateral air/water underdrain equipment for at least 10 years.

4. The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining bridges, closures, and gaskets shall be the products of a single manufacturer/supplier.

5. Uplift Certification: The underdrain manufacturer shall provide third party certification that the underdrain can withstand a minimum of 30 psi internal pressure without lifting or separating from the filter floor when properly installed with grout and no mechanical anchoring.

6. Hydraulic Demonstration:
   a. The underdrain manufacturer shall, at their own facilities, if requested by the Engineer, set up a test lateral run of equal length to that required by the project and provide an opportunity for the Engineer and/or Owner to visit the facility to witness a full scale demonstration of the headloss and flow distribution during backwash.
   b. The test facility shall be capable of demonstrating concurrent air and water distribution in a submerged trough and water only distribution on a non-submerged test bench.
c. These demonstration services shall be provided by the filter manufacturer with reasonable notice and at no additional expense to the Owner or Engineer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Product delivery and unloading at the jobsite shall comply with Section 01 61 00, Common Product Requirements.

B. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage and adequately marked for ease of erection.

C. Equipment shall be protected from exposure to corrosive fumes and kept dry.

D. Store products in a manner that prevents damage and in an area that is protected from the weather.

1.07 SPECIAL GUARANTEE

A. Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of underdrain material found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Filter media to be placed in the following (Equipment Tag Numbers):

1. FLTR-MM-610-A.
2. FLTR-MM-610-B.
3. FLTR-MM-610-C.
4. FLTR-MM-610-D.
5. FLTR-MM-610-E.
6. FLTR-MM-610-F.

2.02 DUAL LATERAL BLOCK FILTER UNDERDRAIN SYSTEM

A. Manufacturers:

1. Where a manufacturer’s standard equipment name or model number is listed, equipment system shall be provided as modified to conform to
performance, functions, features, and materials of construction as specified herein.

2. Materials and products specified herein shall be selected and supplied by filter underdrain system manufacturer, unless specified otherwise.

3. Materials, equipment, and accessories specified in this section shall be products of:
   a. F.B. Leopold Co., Inc., Zelienople, PA; Universal® Type XA® Underdrain with IMS® 200 cap.
   b. Infilco Degremont, Inc., Richmond, VA; Tetra™ LP Block Underdrain with SAVAGE PLATE®.
   c. WesTech Technologies (General Filter), Ames, IA; MULTIBLOCK® Underdrain with Laser Shield™ direct media retention.

B. Underdrain Blocks:

1. Dual lateral type whereby parallel feeder and compensating chambers are contained within cross section of a single block.
   a. Cross section shall be arranged so feeder (or primary) chamber is adjacent and connected to compensating (or secondary) chambers through a series of orifices.
   b. The orifices shall be located at four different elevations and sized to provide uniform distribution of air and water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures to install internal orifices and underdrains with circular water orifices in the primary chamber are unacceptable.
   c. The primary chamber should provide at least 43 square inches (277 square cm) of cross sectional area per block to reduce flow velocity during backwash.
   d. Discharge of flow from top of block shall be controlled by orifices that provide uniform distribution of water during filtration and backwash.
   e. Feeder lateral shall have cross-sectional area of at least 50 square inches per block to achieve acceptable air and water transport velocities and head losses during backwash.

2. Distribution Orifices:
   a. The compensating chambers shall provide the essential uniform pressure and flow distribution from the tip of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provide by approximately 23 dispersion orifices per square foot of filter area.
   b. Sized and located to provide uniform distribution of water and air.
      1) Not less than 11/64-inch (4.5 mm) diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch (3.2 mm).
3. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of air and water coverage which direct flow vertically for effective penetration and cleaning of the media.

4. Dual water recovery channels with return holes shall be incorporated into the top of the underdrain block to ensure uniform and continuous air flow from the top deck orifices and greater air stability. Underdrains without a water recovery channel will be considered unacceptable.

5. Primary Chamber: Vented or baffled to prevent air from remaining in primary chamber during water-only portion of backwash cycle.

6. The secondary chambers of the underdrain shall have baffles sized and located to provide effective air control and to reduce level sensitivity. Underdrains without baffles will not be considered.

7. The secondary chambers of the underdrain shall have baffles sized and located vertically along the exterior of the primary chamber to provide effective air and water control.

8. The underdrain shall have a lug located on the exterior of the underdrain to allow simple connection and disconnection of an optional handle. The optional handle shall be removed once the filter laterals are set in place within the filter tank.

9. Individual Blocks:
   a. Impervious, high strength, completely corrosion-resistant, completely inert, high density polyethylene (HDPE) material.
   b. Resistant to erosion and corrosion.
   c. Uniform, smooth surfaces.
   d. Orifices shall be integrally molded to provide a smooth bore orifice.
   e. Ridges and pockets for structural rigidity and to key into surrounding grout.
   f. Dimensions: The block size and weight shall permit ease of handing and installation. The block nominal dimensions shall be 8.25 inches high by 11 inches wide, maximum, by maximum of 48 inches long. The weight of the block shall be approximately 24.5 pounds. Underdrains with heights greater than 8.25 inches shall not be allowed.
   g. Size and weight permit ease of handling and installation.
   h. The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout. The bottom of the block shall have integral grout pockets located at each end.
   i. The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell.
10. Joints:
   a. Gasketed, bell-and-spigot type with internal registers.
   b. Snap-lock type with integral interlocking snap lugs and receptors.
   c. Air and watertight.
   d. Gaskets:
      1) Supplied by underdrain system manufacturer.
      2) Made of neoprene or cross-linked closed cell polyethylene.
   e. Joining technique shall be such that no leakage (air or water) occurs with a maximum 2-degree misalignment at each joint.

11. Flume Blocks:
   a. Provide for entrance or upstream (backwash mode) end of each underdrain lateral.
   b. Accept backwash water from lower gullet wall opening during backwash and provide an equalizing or secondary flume inside filter.
   c. Sized as required to ensure equal flow distribution among laterals.
   d. Discharge filtered water to effluent flume during filtration.
   e. Accept air from air header located in flume from air risers.
   f. Anchors: Provide angles, preshaped anchor rods (e.g., “L-roses”), epoxy adhesive system, concrete anchors, and sealant to anchor flume blocks to filter floor.
   g. Support from gullet wall and seal to gullet wall.

12. End Plates: HDPE sealed to downstream end of laterals at filter wall.

13. Integral Support Cap:
   a. Constructed of HDPE plastic beads sintered together or Type 316 stainless steel or thermoplastic with injection molding process.
   b. Pore Size and Volume: Sufficient to prevent media from obstructing or passing through underdrain.
   c. Attached to underdrain at factory with Type 316 stainless steel screws and sealed with manufacturer’s recommended caulking.
   d. Eliminate need for, and function in lieu of, support gravel.

14. Equipment Flanges: Comply with ASME B16.1, Class 125 or ASME B16.5, Class 150, unless otherwise indicated.

15. Sleeves and Gaskets: Neoprene, 45 to 55 durometer rated for 200 degrees F.

2.03 SERVICE CONDITIONS

A. Filter underdrain system shall operate in multimedia gravity filters.

B. Backwashing regime for filters uses air scouring and includes air only, air/water combined, and water-only steps.

C. Filter Influent:
   1. Will be clarified water.
   2. Will not be chlorinated.
D. Filter backwash water will be filter effluent supplied from clearwell.

E. Temperature:
   1. Filter influent and backwash water are expected to be approximately 36 to 87 degrees F.
   2. During backwash with air, the underdrain shall be suitable to withstand a maximum air temperature of 200 degrees F.

F. pH ranges of filter influent and backwash water are expected to be approximately 6 to 9 pH units.

2.04 FILTER AIR SCOUR HEADER AND RISER ASSEMBLIES AND ACCESSORIES

A. Design each filter with air scour piping to provide uniform distribution of air during backwash.
   1. The air distribution system shall be generally comprised of a corrosion resistant header specially calibrated to evenly distribute air flow via properly located riser pipes to each underdrain lateral. Sufficient relative velocities shall be maintained in both the header and riser pipes to insure proper distribution of air.
   2. Materials of Construction: Headers and risers shall be Schedule 5 or 10, Type 316 stainless steel pipe. All welded components shall be low carbon grade, Type 316L stainless steel.

B. Provide pipe supports/restraints, concrete anchors, and miscellaneous hardware (for example, fasteners) for header and riser pipes. Metallic components shall be Type 316 stainless steel.

C. Equipment Flanges: Comply with ASME B16.1, Class 125 or ASME B16.5, Class 150, unless otherwise indicated.

2.05 ANCHOR BOLTS

A. Anchor Bolts:
   1. Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

B. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

C. Concrete Anchors: Adhesive type.
D. Anchoring Adhesives:

1. Vinyl Ester:
   a. Two components, insensitive to moisture, designed to be installed in adverse freeze/thaw environment.
   b. Cure temperature, pot life, and workability compatible for intended use and anticipated environmental conditions.
   c. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System (HIT C-100).

2. Mixed Epoxy Adhesive:
   a. Nonsag light paste consistency with ability to remain in 1-inch diameter overhead drilled hole without runout with the following properties:
      1) Slant Shear Strength: ASTM C881 and ASTM C882; No Failure in Bond Line, Dry/Moist Conditions 5,000 psi.
      2) Compressive Strength: ASTM D695; 14,000 psi, minimum.
      3) Tensile Strength: ASTM D695; 4,500 psi.
   b. Manufacturers and Products:
      1) Adhesives Technology Corp., Kent, WA; Anchor-It Fastening System, HS 200 Epoxy Resin.
      2) ITW Ramset/Red Head, Paris, KY; Epcon Ceramic 6 Epoxy Anchor System.

E. Wedge or expansion anchors shall not be acceptable.

2.06 GROUT

A. Grout Retainer: A grout retainer bridge shall be utilized over the filter flume. Grout retainer bridge shall be of high-impact polystyrene properly keyed to fit the underdrain blocks to allow adjustment of lateral center-to-center distance without difficulty. The grout retainer bridge shall span the width of the flume and shall be laid side by side to cover the entire length of the flume and create a homogenous seal. The ends of the grout retainer bridge shall have overlapping edges formed into the piece to create a contiguous seal perpendicular to the width of the flume. The elevation of the grout retainer bridge can be adjusted vertically using flume sealing plates against the bottom side of the grout retainer bridges. Grout retainer bridge shall be supplied by the filter manufacturer.

B. Grout:

1. Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become “lumpy” shall not be used.
2. Water: Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Water with either a total dissolved solids of 1000 mg/l or higher, or greater than 10 NTU shall not be used.

3. Sand: Sand shall be clean and washed masonry sand per ASTM C144. When tested in accordance with ASTM C144, 100 percent of sand particles shall pass No. 4 Sieve (4.75 mm) and not more than 4 percent of sand particles shall pass No. 200 Sieve (0.075 mm).

4. Chemical Admixtures: No chemical admixture is needed in most of the applications. The grout can be mixed in a small batch and used immediately.

5. Strength: The grout used in installing the blocks shall have a minimum compressive strength of 3,000 psi (207 bars) after 30 days of curing. Normally, a grout with one part Portland cement and two parts clean silica sand properly mixed and wetted with a maximum water-cement ratio by weight equal to 0.50 to 0.55 for the base grout and 0.61 to 0.67 for the fill grout will achieve this strength.

2.07 CONCRETE

A. As specified in Section 03 30 00, Cast-in-Place Concrete.

2.08 REINFORCING STEEL

A. As specified in Section 03 21 00, Reinforcing Steel.

2.09 SPECIAL TOOLS

A. Provide special tools and lubricants needed to install underdrain system.

2.10 FABRICATION

A. Metals below top of filter box wall shall be Type 316 or Type 316L stainless steel as appropriate. Hot dipped galvanized steel shall not be acceptable.

B. Metallic components shall be premanufactured (for example, concrete anchors) or shop fabricated (for example, air scour header assemblies) components. Field fabrication, bending, cutting, or welding shall not be acceptable.

C. After fabrication, pickle and passivate stainless steel assemblies and parts according to ASTM A380.
2.11 SOURCE QUALITY CONTROL

A. Factory Testing:
   1. Notify Engineer at least 2 weeks prior to testing so Engineer or Owner can, at their option, witness testing.
   2. Provide written report summarizing factory test results signed and sealed by a professional engineer.

B. Prior to shipment from factory, test one out of every 400 blocks, with integral support caps, for head loss and uniform distribution of air and water. Results of tests shall be within 10 percent of manufacturer’s published values.

C. Prior to shipment from factory test one full length air lateral for head loss and uniform distribution of air. Acceptable results of the head loss and dispersion tests are as specified.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to commencement of installation of underdrain system, manufacturer’s representative shall inspect filter preparation work and provide written confirmation that filters are satisfactorily prepared for the installation of air scour and underdrain system.

3.02 INSTALLATION

A. General:
   1. Install in accordance with 1) manufacturer’s instructions, recommendations, and interface requirements with surrounding structures, including requirements for grouting keys and pockets, dowels, support ledges and piers, anchorage; 2) the oral and written directions provided by the manufacturer's technical representative who is supervising and observing the Work; and 3) any additional requirements specified herein.
   2. Install adhesive anchors in accordance with adhesive manufacturer’s recommendation.

B. Cleaning:
   1. Remove debris and sand from filter gullets and power wash inside of gullet.
   2. Take precautions recommended by underdrain manufacturer or specified herein to ensure filter underdrain system and associated piping and conduits are completely clean and free of debris, dirt, or other
foreign materials which could clog underdrain system or interfere with flow.
3. Flush backwash air piping and recessed flume.
4. Remove loose debris and dirt within filter cell and flume by brooming down and vacuuming.
5. Engineer and filter underdrain manufacturer’s representative shall approve cleaning before Contractor may begin placement of filter media.

C. Protection:
1. As installation progresses, protect partially completed portions of the Work to maintain cleanliness of underdrain system.
2. Maintain protection until media is installed.

D. Floor Preparation: Care shall be exercised in preparing the filter floor slab and in setting the anchors to assure proper alignment and elevation. Steel anchor rods shall be furnished by the filter manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the Drawing provided. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions, but have a rough, broom finish. Do not trowel or finish the floor to a smooth finish. Do not apply concrete sealers or paint.

E. Dual Lateral Block Filter Underdrain System:
1. Do not use blocks with warped surfaces or uneven orifices, or blocks that are cracked or otherwise damaged.
2. The underdrain laterals shall be set in relatively level rows on a bed of grout over the filter floor slab.
3. Spaces between blocks of adjoining underdrain laterals and spaces between underdrain lateral and filter box walls shall not exceed 3 inches.
4. Exercise care in preparing filter floor slab and in setting anchors to ensure proper alignment and elevation. Screen slab to flat level plain and be free from protrusions and depressions.
5. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer and installed by the Contractor.
6. Locate gaskets at expansion joints and couplings to form airtight connection at 20 psig minimum.
7. Install anchor rods. Dowel to existing concrete per manufacturer’s recommendations.
8. Flume blocks shall not be modified in field except under direct supervision of manufacturer’s representative.
9. Grout:
   a. After blocks have been set and carefully aligned, grout spaces between rows and ends of blocks and walls.
b. Prevent grout from entering laterals, orifices, integral support cap pores or from being deposited in a manner that would interfere with distribution and dispersion of flow.

c. Cure for minimum of 3 days before placing filter media or performing backwash tests.

F. Grout:

1. Place and cure grout as directed by grout and underdrain manufacturers.
2. Keep grout out of orifices and flow passages and prevent grout from being deposited where it could interfere with flow.

G. Cleaning and Protection During Installation, Testing, and Startup:

1. The Contractor shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter underdrain system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash air and water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter cell and flume shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed. As installation progresses, partially completed portions of the WORK shall be protected with heavy visqueen or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the support gravel is installed.
2. Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with 1/2 inch (13 mm) minimum plywood sheeting where necessary, to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

3.03 TESTS AND INSPECTIONS

A. Perform backwash and filtration tests on completed system following installation of underdrain system, curing of concrete and grout, and prior to placing filter media.

1. Test grout in accordance with Section 03 62 00, Nonshrink Grouting.

B. Perform tests in both filtration (downflow) and backwash (upflow) modes at specified rates to confirm hydraulic performance is in compliance with this Section.
C. Check for and correct leaks and nonuniform flow of backwash water and air, structural instability, or other defects.

D. During backwash test, visually observe for signs of dead spots or boils. Evidence of flow maldistribution such as a water “mound” or “boil” in filter will constitute a failed test.

E. If defects require correction, retest as necessary until results are acceptable to Engineer.

F. Test Report: State results of tests, procedures used, details of adjustments made to unit, and precautions to be taken to ensure proper and safe operation and maintenance of unit.

G. Filter underdrain system manufacturer’s representative shall not furnish a Certificate of Proper Installation until representative is satisfied filter underdrain system has been properly installed and functionally tested and that detrimental effects of subsequent filter media placement have been remedied.

3.04 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative:

1. The underdrain manufacturer shall retain on its permanent staff, field service representatives with at least 5 years of experience in the placement of underdrain. (Such persons shall be available on a fee-paid basis to instruct the Contractor in the proper placement and testing of the underdrain).

2. Present at Site or classroom designated by Owner for minimum person-days listed below, travel time excluded:
   a. 1 person-day for inspection of each filter prior to installation of underdrain system.
   b. 1 person-day to observe placement of filter media in each filter.
   c. 4 person-days for installation assistance and inspection.
   d. 2 person-days for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.

3. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer’s prevailing per diem rate plus living and travel expenses.

B. See Section 01 43 33, Manufacturers’ Field Services.

END OF SECTION
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 stroke setting (in percent) at specified maximum speed in strokes per minute and at minimum pump speed.
   d. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, required backpressure valve setting, pumped chemical characteristics, pipe connection sizes, stroke rate, materials, testing requirements, intermediate fluid type, 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 and Performance Test Reports.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer’s printed installation instructions.
6. Suggested spare parts list to maintain the 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 01 43 33, Manufacturers’ Field Services.

1.04 EXTRA MATERIALS

A. Any special tools and manufacturer suggested spare parts for operation and maintenance of the equipment shall be provided by the manufacturer.

B. In addition to the pumps called out on the pump data sheets, a minimum of one shelf spare pump shall be provided for each chemical system. The shelf spare pumps shall be labeled, calibrated and tested, and ready for installation and use without further work.

C. Metering pumps spare parts shall include, at a minimum, for each pump:

1. One diaphragm assembly for each size of pump.
2. Two sets of valve gaskets, one set of seals, and O-rings for each size pump.

PART 2 PRODUCTS

2.01 GENERAL

A. The manufacturer shall provide skid mounted chemical metering pump systems complete with chemical metering pumps, all necessary piping, valves, fittings, supports, electrical controls, and accessories as specified herein. The
metering pump skid shall contain the following items and as generally shown on the attached P&ID Drawings:

1. Skid with drip lip.
2. Metering pumps.
3. Calibration column.
4. Discharge pulsation dampener.
5. Ball valves.
6. Pressure relief valve.
7. Pressure gauge and diaphragm seal.
8. Backpressure valve located on the discharge of each pump, if required per pump manufacturer's recommendation, in addition to backpressure valve located at injection point.
10. All piping, valves, gaskets, supports, hardware, wiring, and accessories necessary for a fully functioning skid.
12. Pressure switch and diaphragm seal.

B. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

C. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SKID

A. Skid shall be specially designed, constructed and installed for the service intended and shall comply with the conditions listed in the Pump Data Sheets at the end of this Section.

B. The skid shall conform to the following requirements:

1. Each chemical feed system shall be completely assembled, mounted, calibrated, tested, and delivered to the site on a single skid. Components to be mounted on the skid are as indicated on the drawings and shall include the metering pumps, calibration column, piping, valves, piping accessories (pulsation dampener, etc.), and wiring integral to the skid. The chemical feed system supplier shall be responsible for providing all equipment, valves and piping within the skid boundary. Space for any future equipment, valves, and piping as shown on Drawings shall be provided on the skid. Piping caps shall be provided at future connections. See Drawings for location of pump suction piping connection. See Pump Data Sheets for specific construction materials.

2. The skids shall be constructed of fusion welded polymer sheets with adequate supports for all equipment and piping. Fork lift truck cut outs shall be provided.
3. All components of the skid-mounted system (pumps, piping and controls) shall be tested prior to shipment.
4. Skid shall be designed to contain a spill of 1 gallon minimum and shall have a splash/spray guard.
5. Provide 1-inch drain plug.

2.03 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.04 PUMP

A. Pumps shall be simplex, motor-driven, reciprocating, mechanically-actuated diaphragm type. Pump shall include an integral motor, oil-lubricated gear reducer and a cam-spring drive mounted in aluminum housing. Alternatively, the pumps shall be solenoid-driven. Maximum stroke rate shall be as specified in attached Pump Data Sheet.

B. Diaphragm shall be compression-molded Teflon or compression-molded Teflon composite with internal O-ring seal. Alternatively, diaphragm shall be nylon fabric-reinforced EPDM vulcanized onto a steel core, with Teflon facing on liquid contact side of diaphragm with dual sealing ribs. Diaphragm shall be convex in shape, coordinated with concave head to minimize dead space.

C. Bearings, tapered roller or needle type. Gearing, polished steel or bronze worm type. Mount bearings and internal working parts in weather-resistant gear box with moving parts oil flooded.

D. Pump leakage shall be prevented through hydraulically actuated balanced diaphragm design. Alternatively, for mechanically actuated diaphragm, liquid end shall be physically separated from drive unit by back plate with weep hole creating an air gap. Elastomer shaft wiper seal shall be provided to prevent migration of leakage to drive unit along shaft.

E. Pump shall include adjustable, spring-loaded internal pressure relief valve to protect pump against excessive hydraulic pressure.

F. Process connections shall be MNPT.

G. Motor Mount:

1. Arranged for vertical mounting of a C-face motor.
2. The mounting arrangement shall eliminate exposure to rotating couplings. The coupling enclosure shall be totally enclosed and part of the motor mounting assembly.
H. Performance Requirements:

1. Pumps shall be selected such that the maximum operating capacity point is achieved at a point between 30 and 95 percent of the available stroke adjustment.
2. The pump shall be capable of running dry without damage. An external, adjustable pressure relief valve shall be installed to protect the pump and piping system in the event of a closed or blocked discharge condition.
3. The pump shall be capable of operating with a net positive suction pressure available as low as 3 psia.
4. Speed adjustment shall be from 0 to 100 percent with a repeatability of plus or minus 2 percent steady state on setpoint over a 10:1 flow turndown range.
5. Manual stroke length positions of the metering pumps shall provide 10:1 turndown, resulting in an overall turndown of 100:1.

2.05 BACKPRESSURE CONTROL VALVE

A. If required per pump manufacturer's recommendation, in addition to backpressure valve located at injection point, then an adjustable diaphragm backpressure, sustaining type installed on pump discharge and set as recommended by pump manufacturer shall be installed.

B. All materials in contact with the process fluid shall be chemically compatible with the specified fluid.

C. A union shall be installed on both sides for ease of removal.

2.06 PULSATION DAMPENERS

A. Size: Selected by the metering pump manufacturer to match the capacity of the pump.

B. Style: The pulsation dampener shall consist of two separate chambers separated by an elastomeric diaphragm. The lower section shall be wetted by the process fluid, while the upper section shall be isolated from the fluid and filled with compressed air.

C. Process Connection: FNPT, 1/2-inch minimum.

D. Materials of Construction: As recommended by the pump manufacturer for compatibility with chemical.

E. Accessories: Pressure gauge for local indication of pressure within the air chamber, air charging valve for loading the compressed air chamber; one air charging assembly for use with all installed pulsation dampeners.
2.07 CALIBRATION COLUMN

A. Size: Selected by the metering pump manufacturer to provide a minimum 30 seconds of testing at the maximum capacity of the pump (100 percent speed), or 170 mL, whichever is greater.

B. Style: Clear cylinder with graduations marked in liters and gallons. A minimum of five intermediate graduations shall be provided.

C. Process Connections: FNPT, 1/2-inch minimum, located in the top and bottom end caps.

D. The vent side of all calibration columns on a single pump skid shall be manifolded together to permit easy routing of vent line to the outside.

E. Materials of Construction: As recommended by the pump manufacturer for compatibility with the chemical.

2.08 DIAPHRAGM SEAL AND PRESSURE INDICATORS

A. Pressure gauge shall be resistant to the chemical it is monitoring.

B. See Section 40 91 00, Instrumentation and Control Components, for additional requirements.

2.09 PRESSURE SAFETY VALVES

A. Size: Selected by the metering pump manufacturer to provide external pressure relief on the chemical injection line, as shown, for field installation on the pump discharge line.

B. Style: Internal spring actuated diaphragm type, three-port design. Valve shall be capable of closing without an external source of pressure. Relief pressure setting shall be externally adjustable between 0 and 150 psig via a top-mounted adjustment screw.

C. Operation: The valve shall remain closed with injection line pressures below the setpoint. When the setpoint relief pressure is exceeded, the valve shall open and relieve pressure to the metering pump suction line.

D. Process Connections: FNPT, 1/2-inch minimum. A union shall be installed on both sides for ease of removal.

E. Materials of Construction: As recommended by the pump manufacturer for compatibility with the chemical.
2.10 OTHER VALVES
A. See Section 40 27 02, Process Valves and Operators.
B. All materials in contact with the process fluid shall be chemically compatible with the specified fluid.

2.11 RELIEF LINE FLOW INDICATORS
A. Description: Pumps shall be supplied with a visual flow indicator installed in the relief valve exhaust line.
B. Style: The indicator shall be of double wall construction with a Pyrex inner cylinder, Plexiglas outer cylinder, and stainless steel fasteners. Flow indication shall be accomplished visually without the use of internal streamers or other moving parts.
C. Process Connections: 1/2-inch FNPT.
D. Port Materials: Materials for wetted connection shall be as recommended by the pump manufacturer for compatibility with the chemical.

2.12 MOTOR DRIVE SYSTEM
A. Type: Silicon controlled rectifier (SCR), single-phase, analog AC variable speed drive.
B. Speed Regulation: Pump speed shall be adjusted linearly based on a manual setpoint from a potentiometer or Profibus interface from the designated control panel.
C. Range: 10:1 turndown, which in addition to the manual stroke adjustment at the pump shall provide a cumulative 100:1 turndown for the metering system.
D. Resolution: Motor speed shall be regulated to plus or minus 0.5 percent with 95 percent load change with specified.
E. Power Supply: 120V ac.
F. Number: Each metering pump shall be supplied with its own drive controller.
G. Features: The drive controllers shall be provided with isolated voltage and current feedbacks. Adjustable drive parameters shall include minimum speed, maximum speed, acceleration rate, deceleration rate, current limit, and IR compensation. Power semi-conductors shall be contained in easily accessible power cubes for rapid replacement in the field. An integral surge suppressor shall be provided to protect semi-conductors from line transients. A fail-safe relay shall be provided within the drive control circuit to prevent automatic
restart following power outage. An integral current limit shall be provided within the drive controller to protect the driven equipment from damaging current or torque levels.

2.13 SOLENOID DRIVE SYSTEM

A. Power Supply: 120V ac.

2.14 SIGNAL INTERFACE

A. Provide Profibus communication between the drive and process control system for monitoring, alarm, and control functions.

2.15 CONTROLS

A. Each metering pump shall be furnished with integral controls.

B. Power supply shall be single-phase, 120V ac for the motor-driven pumps and solenoid-driven pumps.

C. Controls shall include the following as a minimum:

1. Drive controller LOCAL-OFF-REMOTE.
2. Power ON-OFF.
3. Power ON indicator.
4. Pump speed controller, for manually adjusting pump speed in the LOCAL operating mode.
5. Pump speed indicator, in units of 0 to 100 percent speed.
6. A motor ON indicator.

D. Internal components shall include the following as a minimum:

1. Drive controller and related accessory components.
2. Terminal blocks for interfacing all field wiring.
3. Interposing control relays.

2.16 PUMP OUTPUT CONTROL

A. Manual Stroke Adjustment: Provide manual stroke length adjustment through adjustment knob on unit that provides adjustment accuracy of 1 percent. Adjustment shall be self-locking, and shall be operable whether or not pump is running.

B. Automatic Stroke Adjustment: Provide automatic stroke position adjustment using either motorized drive or energy from pump. Stroke adjustment system shall be capable of receiving an external 4-20 mA dc control signal to provide linear adjustment of stroke setting from zero to 100 percent. Provide manual override using either integral handwheel or knob, or separate manual
adjustment as specified above. Provide selection of AUTO or MANUAL position adjustment.

C. Adjustable Speed (Stroke Frequency) Adjustment: Provide adjustable speed operation of pump using DC SCR drive. Coordinate pump motor type with drive unit provided. DC SCR drive shall not cause more than 1 percent harmonic distortion into power supply voltage waveform, as defined by IEEE Standard 519. Furnish isolation transformers or filtering devices as necessary to meet this requirement. Drive unit shall include integral or separate control panel with speed indication in percent, HAND/OFF/AUTO selector switch, and manual adjustable potentiometer for adjustment of pump speed when in HAND position. Drive shall accept external 4-20 mA dc control signal to provide linear adjustment of pump speed from zero to 100 percent when in AUTO position. Provide DRIVE FAIL and ON/OFF discrete output signals. Provide 4-20 mA analog output signal for drive speed.

2.17 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch diespun 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, and as specified in Section 05 50 00, Metal Fabrications.

D. Gauge Connections: Tapped and plugged suction and discharge gauge connections on piping headers adjacent to pumps.

E. Screens or Guards: Mesh size of less than 0.5 inch, exposed rotating shafts, rotors, couplings, pulley, wheel, bolts, chains, or similar components. Where guards/screens are over grease fittings, couplings, or other items requiring maintenance, provide a means for ready access.

2.18 FACTORY FINISHING

A. Manufacturer’s standard epoxy finish.

2.19 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.
C. Factory Test Report: Include test data sheets.

D. Functional Test: Perform manufacturer’s standard, motor test on equipment.

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. Touch-up damaged coating on equipment as recommended by the pump manufacturer.

3.03 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Functional Test:

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

C. Performance Test:

1. Perform under actual or approved simulated operating conditions.
2. Test for a continuous 3-hour period without malfunction.
3. Test flow range listed in Data Sheet supplements.

3.04 SUPPLIER’S SERVICES

A. Supplier’s Representative: Present at Site or classroom designated by Contract for minimum person-days listed below, travel time excluded:

1. 1/2 person-day for installation assistance and inspection.
2. 1/2 person-day for functional and performance testing and completion of Supplier’s Certificate of Proper Installation.
3. 1/2 person-day for pre-startup classroom or Site training.
4. 1/2 person-day for facility startup.
5. 1 person-day for post-startup training Owner’s personnel.

B. See Section 01 43 33, Manufacturers’ Field Services, and the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.
3.05 SUPPLEMENTS

A. Supplement listed below, following “End of Section,” are part of this Specification.

1. Chemical Metering Pump Data Sheets.

END OF SECTION
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-1

Tag Numbers: CHEM-P-530-A, B

Pump Name: Sulfuric Acid Metering Pump A, B

Manufacturer and Model Number: (1) ProMinent (2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Sulfuric Acid, 93%

Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 50

Liquid pH: <1 Liquid Specific Gravity: 1.84

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 3

Altitude (ft msl): 850 Area Classification: N/A Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 1.1 Minimum: 0.25

Maximum Discharge Pressure (psig): 100

Internal Bypass Valve Setting (psig): per Mfg.

Relief Valve Setting (psig/as recommended): 150

Back Pressure Valve Setting (psig/as recommended): 15

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N) ○ Other ○

Wet End Material: PVDF Tubular Diaphragm Housing Material: ○

Check Valve Material: PVDF Configuration (Single/Double): As recommended

Diaphragm Material: PTFE Primary: ○ Tubular: ○

Calibration Cylinder: Quantity: ○ Material: Clear CPVC Units: Gal and L

Capacity: As recommended

Diaphragm Actuation Type: Mechanical X Hydraulic ○

Stroke Position Adjustment: Manual ○ Automatic X

Pump Speed Control: Constant ○ Variable X

CHEMICAL METERING PUMPS
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PW/DEN001/662886 44 44 13.01 SUPPLEMENT 1 - 1
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-1

Tag Numbers: CHEM-P-530-A, B

**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors)

- Horsepower: _____
- Voltage: 120
- Phase: 1
- Synchronous Speed (rpm) 1800
- Service Factor: 1.15

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

- Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
- TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

**TESTING**

- Pump Tests: Factory Functional (Y/N) Y  Factory Performance (Y/N) Y
- Field Functional (Y/N) Y  Field Performance (Y/N) Y

- Motor Test: Short Commercial (Y/N) Y  Other

**REMARKS**

The discharge of pumps A and B are to be interconnected with isolation valve to allow either pump to serve as backup for the other.
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-2

Tag Numbers: CHEM-P-530-C

Pump Name: Sulfuric Acid Metering Pump C

Manufacturer and Model Number: (1) ProMinent
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Sulfuric Acid, 93%

Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 50

Liquid pH: <1 Liquid Specific Gravity: 1.84

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 3

Altitude (ft msl): 850 Area Classification: N/A Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 13.2 Minimum: 1.0

Maximum Discharge Pressure (psig): 100

Internal Bypass Valve Setting (psig): per Mfg.

Relief Valve Setting (psig/as recommended): 150

Back Pressure Valve Setting (psig/as recommended): 15

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N) O

Wet End Material: PVDF Tubular Diaphragm Housing Material: ______

Check Valve Material: PVDF Configuration (Single/Double): As recommended

Diaphragm Material: PTFE Primary: ______ Tubular: ______

Calibration Cylinder: Quantity: ______ Material: Clear CPVC Units: Gal and L

Capacity: As recommended

Diaphragm Actuation Type: Mechanical X Hydraulic

Stroke Position Adjustment: Manual ______ Automatic X

Pump Speed Control: Constant ______ Variable X
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-2
Tag Numbers: CHEM-P-530-C

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120 Phase: 1 Synchronous Speed (rpm) 1800_____
Service Factor: 1.15____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y
Field Functional (Y/N) Y Field Performance (Y/N) Y
Motor Test: Short Commercial (Y/N) Y Other

REMARKS


CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-3

Tag Numbers: CHEM-P-531-A, B, C

Pump Name: Sulfuric Acid Metering Pump A, B, C

Manufacturer and Model Number: (1) ProMinent
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Sulfuric Acid, 93%
Pumping Temperature (Fahrenheit): Normal: 70 ___ Max 90 ___ Min 50 ___
Liquid pH: <1   Liquid Specific Gravity: 1.84
Abrasive (Y/N) N ______ Possible Scale Buildup (Y/N): N ______
Suction Pressure (psig): Minimum 3
Altitude (ft msl): 850   Area Classification: N/A   Location (indoor/outdoor): Outdoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 2.3 ______ Minimum: 0.70 ______
Maximum Discharge Pressure (psig): 100 ______
Internal Bypass Valve Setting (psig): per Mfg. ______
Relief Valve Setting (psig/as recommended): 150 ______
Back Pressure Valve Setting (psig/as recommended): 15 ______

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y ______
Tubular (double) Diaphragm (Y/N) ___ Other ____________
Wet End Material: PVDF ______ Tubular Diaphragm Housing Material: ______
Check Valve Material: PVDF Configuration (Single/Double): As recommended
Diaphragm Material: PTFE   Primary: _____ Tubular: _____________
Calibration Cylinder: Quantity: _____ Material: Clear CPVC   Units: Gal and L
Capacity: As recommended ______
Diaphragm Actuation Type: Mechanical X ______ Hydraulic _____________
Stroke Position Adjustment: Manual ______ Automatic X _____________
Pump Speed Control: Constant ________ Variable X _______________
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-3

Tag Numbers: CHEM-P-531-A, B, C

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120 Phase: 1 Synchronous Speed (rpm) 1800_____
Service Factor: 1.15_____
Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

Pump Tests: Factory Functional (Y/N) Y   Factory Performance (Y/N)   Y
Field Functional (Y/N) Y   Field Performance (Y/N) Y
Motor Test: Short Commercial (Y/N) Y   Other

REMARKS

The discharge of pumps A, B and C are to be interconnected with isolation valves to allow pump B to serve as backup for pump A or C.

Provide insulated and heated enclosure(s) to maintain enclosure space at a minimum temperature of 60 degrees F. Space heater to be 480V ac electric.

See Section 01 61 00, Common Product Requirements, for ambient conditions.
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-4

Tag Numbers: CHEM-P-520-A, B, C
Pump Name: Ferric Chloride Metering Pump A, B, C
Manufacturer and Model Number: (1) ProMinent
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Ferric Chloride, 40%
Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 50
Liquid pH: 1.4 Liquid Specific Gravity: 1.42
Abrasive (Y/N) N Possible Scale Buildup (Y/N): N
Suction Pressure (psig): Minimum 3
Altitude (ft msl): 850 Area Classification: N/A Location (indoor/outdoor): Outdoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 14.5 Minimum: 1.0
Maximum Discharge Pressure (psig): 100
Internal Bypass Valve Setting (psig): per Mfg.
Relief Valve Setting (psig/as recommended): 150
Back Pressure Valve Setting (psig/as recommended): 15

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y
Tubular (double) Diaphragm (Y/N) Other
Wet End Material: PVDF Tubular Diaphragm Housing Material: 
Check Valve Material: PVDF Configuration (Single/Double): As recommended
Diaphragm Material: PTFE Primary: Tubular: 
Calibration Cylinder: Quantity: Material: Clear CPVC Units: Gal and L
Capacity: As recommended
Diaphragm Actuation Type: Mechanical X Hydraulic
Stroke Position Adjustment: Manual Automatic X
Pump Speed Control: Constant Variable X
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-4

Tag Numbers: CHEM-P-520-A, B, C

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

- Horsepower: _____ Voltage: 120  Phase: 1  Synchronous Speed (rpm) 1800 _____
- Service Factor: 1.15____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

- Enclosure:  DIP _____  EXP _____  ODP _____  TEFC X  CISD-TEFC _____
- TENV _____  WPI _____  WPII _____  SUBM _____

- Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

- Pump Tests: Factory Functional (Y/N) Y  Factory Performance (Y/N) Y
- Field Functional (Y/N) Y  Field Performance (Y/N) Y
- Motor Test:  Short Commercial (Y/N) Y  Other

REMARKS

- The discharge of pumps A, B and C are to be interconnected with isolation valves to allow pump B to serve as backup for pump A or C.

- Provide insulated and heated enclosure(s) to maintain enclosure space at a minimum temperature of 60 degrees F. Space heater to be 480V ac electric.

- See Section 01 61 00, Common Product Requirements, for ambient conditions.
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-5

Tag Numbers: CHEM-P-500-A, B, C, D

Pump Name: Sodium Bisulfite Feed Pump A, B, C, D

Manufacturer and Model Number: (1) ProMinent
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Sodium Bisulfite, 40%
Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 50
Liquid pH: 4 Liquid Specific Gravity: 1.35
Abrasive (Y/N) N Possible Scale Buildup (Y/N): N
Suction Pressure (psig): Minimum 3
Altitude (ft msl): 850 Area Classification: N/A Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 0.30 Minimum: 0.07
Maximum Discharge Pressure (psig): 100
Internal Bypass Valve Setting (psig): per Mfg.
Relief Valve Setting (psig/as recommended): 150
Back Pressure Valve Setting (psig/as recommended): 15

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y
Tubular (double) Diaphragm (Y/N) Other
Wet End Material: PVC Tubular Diaphragm Housing Material: ______
Check Valve Material: PVDF Configuration (Single/Double): As recommended
Diaphragm Material: PTFE Primary: Tubular: ______
Calibration Cylinder: Quantity: Material: Clear CPVC Units: Gal and L
Capacity: As recommended
Diaphragm Actuation Type: Mechanical X Hydraulic
Stroke Position Adjustment: Manual Automatic X
Pump Speed Control: Constant Variable X
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-5

Tag Numbers: CHEM-P-500-A, B, C, D

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120 Phase: 1 Synchronous Speed (rpm) 1800

Service Factor: 1.15

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____

TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

Pump Tests: Factory Functional (Y/N) Y  Factory Performance (Y/N) Y

Field Functional (Y/N) Y  Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) Y  Other

REMARKS

The discharge of pumps A and B are to be interconnected with isolation valves to allow either pump to serve as backup for the other pump.

The discharge of pumps C and D are to be interconnected with isolation valves to allow either pump to serve as backup for the other pump.
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-6

Tag Numbers: CHEM-P-550-A, B

Pump Name: Sodium Hydroxide Pump A, B

Manufacturer and Model Number: (1) ProMinent
(2) Or Equal

**SERVICE CONDITIONS**

- **Liquid Pumped (Material and Percent):** Sodium Hydroxide, 15%
- **Pumping Temperature (Fahrenheit):** Normal: 70 Max 90 Min 50
- **Liquid pH:** 14
- **Liquid Specific Gravity:** 1.17
- **Abrasive (Y/N):** N
- **Possible Scale Buildup (Y/N):** N
- **Suction Pressure (psig):** Minimum 3
- **Altitude (ft msl):** 850
- **Area Classification:** N/A
- **Location (indoor/outdoor):** Indoor

**PERFORMANCE REQUIREMENTS**

- **Capacity (US gph):** Maximum: 0.60 Minimum: 0.10
- **Maximum Discharge Pressure (psig):** 100
- **Internal Bypass Valve Setting (psig):** per Mfg.
- **Relief Valve Setting (psig/as recommended):** 150
- **Back Pressure Valve Setting (psig/as recommended):** 15

**DESIGN AND MATERIALS**

- **Pump Type:** Single Diaphragm (Y/N) Y
- **Tubular (double) Diaphragm (Y/N):** Other
- **Wet End Material:** PVDF
- **Tubular Diaphragm Housing Material:**
- **Check Valve Material:** CPVC
- **Configuration (Single/Double):** As recommended
- **Diaphragm Material:** PTFE faced EPDM
- **Primary:** Tubular:
- **Calibration Cylinder: Quantity:**
- **Material:** Clear CPVC
- **Units:** Gal and L
- **Capacity:** As recommended
- **Diaphragm Actuation Type:** Mechanical X Hydraulic
- **Stroke Position Adjustment:** Manual Automatic X
- **Pump Speed Control:** Constant Variable X

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PW/DEN001/662886
JUNE 30, 2017
CHEMICAL METERING PUMPS
44 44 13.01 SUPPLEMENT 6 - 1
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-6

Tag Numbers: CHEM-P-550-A, B

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

- Horsepower: _____ Voltage: 120 Phase: 1 Synchronous Speed (rpm) 1800
- Service Factor: 1.15

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
- TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

- Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y
- Field Functional (Y/N) Y Field Performance (Y/N) Y
- Motor Test: Short Commercial (Y/N) Y Other

REMARKS

The discharge of pumps A and B are to be interconnected with isolation valve to allow either pump to serve as backup for the other.
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-7

Tag Numbers: CHEM-P-540-A, B, C, D

Pump Name: Organosulfide Polymer Metering Pump A, B, C, D

Manufacturer and Model Number: (1) ProMinent
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Organosulfide Polymer (Nalco Nalmet1691), 100%

Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 50

Liquid pH: 12.5       Liquid Specific Gravity: 1.15

Liquid Viscosity, Neat @ 60 F (cP): 25

Liquid Viscosity, 0.5% Solution @ 60 F (cP): 25

Abrasive (Y/N) N   Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 3

Altitude (ft msl): 850  Area Classification: N/A  Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 1.1    Minimum: 0.20

Maximum Discharge Pressure (psig): 100

Internal Bypass Valve Setting (psig): per Mfg.

Relief Valve Setting (psig/as recommended): 150

Back Pressure Valve Setting (psig/as recommended): 15

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y
     Tubular (double) Diaphragm (Y/N)       Other

Wet End Material: PVC       Tubular Diaphragm Housing Material: ______

Check Valve Material: PVDF Configuration (Single/Double): As recommended

Diaphragm Material: PTFE   Primary: ______  Tubular: ______

Calibration Cylinder: Quantity: ______  Material: Clear CPVC  Units: Gal and L

Capacity: As recommended

Diaphragm Actuation Type: Mechanical X    Hydraulic

Stroke Position Adjustment: Manual ______  Automatic X

Pump Speed Control: Constant ______  Variable X
CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-7

Tag Numbers: CHEM-P-540-A, B, C, D

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120 Phase: 1 Synchronous Speed (rpm) 1800_____
Service Factor: 1.15____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y
Field Functional (Y/N) Y Field Performance (Y/N) Y
Motor Test: Short Commercial (Y/N) Y Other

REMARKS

The discharge of pumps A and B are to be interconnected with isolation valves to allow______ either pump to serve as backup for the other pump.

The discharge of pumps C and D are to be interconnected with isolation valves to allow______ either pump to serve as backup for the other pump.
*Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)*

Clarifier/Thickener System

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</table>

**Document Review & Approval:**

**Originator:**
Karen M. Leber, PE/Process Lead Engineer  
*Signature: [Signature]*  
*Date: 6/14/17*

**Design Verification Complete:**
Mark Davis/Senior Technical Consultant  
*Signature: [Signature]*  
*Date: 6/15/17*

**Approved:**
W. Laird Ellis, Jr. PE/Design Manager  
*Signature: [Signature]  
*Date: [Signature Date]*
PART 1   GENERAL

1.01   GENERAL

A.  This section covers the design, manufacture, delivery, site storage, installation, testing and placement into operation of the clarifier/thickener equipment.

B.  The clarifier/thickener system includes but is not limited to inclined plate packs consisting of plates, frames, effluent troughs and weirs, effluent trough connections/extensions, influent baffles, thickener tank located below the clarifier section, thickener mechanism and its drive train, spacers/stiffeners, gaskets, lifting attachments, supports and anchoring systems, and all appurtenances necessary for a complete and operating system.

1.02   REFERENCES

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

1.  American Gear Manufacturers Association (AGMA):
   a.  6034, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
   b.  9005, Industrial Gear Lubrication.


3.  Institute of Electrical and Electronics Engineers:

1.03   GENERAL

A.  The clarifier/thickener equipment manufacturer shall furnish an engineered system suitable for clarification of coagulated and flocculated water and thickening of settled solids. The clarifier and thickener shall be integrated within a single tank.

B.  The clarifier/thickener manufacturer shall size inlet and outlet flanged connections. Contractor shall provide gaskets, bolts and nuts, and transitions connections (if necessary) to piping that connects to the clarifier/thickeners.

C.  The clarifier/thickener manufacturer shall utilize a fabrication facility regularly engaged in the manufacture of clarifier/thickeners.
1.04 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s catalog cuts and technical literature describing the proposed clarifier/thickener, and identifying all components of the proposed system.

2. Scaled and dimensioned drawings showing layout, configuration, and installation details for the clarifier/thickener system. Include dimensions, size, and locations of connections to other work, and weights of associated equipment with and without water.

3. Provide written interface requirements, installation details, and recommendations as are necessary to properly interface the clarifier/thickener with concrete foundation and connecting piping.

4. Clearly identify sample port location recommendations if different from those shown on the Drawings.

5. A complete listing of materials, including detailed information on materials of construction.

6. Drawings shall include controlling elevations (i.e., V-notch weir, wall openings, bottom of equipment, water surface elevations in the clarifier and along the effluent trough at minimum and maximum flows).

7. Hydraulic calculations including headloss and velocity through the inclined plate system at average and peak flows.

8. Calculations and other information to show projected plate area meets design criteria, including evidence (pilot test results, video proof) that solids settling in the inlet end of the plates is either undisturbed by incoming feed or the effective projected plate area shall be a maximum of 80 percent of the calculated projected plate area.

9. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

10. Power and control wiring diagrams, including terminals and numbers.


B. Informational Submittals:

1. Installation List: The manufacturer shall submit a list of Clarifier/Thickener systems installed within the last 5 years.

2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

4. Certification that the factory-applied coating system(s) is identical to the requirements specified.

5. Special shipping, storage and protection, and handling instructions.

6. Manufacturer’s written/printed installation instructions.
7. Routine maintenance requirements prior to plant startup.
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 01 43 33, Manufacturers’ Field Services.

1.05 FACILITY DESIGN BASIS
A. The structure and appurtenant facilities have been designed around the Parkson EcoFlow™ Clarifier/Thickener. Equipment by other named manufacturers may require adjustments to the facility design and configuration to accommodate their system. Contractor shall be responsible for additional costs to accommodate other manufacturer’s systems, and shall clearly identify such changes to Engineer in the Submittals for this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Materials, equipment, and accessories specified in this section shall be products of:
   1. Parkson Co.
   2. WesTech, Inc.

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

2.03 EQUIPMENT TAG NUMBERS
A. CHTR-CLAR-440-A Clarifier/Thickener A.
B. CHTR-CLAR-440-B Clarifier/Thickener B.

2.04 DESIGN REQUIREMENTS
A. Number of Clarifier/Thickeners: Two.
B. Flow Rates:
   1. Peak: 1,710 gpm per clarifier/thickener.
   2. Average: 845 gpm per clarifier/thickener.
   3. Minimum: The clarifier/thickeners shall be capable of operating in a standby mode with no influent flow for an indefinite period.
C. Influent Water Quality:

1. Total Suspended Solids (TSS) Design Concentrations:
   a. At Peak Flow Rate: 750 mg/L.
   b. At Average Flow Rate: 3,500 mg/L.
   c. The majority of the influent TSS is from recycle of solids from the bottom of the Clarifier/Thickener. The recycle rate will be adjusted during operation to maintain TSS concentration in the reaction tank upstream of the clarifier/thickener. When flow rate exceeds the average flow rate, the recycle rate will be reduced to lower the TSS concentration in the reaction tank. In addition to recycled solids, the reaction tank influent will have an average TSS concentration of 40 mg/L and a peak TSS concentration of 65 mg/L. These solids include solids recycled from backwashing of filters downstream of the Clarifier/Thickener along with solids remaining in the MTF influent stormwater after treatment in a vortex grit chamber. Ferric hydroxide precipitant is formed in the reaction tank through addition of ferric chloride. Other precipitants are formed in the reaction tank, but their concentrations are negligible in comparison to ferric hydroxide. Flocculating polymer will be added to the reaction tank effluent, which will flow to a flocculation tank where slow-speed mixing will be used to flocculate solids. The flocculation tank is not included in the clarifier/thickener system. The effluent of the flocculation tank will flow by gravity into the clarifier/thickener.
   2. Temperature Range: 13 to 28 degrees C.
   3. pH Range: 6 to 8. Nominal pH is 6.4; pH will be controlled by addition of sulfuric acid to the reaction tank.

D. Primary Coagulant:

1. Ferric chloride, as FeCl3-6H2O: Maximum dose, 80 mg/L.
2. Other Chemicals Added: Organosulfide polymer and flocculating polymer.

E. Hydraulic Loading Rate: Maximum of 0.44 gallons per minute per square foot of the effective projected horizontal plate area. If evidence is not provided that shows solids settling is undisturbed by incoming feed, the effective projected plate area shall be a maximum of 80 percent of the calculated projected plate area.

F. Clarifier Effluent TSS Concentration: Maximum 20 mg/L at both peak flow rate and TSS and average flow rate and TSS.

G. Clarifier Sludge TSS Concentration: Minimum 3 percent solids by weight.
H. Structural Design: Conform to requirements of Section 01 88 15, Anchorage and Bracing.

I. Plate Angle: 55 degrees to 60 degrees from horizontal.

J. Minimum Perpendicular Distance Between Parallel Plates: 2 inches.

K. Inclined Plate Length to Width Ratio: minimum of 10 to 1; this ratio may be achieved through the use of longitudinal stiffeners that divide a single plate into multiple settling chambers. For example, a single plate may be 2 feet wide and 10 feet long with a longitudinal stiffener located in the center to give two settling chambers, each with a width of 1 foot and length of 10 feet.

L. Wastewater Velocities:
   1. Feed Duct: Maximum 0.5 ft/sec.
   2. Feed Box: Maximum 0.2 ft/sec.
   3. Feed Slot: Maximum 0.08 ft/sec.

M. Piping Connections:
   1. Feed Inlets (two): Rectangular, 17-inch by 30-inch each.
   2. Effluent Outlets (two): Circular, nominal 18-inch diameter, flanged.

N. Pressure Drop Across Each Plate: minimum of 2 to 4 inches of water across each plate at peak flow rate using submerged effluent throttling devices provided on each plate.

O. Thickener Section:
   2. Sludge Outlet Nozzle: 8-inch, 150-pound ANSI, raised face flange.
   3. Manway: 30-inch diameter, flanged.
   4. Sample Valves: Four, 1-inch diameter, Type 316 stainless steel ball valves evenly spaced along the thickener wall to be used to assess sludge blanket depth.

P. Footprint: The width, length, and height planned for the clarifier/thickeners are as shown on the Drawings and are based on the Parkson Clarifier/Thickener. Contractor shall be responsible for making adjustments as necessary to install a clarifier/thickener that does not have the same dimensions as shown on the Drawings.

Q. Sample port and manway locations shall be provided as identified on Drawings. The two clarifiers should mirror each other so that sample ports from each clarifier will be across from each other after installation, as shown
on the Drawings. Supplier shall advise in submittals if different sampling elevation are recommended.

R. Equipment must be rated for outdoor use.

2.05 SLUDGE RAKE MECHANISM

A. Equipment Tag Numbers:

1. 941002-CHTR-M-440-A Thickener Rake A.
2. 941002-CHTR-M-440-B Thickener Rake B.

B. Sludge Rake: Full-length picket fence, sludge scraper/thickener rake.

C. Sludge Rake Drive:

1. Speed: Maximum of 2.5 rpm.
2. Design Torque: 500 foot-pounds.
5. Mechanism shall have no moving parts below the water surface which require lubrication or which will be subject to wear or blockage.
6. The drives, bearings, and support equipment shall be supported by a support frame that is provided with the clarifier/thickener. This equipment shall be readily accessible from walkways adjacent to the clarifier/thickener as shown on the Drawings.

D. Sludge Rake Motor: As specified on the Induction Motor Data Sheet.

E. Speed Reducer.

1. Horizontally mounted cylindrical-worm or helical-worm gear motor type with gears supported by antifriction bearings.
2. AGMA 6034.
3. Service Factor: Minimum 1.25 applied to the input horsepower of the speed reducer when the rake drive is operating at the design running torque specified herein.
4. Oil Fill, Drain and Level Indicator Devices, and Lubricant: AGMA 9005.

F. Controls:

1. Wire high torque alarm and high-high-torque shutoff switches to a terminal block in a NEMA 4X junction box.
2. Conform to the requirements of Section 40 99 90, Package Control Systems.
G. Maintenance Platform Around Thickener Drive:

1. Provide a platform structure that supports the thickener drive and gives access for personnel performing maintenance on the drive. Provide a minimum of 3 feet of clearance on each side of the drive as shown on the Drawings. All FRP grating, platforms and stair treads shall be Fibergrate Molded Vi-Corr, 1-1/2 inches deep by 1-1/2 inches square mesh, grit top surface, dark grey. Other FRP grating products may be substituted if they have the same, or higher, strength and deflection characteristics in a 1-1/2-inch thick grating. Design platform to meet minimum and/or maximum dimensions and clearances as shown on Drawings.

2. Raised platform shall be designed and stamped by a structural engineer registered in the state of Tennessee.

3. Construct the platform using structural steel framing as identified in Section 05 12 00, Structural Steel Framing, and coated in accordance with Section 09 90 00, Painting and Coating.


5. Fasteners: Stainless steel.

6. No aluminum shall be used in the area due to potential contact with mercury contained in sludge material.

2.06 MATERIALS OF CONSTRUCTION

A. Conform to requirements of Section 05 50 00, Metal Fabrications.

B. Plate Pack Frames: Type 304L stainless steel.

C. Parallel Plates: Minimum 0.09-inch thick FRP with rigid PVC stiffeners.

D. Inlet Feed Baffles: Type 304L stainless steel.

E. Outlet Weirs/Flumes: Type 304L stainless steel.

F. Thickener Sludge Rake: Type 304L stainless steel for all wetted parts.

G. Clarifier Tank Walls: Minimum 1/4-inch thick, carbon steel.

H. Thickener Tank Walls and Bottom: Carbon steel with minimum 3/8-inch thick walls and minimum 1/2-inch bottom plate.

I. Fasteners: Type 304L stainless steel.

J. Coating: All interior and exterior carbon steel surfaces shall be coated as specified in Section 09 90 00, Painting and Coating, System No. 1, shall be
used on all internal surfaces for continuous immersion service. System No. 4 shall be used on all other surfaces.

2.07 MISCELLANEOUS PRODUCTS

A. General:

1. Furnish incidental products, such as gaskets, supports, bolts, lubricants and coating products for touch up, as required for proper operation of equipment installed under this section.
2. Products shall conform to applicable sections of these Specifications for the intended service.

B. Anchor Bolts:

1. Furnish anchor bolts, fasteners, washers, etc., needed for installation.
2. Verify the number and size of anchor bolts required by the manufacturer’s equipment and furnish all necessary anchor bolts.
3. Locate anchor bolts in accordance with manufacturer’s shop drawings and installation instructions.
4. Anchor bolts, fasteners, washers, etc., shall be Type 304 stainless steel or Type 316 stainless steel to match connecting component. Fasteners shall be threaded in accordance with ANSI B1.1 for screw threads, coarse-thread series. Stainless steel fasteners lubricant (non-copper or non-molybdenum containing anti-seizing) shall be applied to the threads prior to making up the connections.

PART 3 EXECUTION

3.01 PREPARATION FOR SHIPMENT

A. Insofar as is practical, the plate pack modules shall be shipped assembled, ready for installation at the Site. Parts and assemblies that are, of necessity, shipped unassembled shall be trial assembled at the factory and marked in a manner to facilitate final assembly in the field. The equipment and materials shall be packaged in a manner that will protect the equipment from damage during shipment.

B. Contractor shall have a Manufacturer’s Representative at the Job Site during receipt of equipment and materials. This representative together with a representative of Contractor and Engineer will inspect all equipment and materials for condition upon arrival at the Job Site. Damaged or otherwise unacceptable equipment and materials will be removed from the Job Site and replaced with new equipment and materials. Accepted equipment and materials will be turned over to Contractor for storage, in accordance with the manufacturer’s instructions, until installation is required.
3.02 INSTALLATION OF CLARIFIER/THICKENERS

A. A detailed description of the various items of work and precaution in handling the clarifier/thickener components shall be provided by the manufacturer to Contractor prior to delivery and installation.

B. Manufacturer shall provide any special tools required for installation of the clarifier/thickener.

C. Installation work shall conform to manufacturer’s recommended procedures, instructions, and shop drawings.

3.03 MANUFACTURERS’ SERVICES

A. A manufacturer’s technical representative for the equipment specified herein shall be present at the Job Site and/or classroom designated by Owner for the minimum person-days listed for the services hereinafter, travel time excluded:

1. 1 person-day for inspection of equipment and materials upon arrival at the Job Site and inventory.
2. 1 person-day for inspection, certification of the installation, and instructing the Contractor on proper installation procedures.
3. 2 person-days for functional and performance testing.
4. 1 person-day for prestartup classroom or Job Site training.
5. Note: The manufacturer’s representative shall be present at the Job Site for whatever duration is necessary to assure proper assembly, installation, testing, startup and certification of the equipment specified herein.

B. Startup and assistance services shall be at such times as requested by Owner. Owner will schedule such services in advance with the manufacturer. In the event of unforeseen installation difficulty or problems, the manufacturer shall provide a qualified technical representative to the Job Site within 48 hours of notification that such a situation exists.

C. Training services for Owner’s personnel shall be at such times as requested by the Owner.

3.04 FUNCTIONAL TESTING

A. Functional Test: Prior to plant startup, all equipment described in this Specification shall be inspected for proper alignment and connection and satisfactory performance by means of a functional test as performed by Contractor. Functional testing shall include a hydrotest to check for leakage. If any leaks are detected, make necessary repairs and reperform the hydrotest.
3.05 PERFORMANCE TESTING

A. Timing: To be conducted by Contractor during startup using clean water and addition of ferric chloride, sulfuric acid, and flocculating polymer to generate ferric hydroxide solids.

B. Procedure: Reaction tank, flocculating tank, chemical feed systems, Clarifier/Thickener, and sludge recycle pumps shall be operated continuously to build-up the sludge blanket in the Clarifier/Thickener and to increase TSS concentrations in the reaction tank to the peak and average design conditions. Two separate tests shall be performed, one at average design conditions and one at peak design conditions. After TSS concentrations in the reaction tank and the thickener sludge have reached design conditions, the system shall be operated for a minimum of 24 hours while maintaining constant feed rate, sludge recycle rate, and chemical metering. During this testing period, performance test data shall be collected, including flow rates, chemical addition rates, and influent, effluent, and solids TSS concentrations. The data collection period shall include a minimum of 10 samples taken over a minimum of 24 hours of operation. This testing shall be performed on both treatment trains.

C. Testing results shall confirm compliance with the performance requirements as defined in Article Design Requirements. If the equipment fails to meet the required performance criteria, the manufacturer shall make adjustments to the equipment and/or chemical dosages as needed and the testing shall be repeated. This cycle of adjustment and retesting is allowed for two additional cycles (three tests total), after which time the equipment will be considered to be non-compliant with the Specification if it has not met the performance requirements. At this point, the equipment shall be removed and replaced with another manufacturer’s equipment at the Contractor’s expense, including complete submittals and performance testing on the replacement equipment as specified.

3.06 SPARE PARTS

A. Furnish a minimum of two extra plates for every five plate packs.

B. Furnish 10 additional fasteners of each type.

C. Provide coating products for touch up work post-installation.
3.07 MANUFACTURER’S CERTIFICATE

A. The following certificates shall be provided:

1. Certification of Proper Installation.
2. Certification of Materials Compliance.

3.08 SUPPLEMENTS

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

1. Induction Motor Data Sheet.

END OF SECTION
| Project: OF200 Mercury Treatment Facility |
| Owner: Y-12 National Security Complex |
| Equipment Name: Thickener Rake A, Thickener Rake B |
| Equipment Tag Number(s): 941002-CHTR-M-440-A, 941002-CHTR-M-440-B |
| **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 | **Guaranteed Minimum Efficiency at Full Load:** 80.0 percent |
| **Voltage:** 460 | **Guaranteed Minimum Power Factor at Full Load:** N/A percent |
| **Phase:** 3 | **Service Factor (@ rated max. amb. temp.):** | 1.0 | 1.15 |
| **Frequency:** 60 | **Enclosure Type:** TEFC |
| **Synchronous Speed:** ______ rpm | **Multispeed, Two-Speed:** ____ / ____ rpm |
| □ Thermal Protection: None | | | | |
| □ Space Heater: 120 volts, single-phase | **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:** N/A to N/A_% of Rated Speed |
| | □ Variable Torque |
| | □ Constant Torque |
| **Additional Motor Requirements:** □ See Section 26 20 00, Low-Voltage AC Induction Motors. |
| **Special Features:** | | | |
| **IEEE-841 and UL-listed motor** |
| **Coated per Section 09 90 00, Painting and Coating, System No. 4, or Engineer-approved coating system.** |
Specification Title & Description: (List attached Specifications by Section number, revision, date, and number of pages for each Section Specification compiled under this cover page. Attached Specifications are to have sequentially numbered pages.)
Polymer Feed System, Liquid

Revision History:

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</table>

Document Review & Approval:

Originator:

Steven R. Polson, P.E./Lead Process Mechanical

NAME/POSITION

Steve Polson

SIGNATURE

DATE: 6/13/17

Design Verification Complete:

Qingshan Wang, P.E./Process Mechanical QC Reviewer

NAME/POSITION

Qingshan Wang

SIGNATURE

DATE: 6/14/17

Approved:

W. Laird Ellis, Jr. PE/Design Manager

NAME/POSITION

W. Laird Ellis, Jr.

SIGNATURE

DATE: 2017.06.16 12:02:13 -06'00'
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 in accordance with the Contracting Requirements:
   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 stroke setting (in percent) at specified maximum speed in strokes per minute and at minimum pump speed.
   d. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, required backpressure valve setting, pumped chemical characteristics, pipe connection sizes, stroke rate, materials, testing requirements, intermediate fluid type, and appurtenances to be provided with pumps.
   e. Information on rotameters and mixer chamber shaft seals indicating pressure rating and service requirements specified herein.
   f. Retention time and Gt (mean velocity gradient multiplied by retention time) values for polymer mixing chamber.
   g. Detailed dimensional drawings for pump and driver, including mounting requirements and piping connection sizes and locations.
   h. Power and control wiring diagrams, including terminals and numbers.
i. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.

j. Manufacturer’s materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.

k. Factory finish system.

l. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

m. Electrical control schematic and wiring diagrams that clearly show alarms, shutdowns, and contact closures for central control system.

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 and Performance Test Reports.

4. Special shipping, storage and protection, and handling instructions.

5. Manufacturer’s printed installation instructions.

6. Suggested spare parts list to maintain the 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 01 43 33, Manufacturers’ Field Services.

10. Record Drawings in accordance with the Contracting Requirements.

11. Interconnection wiring diagrams showing 460-volt power distribution, 120-volt control interconnection, instrument connection, wire sizes and quantities, wire identification per control diagrams, and terminal block locations.

1.04 QUALITY ASSURANCE

A. The polymer feed systems shall be furnished, coordinated, and tested by one supplier. The system shall be completely shop assembled, skid mounted, and shop tested prior to shipment.

B. All components shall be the standard product of a manufacturer regularly engaged in the production of required materials and equipment.
C. All equipment and material shall be designed and constructed in accordance with applicable standards as indicated.

PART 2 PRODUCTS

2.01 GENERAL

A. The polymer feed systems shall be skid mounted assemblies consisting of one metering pump, mixing chamber, and all piping, valves, and controls capable of delivering required minimum and maximum gallons per hour of polymer solution as shown on attached schedule. Included with each polymer feed system shall be a pressure relief valve, backpressure valve (if required), and calibration chamber.

2.02 EQUIPMENT

A. General:

1. Polymer feed system shall consist of an integrated equipment package system which shall meter, dilute, activate, mix, and feed liquid polymer and water. System shall not rely upon a static mixer as the means of polymer activation. Polymer shall not be exposed to a rotating centrifugal pump turbine or other machinery that would cause excessive shear.

2. Feed systems shall include a peristaltic or progressing cavity feed pump to provide the capability of pumping emulsion type liquid polymers, with maximum apparent viscosities of up to 10,000 centipoise. At no time shall liquid polymer or polymer solution be exposed to excessive shear that could degrade the effectiveness of the polymer molecular chains.

3. Polymer feed system shall be furnished with an integrally mounted control panel.

4. Provide variable speed drive for pump to accept 4-20 mA signal.

5. Each polymer feed system shall be equipped with Type 304 stainless steel side frame and stainless steel base with nonskid feet.

B. Mixing Requirements:

1. Polymer mixing system shall be specifically designed to invert, disperse, and activate in solution emulsion polymers that may vary in specific gravity from 1.05 to 1.15 and vary in viscosity from 25 to 7,500 cp.

2. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy. This design shall include a motor-driven impeller that will create high fluid sheer. Solution shall undergo a tapered mixing intensity slope as it exits the initial sheer zone and pass through a second zone, isolated by a baffle. Polymer activation efficiency shall be consistent over the entire dilution water range.
Mixing chamber shall be transparent to allow viewing of mixing intensity.

3. Mixing energy shall be provided by a variable speed, motor-driven impeller. Impeller shall rotate on a stainless steel shaft supported by double sealed ball bearings. Variable speed shall be achieved by variable frequency drive. Impeller shall be adjustable of a range of 900 rpm to 3,450 rpm to ensure complete flexibility in creating mixing energy. Systems not providing means of varying mixing intensities to compensate for different polymers will not be considered.

C. Pump:

1. Unit shall have a neat polymer metering pump. Pump shall be progressive cavity or peristaltic type.
2. The metering pump shall have minimum output capacity as shown in the attached pump data sheet with a 10:1 turndown.

D. Dilution Water System:

1. Polymer feed system shall have a solenoid valve for automatic OPEN/CLOSE control of dilution water supply. Solenoid valves shall be NEMA 4X with 120V ac coil. Solenoids shall be internally controlled.
2. Dilution water system shall contain primary dilution and post dilution assemblies. Dilution system shall have a rotameter type flow indicator equipped with integral rate-adjusting valves. Total water flow rate into unit shall be adjustable as shown in the attached schedule.
3. Water supply pressure will be approximately 65 to 100 psig. All components in the system shall be designed for at least 150 psig working pressure.
4. Polymer feed system shall have a manufacturer’s standard dilution water pressure differential type flow element and low flow switch. Flow switch and element assembly shall be installed as per manufacturer’s recommendation.

2.03 CONTROL SYSTEMS

A. General: See Section 40 99 90, Package Control Systems, 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 Control Systems.

B. Commission-Supplied Controls: Commission shall provide programming and controls for interface between the polymer systems and filter press systems, including switching for swing units.
C. Panels:
   1. Provide a skid mounted control panel.
   2. Material: Anodized aluminum or Type 316 stainless steel.
   3. NEMA Rating: 4X.

D. Operator Controls and Indicators: Provide the following panel mounted operator controls and indicators:
   2. Pump Speed Indicator.
   3. Potentiometer (to adjust pump speed in Internal Mode).

E. External Interfaces
   1. Analog Input(s): Pump speed adjustment.
   2. Discrete Input(s): System RUN command.
   3. Discrete Output(s):
      a. Common alarm for:
         1) Loss of water flow alarm.
         2) Feed pump failure alarm.
         3) Mixer motor failure alarm.
      b. System ON status.
      c. In remote status.
   4. Analog Output:
      a. Polymer pump flow rate.

F. Functional Requirements
   1. When in Remote, unit runs in response to external System RUN command.
   2. When in Remote, pump speed is adjusted in response to external pump speed adjust signal.
   4. Activate loss of water flow alarm if Low Flow of dilution water is sensed for a preset time (initial setting, 15 seconds).

2.04 ELECTRICAL

A. Wiring:
   1. Provide wiring between pump controller’s termination enclosure, solenoid valves, pressure switches, and the pumps.
   2. Provide circuit breakers and controllers for each pump.
   3. One 480V ac, 15-amp power feed will be brought to the polymer unit.
4. Wiring shall be in conduit.
5. Provide device fusing/circuit breakers as required.
6. Drives and solenoid valves shall be powered from the polymer blend unit.
7. Fuses and circuit breakers shall be housed in each respective control panel, which shall be NEMA 4X.

2.05 ACCESSORIES

A. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. Plate shall bear 1/4-inch die-stamped equipment identification name indicated in this specification and/or as shown on Drawings.

B. Lifting Lugs: Equipment over 100 pounds in weight shall be provided with lifting lugs.

C. Graduated cylinder calibration kits complete with necessary control valves, connective tubing and fittings shall be furnished for each polymer feed system. Calibration columns shall be sized (capacity) as recommended by the polymer feed equipment manufacturer.

D. Pressure Relief Valve: Adjustable relief valve set at 100 psig for installation on polymer solution pipeline.

2.06 FACTORY TESTS

A. Shop Test: Each unit shall be shop-tested prior to shipment from the manufacturer’s factory prior to installation. Owner may, at its discretion, choose to witness the shop performance test.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Manufacturer of polymer feed equipment shall furnish a qualified representative who shall supervise installation of equipment, check for proper mounting, assembly, mechanical adjustment, lubrication, proper control sequencing, general functioning of equipment, and quality of workmanship. Polymer feed equipment shall be installed in strict conformance with manufacturer’s recommendations.

B. Polymer equipment shall meet the requirements of applicable industrial standards or specifications as to design, construction, and performance.

C. Polymer feed system shall be installed to conform to general layout and alignment shown on Drawings.
3.02 PAINTING

A. All equipment shall be painted with manufacturer’s standard painting system for corrosive service.

3.03 MANUFACTURERS’ SERVICES

A. A manufacturer’s representative for equipment specified herein shall be present at Job Site and/or classroom designated by Owner for the minimum person-days listed for services hereunder, travel time excluded:

1. 2 person-days for installation assistance, inspection, certification of installation, and functional and performance testing.
2. 1 person-day for pre-startup classroom or Job Site training.
3. 1 person-day for startup services.

3.04 FIELD TESTING

A. Test in accordance with general requirements in the UCOR-4931, Outfall 200 Mercury Treatment Facility Startup Test Plan.

1. Preliminary Test
   a. Demonstrate Valve Operation:
      1) Check operation of OPEN/CLOSED indication lights at PLC.
      2) Open and close valves through full range and verify valve operation in manual and automatic modes. In remote mode, demonstrate that valves open and close in response to a PLC signal.
   b. Check Electrical and Operator Controls:
      1) HAND/OFF(COMPUTER) selector switch.
      2) Verify indicating lights.
      3) Stroke length adjustment
      4) Unit responds to 4-20 mA signal.
         a) Test unit for a continuous 30-minute period without malfunction under simulated operating conditions. During this operating period, the pumps shall obtain suction from the chemical storage tanks, but the Contractor shall direct the discharge to a suitable clean container for collection of the chemical. Chemical shall then be returned to the chemical storage tanks or disposed of at the direction of Owner. During the test, record the following:
         b) Neat polymer flow rate.
         c) Dilution water flow rate.
3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.

1. Polymer Feed System Data Sheets.

END OF SECTION
POLYMER FEED SYSTEM DATA SHEET, 44 44 63.01-1

Tag Numbers: CHEM-P-511-A, B, C

Pump Name: Flocculant Polymer Metering Pump A, B, C

Manufacturer and Model Number: (1) ProMinent  
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and %): Emulsion Polymer (Nalco Nalclear 7763), 100%
Pumping Temperature (Fahrenheit): Normal: 70     Max 90     Min 50
Liquid pH: 8       Liquid Specific Gravity: 1.05
Liquid Viscosity, Neat @ 68 F (cP): 1200
Liquid Viscosity, 0.5% Solution @ 68 F (cP): 200
Abrasive (Y/N) N_____   Possible Scale Buildup (Y/N): N_____
Suction Pressure (psig): Minimum -5____
Altitude (ft msl): 850     Area Classification: N/A     Location (indoor/outdoor): Indoor

SYSTEM PERFORMANCE REQUIREMENTS

Dilute Solution Range (US gph): 3 - 25
Neat Chemical Rated Capacity: 0.12 US gph at 65 psi differential pressure
Neat Chemical (US gph): 0.01 – 0.12
Speed Range: 10% to 110% of Rated Speed  Constant Torque (Y/N): ______

DESIGN AND MATERIALS

Pump Type: Peristaltic
Wet End Material: 316 Stainless Steel     Housing Material: Coated Carbon Steel
Check Valve Material: CPVC     Configuration (Single/Double): As recommended
Hose Material: FKM
Calibration Cylinder: Quantity: 3     Material: Clear CPVC
Units: Gal and L     Capacity: As recommended
Diaphragm Actuation Type: Mechanical X   Hydraulic
Stroke Position Adjustment: Manual _______   Automatic X _______________
Pump Speed Control: Constant ___________   Variable X ______________
DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120 Phase: 1 Synchronous Speed (rpm) 1800
Service Factor: 1.15

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y
Field Functional (Y/N) Y Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) Y Other

REMARKS

The discharge of pumps A, B and C are to be interconnected with isolation valves to allow Pump B to serve as backup for Pump A or C.
POLYMER FEED SYSTEM DATA SHEET, 44 44 63.01-2

Tag Numbers: CHEM-P-512-A, B, C

Pump Name: Filter Aid Polymer Metering Pump A, B, C

Manufacturer and Model Number: (1) Seepex MD 003-12
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Polymer (BASF Magnafloc LT-7991), 100%
Pumping Temperature (Fahrenheit): Normal: 70___ Max 90___ Min 50_____
Liquid pH: 6___ Liquid Specific Gravity: 1.14
Liquid Viscosity, Neat @ 68 F (cP): 7500
Liquid Viscosity, 0.5% Solution @ 68 F (cP): 25
Abrasive (Y/N) N _____ Possible Scale Buildup (Y/N): N _____
Suction Pressure (psig): Minimum -5____
Altitude (ft msl): 850 Area Classification: N/A Location (indoor/outdoor): Indoor

SYSTEM PERFORMANCE REQUIREMENTS

Dilute Solution Rated Capacity: 90 US gph at 65 psi differential pressure
Dilute Solution Range (US gph, dilute solution): 20 - 90
Neat Chemical Rated Capacity: 0.50 US gph at 65 psi differential pressure.
Neat Chemical (US gph): 0.10 – 0.50
Max. Pump Speed (rpm): ______ Constant (Y/N): N _____ Adjustable (Y/N): Y
Speed Range: 10% to 110% of Rated Speed
Constant Torque (Y/N): ____________________________

DESIGN AND MATERIALS

Pump Type: Progressing Cavity
Pump Body Material: Carbon Steel ______ Drive Housing Material: Carbon Steel ______
Pump Stages: Per Mgf.
Connections: Per polymer feed system manufacturer
  Suction: Flanged: _____ Flange Type: ___Open-Throat: ___Screwed: ______
  Discharge: Flanged: ___ Flange Type: ___Screwed: ______
Suction Port: Per polymer feed system manufacturer
Stator Material: EPDM ______ Stator Thermal Protection (Y/N): Y ______
Dry Run Capable (Y/N): Y
Rotor Material: Chrome plated stainless steel
POLYMER FEED SYSTEM DATA SHEET, 44 44 63.01-2

Tag Numbers: CHEM-P-512-A, B, C

Connecting Rod Material: Stainless Steel  Drive Shaft Material: Stainless Steel
Joints: Gear Type Universal (Y/N): _____  Pin Type Universal (Y/N): Y  Other: ______
Shaft Sleeve (Y/N): Y  Material: Stainless Steel
Calibration Cylinder: Quantity: 3  Material: Clear CPVC
Units: Gal and L  Capacity: Per polymer feed system manufacturer

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____  Voltage: 120  Phase: 1  Synchronous Speed (rpm) 1800
Service Factor: 1.15
Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.
Enclosure: DIP _____  EXP _____  ODP _____  TEFC X  CISD-TEFC _____
TENV _____  WPI _____  WPII _____  SUBM _____
Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

TESTING

Pump Tests: Factory Functional (Y/N) Y  Factory Performance (Y/N) Y
Field Functional (Y/N) Y  Field Performance (Y/N) Y
Motor Test: Short Commercial (Y/N) Y  Other

REMARKS

The discharge of Pumps A, B and C are to be interconnected with isolation valves to allow
Pump B to serve as backup for Pump A or C.
POLYMER FEED SYSTEM DATA SHEET, 44 44 63.01-3

Tag Numbers: CHEM-P-513-A, B

Pump Name: Thickening Aid Polymer Pump A, B

Manufacturer and Model Number: (1) Seepex MD 003-12
(2) Or Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Inverse Emulsion Polymer (BASF Zetag 8844FS), 100%

Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 50

Liquid pH: 4 Liquid Specific Gravity: 1.03

Liquid Viscosity, Neat @ 68 F (cP): 1000

Liquid Viscosity, 0.5% Solution @ 68 F (cP): 600

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum -5

Altitude (ft msl): 850 Area Classification: N/A Location (indoor/outdoor): Indoor

SYSTEM PERFORMANCE REQUIREMENTS

Dilute Solution Rated Capacity: 300 US gph at 65 psi differential pressure.

Dilute Solution Range (US gph, dilute solution): 40 - 300

Neat Chemical Rated Capacity: 1.8 US gph at 20 psi differential pressure.

Neat Chemical (US gph): 0.20 – 1.8


Speed Range: 10% to 110% of Rated Speed

Constant Torque (Y/N): ______________________

DESIGN AND MATERIALS

Pump Type: Progressing Cavity

Pump Body Material: Carbon Steel Drive Housing Material: Carbon Steel

Pump Stages: Per Mgf.

Connections: Per polymer feed system manufacturer

Suction: Flanged: _____ Flange Type: ______ Open-Throat: ______ Screwed: ______

Discharge: Flanged: _____ Flange Type: ______ Screwed: ______

Suction Port: Per polymer feed system manufacturer

Stator Material: FKM or FPM Stator Thermal Protection (Y/N): Y

Dry Run Capable (Y/N): Y
POLYMER FEED SYSTEM DATA SHEET, 44 44 63.01-3

Tag Numbers: CHEM-P-513-A, B

Rotor Material: Chrome plated stainless steel

Connecting Rod Material: Stainless Steel

Drive Shaft Material: Stainless Steel

Joints: Gear Type Universal (Y/N):

Pin Type Universal (Y/N): Y

Other:

Shaft Sleeve (Y/N): Y

Material: Stainless Steel

Calibration Cylinder: Quantity: 2

Material: Clear CPVC

Units: Gal and L

Capacity: Per polymer feed system manufacturer

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 
Voltage: 120
Phase: 1
Synchronous Speed (rpm) 1800

Service Factor: 1.15

Motor nameplate horsepower shall not be exceeded at any head-capacity point on
pump curve.

Enclosure: DIP EXP ODP TEFC X CISD-TEFC

TENV WPI WPII SUBM

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency
Drive System.

TESTING

Pump Tests: Factory Functional (Y/N) Y

Factory Performance (Y/N) Y

Field Functional (Y/N) Y

Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) Y

Other

REMARKS

The discharge of Pumps A and B are to be interconnected with isolation valves to allow

either pump to serve as backup for the other pump.