CONTRACT DOCUMENTS
AND
SPECIFICATIONS
FOR
PROJECT NO. TMUA-W 18-19

AB JEWELL WATER TREATMENT PLANT
CLARIFIER NO. 2 IMPROVEMENTS

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

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CITY OF Tulsa
A New Kind of Energy

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TECHNICAL SPECIFICATIONS
VOLUME II con't

CITY OF TULSA

TULSA, OKLAHOMA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

A.B. JEWELL WATER TREATMENT PLANT
CLARIFIER 2 IMPROVEMENTS

Project No. TMUA-W 18-19

VOLUME II con't
DIVISIONS 31 THROUGH 49

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JACOBS

Tulsa, Oklahoma

April 2021

Project No. WFXQ2600 Copy No. _____

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B. Luke Lenard

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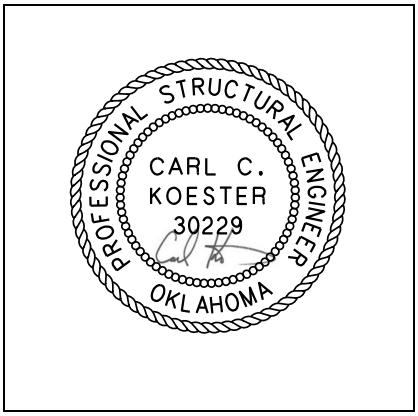

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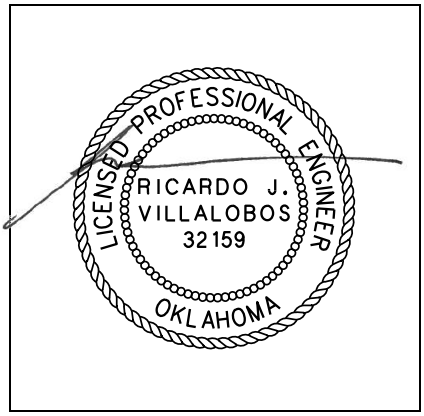

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SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

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

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

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

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

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

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

1.02 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. Contractor is responsible for preparing Stormwater Pollution Prevention Plan (SWPPP), procuring associated permit, and installing and maintaining SWPPP required controls.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

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

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

3.02 LIMITS

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

1. Excavation Excluding Trenches: 5 feet beyond top of cut slopes.
2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
3. Structures: 10 feet outside of new structures.
4. Other Areas: As shown.

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

3.03 CLEARING

A. Clear areas within limits shown or specified.

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

3.04 GRUBBING

A. Grub areas within limits shown or specified.

3.05 SCALPING

A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.

B. Scalp areas within limits shown or specified.

3.06 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stockpile strippings, for topsoil, separately from other excavated material.

3.07 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite.
2. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).

1.02 DEFINITIONS

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

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

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

D. Subgrade: Layer of existing soil after completion of clearing, grubbing, roadway structure or base for floor slab.

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

F. Weathered Shale: Firm unyielding native bedrock, commonly grey in color. Underlies Highly Weathered Shale.

G. Highly Weathered Shale: highly weathered native bedrock, commonly tan in color, with properties resembling stiff clay.

H. Concrete Seal Slab: thin covering of exposed subgrade with concrete to protect subgrade from ponding of water and disturbance from construction activities.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

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

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

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

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

3.02 COMPACTION

A. Under Structure, Floor Slabs, or Structural Fill under Structures: Proof-roll the subgrade with a loaded dump truck or similar heavy-wheeled vehicle to detect soft or loose zones. Notify the Engineer prior to commencement of proof-rolling.

1. If soft or loose zones are found under footings or slabs, excavate the soft or loose material to a depth accepted by the Engineer, then fill with Structural Fill compacted as specified for such fill.
2. If soft or loose materials are found under fills or roads, excavate the soft or loose material to a depth accepted by the Engineer, then fill and compact as specified for the overlying fills or roads.

B. Under Earthfill: Compact upper 8 inches to minimum of 90 percent relative compaction and with moisture content within 2 percentage points of optimum water content as determined in accordance with ASTM D698.

C. Under Structural Fill: Compact upper 8 inches to minimum 98 percent relative compaction and with moisture content within 2 percentage points of optimum water content as determined in accordance with ASTM D698.

D. Under Granular Fill: Compact upper 8 inches to minimum 98 percent relative compaction and with moisture content within 2 percentage points of optimum water content as determined in accordance with ASTM D698.

E. Where subgrade is undisturbed Weathered Shale Bedrock free from soft or loose material and acceptable to the Engineer, compaction of bedrock surface is not required.

F. Where subgrade beneath structures, foundations, or floor slabs exposes Weathered Shale Bedrock, carefully remove disturbed shale material to expose intact native shale. Trim to neat lines. Do not compact disturbed shale.

G. If soft or loose zones are found under footings or slabs founded on soil or Highly Weathered Shale Bedrock, excavate the soft or loose material to a depth accepted by the Engineer, then fill with Structural Fill compacted as specified for such fill.

H. If soft or loose zones are found under footings or slabs founded on Weathered Shale Bedrock, excavated soft or loose material to a depth accepted by the Engineer, then fill with Concrete Fill.

I. Under Pavement: Road subgrade shall be compacted to at least 100 percent of the maximum dry density. Determine the moisture content of the material at the beginning and during compacting.

3.03 SUBGRADE PROTECTION

A. Do not allow water to pond on subgrade.

B. Do not allow subgrade to dry out. Prevent slaking or deterioration by maintaining a moist condition at all times. Corrective action for deteriorated subgrade shall be repaired at the Engineer’s direction at the Contractor’s sole expense.

3.04 MOISTURE CONDITIONING

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

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

3.05 TESTING

A. The Contractor shall retain an independent soil testing company to determine in-place density and moisture content.

B. One test per every 5,000 square feet on every lift of subgrade; or one test per lift, whichever requires more tests.

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

3.06 CORRECTION

A. Soft or Loose Subgrade:

1. Where Subgrade is Native Soil: Adjust moisture content and recompact.
2. Where Subgrade is Shale: Over excavated soft or loose material to undisturbed native material acceptable to the Engineer.
3. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material, as specified in Section 31 23 23, Fill and Backfill.

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

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

B. Monitor potential adverse impacts on adjacent facilities and completed work.

1.02 WEATHER LIMITATIONS

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

1.03 SEQUENCING AND SCHEDULING

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

B. Sheeting and Shoring: Conform to applicable requirements of Section 31 41 00, Shoring.

1.04 EXCAVATION SAFETY

A. The Contractor shall be solely responsible for making all excavations in a safe manner. Provide appropriate measures as necessary to retain excavation sideslopes and prevent slope failure to ensure that persons working in or near the excavation are protected.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

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

B. Do not overexcavate without written authorization of Engineer.

C. Conduct excavation in accordance with OSHA Standards 29CFR Part 1926.650 Subpart P. Trenching and Excavation regulations and requirements.

D. Prevent loss or loosening of existing backfill or subgrade materials beneath existing foundations, except where limited removal of these materials is required to complete the work. Do not create voids or overhangs. Notify Engineer immediately if such voids are created.

E. Sludge Pump Station and Raw Water Control Vaults:

1. Existing Sludge Pump Station No. 2 and Raw Water Controller Vaults are not to be used as shoring to finish grade. Refer to Section 31 41 00, Shoring, for excavation requirements.

3.02 UNCLASSIFIED EXCAVATION

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

B. Make own estimate of the kind and extent of the various materials to be excavated in order to accomplish the Work.

C. Excavation of shale bedrock will require large backhoes equipped with rock teeth or a single-tooth ripper behind a large bulldozer.

D. Blasting is not permitted.

3.03 STRUCTURAL EXCAVATION

A. Excavate for structures to the lines and grades shown or as required to accomplish the construction. Perform all excavation regardless of the type, nature, or condition of the material encountered. The method of excavation used is optional; however, no equipment shall be operated within 5 feet of existing structures or newly completed construction. Excavation that cannot be accomplished without endangering the present or new structures shall be done with hand tools.

3.04 LIMITS OF EXCAVATION

A. Excavate to the depths and widths, specified or necessary to complete the Work. Allow for forms, working space, granular fill under facilities, and finish topsoil as shown or required. Do not carry excavation for footings and slabs deeper than the elevation shown. Excavation carried below the lines and grades shown or established by the Engineer shall be replaced with the same fill material as specified for the overlying fill or backfill, and compacted as required for such overlying fill or backfill. Where the overlying area is not to receive fill or backfill, replace the overexcavated material and compact to a density not less than that of the underlying ground. Excavations under footings shall be filled with concrete of strength equal to that of the footing. Cuts below grade shall be corrected by similarly cutting adjoining areas and creating a smooth transition. Correct all overexcavated areas at Contractor's sole expense.

3.05 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Four-Inch and Greater Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between them, as shown on Drawings.

3.06 EMBANKMENT AND CUT SLOPES

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

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

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

3.07 STOCKPILING EXCAVATED MATERIAL

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

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

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

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

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

3.08 DISPOSAL OF SPOIL

A. Dispose of unsuitable or excess soil off-site at a location arranged by the Contractor.

END OF SECTION

SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Quality Control Submittals:

1. Copies of any authorization and permits required to perform Work.
2. Dewatering plans.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall be responsible for design, installation, and operation of a dewatering system to keep excavations free of water. The dewatering system shall be designed and signed and sealed by a professional geotechnical engineer registered in the State of Oklahoma.

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

3.02 SURFACE WATER CONTROL

A. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

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

B. For excavations and trenches dewatering systems shall include wells or well points, and other equipment and appurtenances installed outside limits of excavations and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation.

C. Design and Operate Dewatering Systems:

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

3.04 DISPOSAL OF WATER

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

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

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

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

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D75, Standard Practice for Sampling Aggregates.
   b. D422, Standard Test Method for Particle-Size Analysis of Soils.
   c. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   d. D2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   e. D3740, Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   f. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   g. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   h. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.02 DEFINITIONS

A. Relative Compaction:

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

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

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

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

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

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

G. Well-Graded:

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

H. Influence Area:

1. Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
   a. 1-foot outside outermost edge at base of foundations or slabs.
   b. 1-foot outside outermost edge at surface of roadways or shoulder.
   c. 0.5-foot outside exterior at spring line of pipes or culverts.

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

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

1.03 SUBMITTALS

A. Samples: Imported material taken at source.

B. Information Submittals:

1. Certification, test results, source, and samples for all imported material.
2. Copies of permits obtained for excavation, etc., that are required by state and local governing authorities.

3. Name, address, and qualifications of the Inspection and Testing Laboratory in conformance with ASTM D3740.
4. Results of all laboratory and field tests.

1.04 INSPECTION AND TESTING LABORATORY

A. The Contractor shall be responsible for hiring and Inspection and Testing Laboratory to perform all earthwork quality control tests, including, but not limited to determination of moisture density relationships, minimum/maximum densities, grain size distribution, in-place density, moisture content, and percent compaction measurements and calculations. The Independent Testing Laboratory shall be an independent testing agency that meets the requirements specified in ASTM D3740 and shall be approved by the Engineer.

1.05 IMPORTED MATERIAL ACCEPTANCE

A. All imported materials specified in this section are subject to the following requirements:

1. All tests necessary for the Contractor to locate and acceptable material shall be made by the Contractor. Certification that the material conforms to the Specification requirements along with copies of the test results from a qualified commercial testing laboratory shall be submitted to the Engineer for approval at least 20 days before the material is required for use. All material samples shall be furnished by the Contractor at the Contractor's sole expense. Samples shall be representative and clearly marked to show the source of the material and the intended use on the project. Sampling of the material source shall be done by the Contractor in accordance with ASTM D75. Notify the Engineer at least 48 hours prior to sampling. The Engineer may, at the Engineer's option, observe the sampling procedures. Tentative acceptance of the material source shall be based on an inspection of the source by the Engineer and/or the certified test results submitted by the Contractor to the Engineer, at the Engineer's discretion. No imported materials shall be delivered to the site until the proposed source and materials tests have been tentatively accepted in writing by the Engineer. Final acceptance will be based on tests made on samples of material taken from the completed and compacted course.
2. Gradations tests by the Contractor shall be made on samples taken at the place of production prior to shipment. Samples of the finished product for gradation testing shall be taken from each 400 cubic yards of prepared materials or more often as determined by the Engineer, if variation is observed, or if the material appears to depart from the

Specifications. Test results shall be forwarded to the Engineer within 48 hours after sampling.

3. If tests conducted by the Contractor or the Engineer indicate that the material does not meet Specification requirements, material placement will be terminated until corrective measures are taken. Material which does not conform to the Specification requirements and is placed in the work shall be removed and replaced at the Contractor's sole expense. Sampling and testing performed by the Contractor shall be done at the Contractor's sole expense.

1.06 QUALITY ASSURANCE

A. Notify Engineer when:

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

1.07 SEQUENCING AND SCHEDULING

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

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 10, Structural Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 10, Structural Concrete.

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

1.08 STANDARD SPECIFICATIONS

A. Standard Specifications, where referenced in this section, shall mean the current edition of the Standard Specifications for Highway Construction, Oklahoma Department of Transportation. Parts of these Standard Specifications that are specifically referenced shall become a part of this section as though stated herein in full. In case of a discrepancy between the

requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all labor, materials, and equipment necessary to accomplish the Work specified in this section.

2.02 SOURCE QUALITY CONTROL

A. Gradation Tests: By Contractor's testing laboratory, as necessary to locate acceptable sources of imported material.

B. Samples: Collected in accordance with ASTM D75: During production of imported material, provide samples of granular fill.

2.03 TOPSOIL

A. Selected topsoil at the site, properly stored and protected, free from roots, sticks, hard clay, and stones which will not pass through a 1-inch square opening. Remove existing grass and overburden before topsoil is excavated. Provide imported topsoil of equal quality if required to accomplish the work.

2.04 EARTHFILL

A. Excavated material free from rocks and clay balls larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Provide imported material of equivalent quality, if required to accomplish Work.

2.05 STRUCTURAL FILL

A. Nonexpansive, well-graded, granular material with maximum particle size of 2 inches; free of organic matter, trash, debris, and other deleterious materials; with less than 35 percent by weight of fines and with a plasticity index less than 18 when tested in accordance with ASTM D4318. Material conforming to the Standard Specifications Section 703.01, Grading A, B, or C, are acceptable.

B. Re-use of existing structural fill is permitted pending Engineer's review. Contractor shall submit test results Engineer demonstrating conformance with this specification. Otherwise, structural fill shall be imported.

C. Shale is not permitted within structural fill.

2.06 GRANULAR FILL

A. Granular fill shall conform to the granular backfill specified in the Standard Specification Section 703.07, but with less than 8 percent fines, by weight.

B. Shale is not permitted in granular fill.

C. Granular fill is not available onsite, and shall be imported.

2.07 DRAIN GRAVEL

A. Drain Gravel shall be crushed rock or crushed gravel suitable for use as a free draining subbase beneath slabs and foundations, and conforming to Coarse Cover Aggregate specified in Standard Specification Section 703.06.

B. Drain gravel is not available onsite and shall be imported.

2.08 WATER FOR MOISTURE CONDITIONING

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

B. Equipment used for applying water shall be of a type and quality adequate for the work, shall not leak, and shall be equipped with a distributor bar or other approved device to assure uniform application. Equipment for mixing and drying out material shall consist of blades, discs, or other approved equipment.

2.09 LEAN CONCRETE MUD MAT

A. Lean Concrete Mud Mat shall be as specified in Section 03 30 10, Structural Concrete, placed where indicated on Drawings.

2.10 FLOWABLE FILL

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

B. Materials:

1. Cement: ASTM C150/C150M, Type I or Type II.
2. Aggregate: ASTM C33/C33M, Size 7.

3. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
   a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.

PART 3 EXECUTION

3.01 GENERAL

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

B. Do not place materials when frozen or if surface upon which materials are to be placed is frozen.

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

D. During filling and backfilling, keep level of fill and backfill around each structure even.

E. If Pipe, Conduit, Duct Bank, or Cable is to be laid within fill or backfill:

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

F. Tolerances:

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

G. Settlement:

1. Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.
2. Any subsequent damage to slabs, piping, concrete structures, facilities, or other structures caused by settlement of fill material shall be corrected and repaired by the Contractor at the Contractor's sole expense.

3.02 BACKFILL UNDER FACILITIES

A. Structural Fill:

1. Within influence area beneath structures, slabs, pavements, curbs, trenches for piping, conduits, duct banks, and other facilities, backfill with structural fill, unless otherwise shown.
2. Include allowance for granular fill as specified hereinafter.
3. Place in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D698 and within two percentage points of the optimum water content.

B. Granular Fill Under Structures:

1. Place a minimum of 6 inches of compacted granular fill material beneath all foundations and slabs, unless otherwise shown.
2. Place material in horizontal lifts not more than 6 inches thick, moisture condition material as required for proper compaction, and compact with vibratory plate compactor to at least 98 percent relative compaction.

C. Concrete Fill:

1. Fill voids or overhangs which are created by excavation adjacent to existing foundations with concrete fill.
2. Notify the Engineer at least 24 hours before placing backfill in voids, Engineer may choose to observe backfill placement.
3. Remove loose material and completely fill voids beneath foundation to restore support to entire foundation.
4. Coordinate with placement of structural fill, granular fill, and drain gravel as required to complete the work.

3.03 BACKFILL NOT UNDER STRUCTURES OR FACILITIES

A. Backfill Around Structures:

1. Backfill excavation around all structures with granular fill, to a minimum distance of one-half of the total embedded height from the footing, or as shown. Stop granular fill 2 feet below finish grade and complete overlying 2 feet to finish grade with earthfill as specified hereinafter. Place granular fill in maximum 6-inch loose lifts and compact each lift to not less than 95 percent relative compaction, as determined by ASTM D698 and within 2 percentage points of the optimum water content.
2. Place hereinbefore specified earthfill in all areas around structures not designated to be granular fill. Deposit earthfill in horizontal lifts less than 6 inches loose thickness, and compact each lift to not less than 95 percent relative compaction as determined by ASTM D698 and within 2 percentage points of the optimum water content.

B. Backfill Not Around Structures: Place earthfill to the lines and grades shown. Place earthfill material in maximum 8-inch lifts and compact each lift to not less than 95 percent relative compaction. Make proper allowance for topsoil, surfacing, and slope protection, where applicable.

3.04 COMPACTION

A. Compact all materials by mechanical means. Flooding or jetting will not be permitted. If compaction tests indicate that compaction or moisture content is not as specified, material placement shall be terminated and corrective action shall be taken by the Contractor prior to continued placement.

3.05 MOISTURE CONTROL

A. During all compaction operations, maintain optimum practicable moisture content required for compaction purposes in each lift of fill. Maintain moisture content uniform throughout the lift. Insofar as practicable, add water to the material at the site of excavation. Supplement, if required, by sprinkling the fill. At the time of compaction, the water content of the material shall be at the optimum water content, plus or minus 2 percentage points, or as specified.

B. Do not attempt to compact fill material that contains excessive moisture. Aerate material by blading, discing, harrowing, or other methods to hasten the drying process.

3.06 SITE TESTING

A. Samples for all tests shall be collected in accordance with ASTM D75 from different locations or truck loads. Notify the Engineer prior to sampling. The Engineer may, in the Engineer's option, observe the sampling procedures.

1. Perform at a minimum, two laboratory compaction or minimum/maximum density tests for each different soil material used. Additional tests shall be performed when variations in materials occur, or when requested by the Engineer. For soil with more than 3 percent fines, perform laboratory compaction tests in conformance with ASTM D698. If good compaction curves cannot be developed with this method, perform additional minimum/maximum density tests in conformance with ASTM D4253 and ASTM D4254. For soil with less than 6 percent fines, perform minimum/maximum tests in conformance with ASTM D4253 and ASTM D4254.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. Gradation:

1. Gradation tests shall be made for each 400 cubic yards increment of material placed or more often as determined by the Engineer, if variation in gradation is occurring, or if the material appears to depart from Specifications. In addition, perform a gradation test on each sample tested for laboratory compaction or minimum/maximum density. Gradation tests shall be in conformance with ASTM D422. In addition, for structural fill perform an Atterberg Limits test in accordance with ASTM D4318 for each gradation test.
2. Additional laboratory tests may be requested by the Engineer.
3. Written test results shall be forwarded to the Engineer within 24 hours after completion of the test or 3 days after sampling, whichever is less.

C. In-Place Density Tests:

1. In-place density and moisture content in accordance with ASTM D2922. The minimum frequency of testing shall be one test per day per material type placed per structure and area worked, but not less than one test for each 200 cubic yards of material placed.
2. The Engineer may require additional testing of any lift or fill at any time, location, or elevation. The Engineer reserves the right to determine the location and method of testing.

3. Test results shall be forwarded to the Engineer within 24 hours after completion of the test. Results of all field tests shall be available on site at all times, for the Engineer's review.

3.07 PLACING TOPSOIL

A. After rough grading is completed and reviewed by the Engineer, spread topsoil hereinbefore specified, over entire graded area to a minimum compacted depth of 6 inches with surface elevations as shown. Loose the finished surface to a depth of 2 inches and leave in a smooth condition, free from depressions or humps, ready for seeding.

END OF SECTION

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   c. D2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

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

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

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

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

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

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

G. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.03 SUBMITTALS

A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Quality Control Submittals:

1. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Plastic:

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

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: Minimum 3 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.

7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

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

2.02 TRENCH STABILIZATION MATERIAL

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

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

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

2.04 EARTH BACKFILL

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

2.05 SOURCE QUALITY CONTROL

A. Contractor's testing laboratory to perform gradation analysis in accordance with ASTM C136.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe,

conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.

2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

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

3.02 TRENCH BOTTOM

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

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

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

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

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

3.04 BEDDING

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

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

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

D. Minimum Thickness: As follows:

1. Pipe, 15 Inches and Smaller: 4 inches.
2. Pipe, 18 Inches to 36 Inches: 6 inches.
3. Pipe, 42 Inches and Larger: 8 inches.
4. Conduit: 4 inches.

5. Direct-Buried Cable: 4 inches.
6. Duct Banks: 4 inches.

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

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

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

3.05 BACKFILL PIPE ZONE

A. Upper Limit of Pipe Zone shall Not be Less than Following:

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

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

C. Under Facilities: Concrete fill.

D. Place material simultaneously in 6-inch lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

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

E. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift. Compact the material in each lift to at least 95 percent of the maximum dry density as determined by ASTM D698.

F. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

G. Do not use power-driven impact compactors to compact pipe zone material.

3.06 MARKING TAPE INSTALLATION

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

1. Metallic Marking Tape: Install with nonmetallic piping and waterlines.
2. Plastic Marking Tape: Install with metallic piping.

3.07 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content to within 2 percentage points of optimum water content as determined by ASTM D698.
3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

B. Backfill Areas to be Seeded:

1. Place Earthfill in lifts not exceeding 8-inch thickness.
2. Mechanically compact each lift to a minimum of 90 percent of the maximum dry density as determined by ASTM D698 prior to placing succeeding lifts.

C. Backfill for Areas Under Facilities and Asphalt or Portland Concrete Paving: Backfill trench above pipe zone with structural fill in lifts not to exceed 6 inches. Compact each lift to a minimum of 95 percent of the maximum dry density as determined by ASTM D698 prior to placing succeeding lifts.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 4 inches of backfilled trench.

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

3.09 MAINTENANCE OF TRENCH BACKFILL

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

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

C. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified for asphalt concrete pavement.

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

3.10 SITE TESTING

A. Gradation:

1. One sample from each 150 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests:

1. In accordance with ASTM D2922. During placement of materials, test as follows:
   a. Granular Fill and Pipe Zone Fill: One test for every 300 feet of each lift; or one test per lift, whichever requires more tests.

3.11 SETTLEMENT OF BACKFILL

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

END OF SECTION

SECTION 31 23 24
COMPACTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

A. The most recent version of the following testing methods or standards shall be employed:

1. ASTM International (ASTM):
   a. C143, Test Method for Slump of Portland Cement Concrete.
   b. C150, Compliance Standard for Portland Cement.
   c. D344, Static Cone Penetration Testing (CPT).
   d. D1586, Standard Penetration Testing (SPT).
   e. D6432-11, Standard Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation.

B. Reference Documents:

1. This Specification.
2. Project Drawings.

1.02 DEFINITIONS

A. Ground Penetrating Radar (GPR): A device that transmits an electromagnetic pulse through the ground and displays the reflection on a screen for interpretation. The device shall meet the requirements as specified in ASTM D6432-11.

B. Compaction Grout: A material blend of fine aggregate, fines and water to achieve a pumpable, viscous grout of a low slump to enable pumping at high pressure and remain intact after injection. Material components shall include sand, cement, flyash, water and other ingredients. Strength of grout is designed only to be greater than existing strengthened soil conditions.

1.03 SCOPE OF WORK

A. General contractor shall retain a subcontractor specialized in conducting GPR scanning to locate voids under the slab and summarize the results in a report. Using the report, the Engineer will develop a grouting plan.

B. The grouting work shall consist of installation, monitoring and testing of compaction grouting within the limits of the grouting plan developed by Engineer.

C. In connection with the compaction grouting program, developed by the Engineer, the grouting contractor shall provide all labor, materials and equipment to accomplish the following items of work:

1. Locate the grout holes and core the concrete slab at grout hole locations
2. Implement ground/structure movement monitoring system.
3. Install and remove grout pipes.
4. Furnish and inject compaction grout.
5. Monitor surface ground/structure movements during compaction grouting operations.
6. Follow compaction grouting sequence of operations.

D. It shall be the grouting contractor's responsibility to determine and implement the systems and criteria to ensure that specified improvement is achieved.

1.04 SUBMITTALS

A. The following shall be submitted to the Engineer by the GPR and grouting contractor with the Bid Documents:

1. A list of at least five previously completed projects using GPR to scan concrete slab to locate underground voids.
2. A list of at least five previously completed grout injection projects of similar scope and purpose for approval by the Engineer. The list shall include a description of the project, relative size, and contact person with phone number.

B. The following shall be submitted to the Engineer by the GPR and grouting contractor 2 weeks prior to the start of the Work:

1. Resumes of the management, supervisory, and key personnel, for approval by the Engineer.
2. A ground movement monitoring plan.
3. A mix design for the project indicating sources and types of grout materials, with volumetric proportions, and field test data from previous projects indicating compressive strength achieved at a slump of less than 4 inches.
4. Work procedures and control criteria (including volumes and pressure for each stage).

C. The following shall be submitted to the Engineer by the GPR and grouting contractor during and after the Work:

1. A GPR scanning plan showing the locations and depths of the detected voids. Based on the scanning results, The Engineer will develop a grouting plan showing the grout hole locations and depths.
2. Accurate daily records of all grout pipe installation, compaction grouting quantities, including stage data, volume, pressure and depth for each grout pipe location.
3. Any change in the predetermined grouting program necessitated by a change in the subsurface conditions.

1.05 QUALITY ASSURANCE

A. The GPR scanning shall be conducted by a specialist with at least 5 years of experience in locating voids using GPR.

B. The compaction grouting program, including installation of grout pipes, shall be performed by a specialist grouting contractor with at least 10 years' continuous documented experience in compaction grouting.

C. The grouting contractor shall provide experienced management, supervisory and key personnel as required to implement the compaction grouting program, as follows:

1. The Project Manager shall have at least 5 years' continuous experience in compaction grouting, with at least the last 2 years in the full-time employ of the grouting contractor.
2. The superintendent shall have at least 5 years' experience in compaction grouting.
3. The grouting contractor shall provide:
   a. Evidence of previous compaction grouting project experience.
   b. Evidence of management, supervisory, and key personnel experience.

D. The Engineer will ensure that procedures and documentation conform to these specifications.

PART 2 PRODUCTS

2.01 GPR SCANNING

A. The GPR equipment shall meet the requirements as specified in ASTM D6432-11.

2.02 GROUTING EQUIPMENT

A. The grouting contractor shall supply equipment capable of advancing the grout pipe through subgrade soils, and other natural obstructions to the specified depth or as required to meet the project objectives.

B. The grouting contractor shall supply all equipment required to operate a compaction grouting system capable of supplying the specified grout at variable pressures, measured at the pump, up to 400 psi and at rates of 0.5 to 12 cubic feet per minute, as required to suit the application.

C. The mixer shall be a continuous auger type to ensure complete uniform mixing of the materials used and shall be of sufficient capacity to continuously provide the pumping unit with mixed grout at its normal pumping rate. The mixer must be capable of volumetrically proportioning the grout materials. Ready mixed grout is also acceptable with an approved mix design.

D. The grouting contractor shall provide gauges or other instrumentation (measuring devices) to measure:

1. Continuous grout pressure close to the top of the injection casing.
2. Flow rate of grout.
3. Volume of grout injected.

E. An adequate communication system shall be maintained between the pumping and batching plant and the injection location.

2.03 GROUT PIPES

A. Grout pipes and connections shall be steel casing of adequate strength to maintain the hole and to withstand the required jacking and pumping pressures. The pipes shall be at least 2.0 inches inside diameter in order to adequately handle the specified low slump material without plugging. All casing shall be flush joint threaded or a single piece tubing to provide a smooth inner wall and unobstructed inside diameter. It shall be the contractor’s responsibility to install casing that does not detrimentally impact the grouting procedure.

B. Pipes shall be installed such that grout material will not travel in the annulus area between the pipe and adjacent ground and escape at the surface when pumped.

2.04 GROUT MATERIALS

A. Portland cement (ASTM C150).

B. Fine aggregate shall be sand with a fines content (percent passing No. 200 sieve) of not less than 10 percent and not more than 30 percent. The maximum particle size shall be less than No. 4 sieve. Natural fines may be supplemented with Fly/ash, bentonite, or aggregate washings.

C. Proportions of the mixture shall be as required to achieve a pumpable mix with not more than a 4-inch slump with a 3-day unconfined minimum compressive strength of 400 psi.

D. Upon discharge into the pump hopper or holding tank, the grout must be continuously agitated. Mixed grout may not be held in the agitator for more than 1.5 hours unless using a set retarder, approved by the Engineer.

PART 3 EXECUTION

3.01 GPR SCANNING

A. Conduct the GPR scanning in accordance with the procedures specified in ASTM D-6432-11. The contractor shall submit a scanning plan to Engineer for approval before conducting the work.

B. At the completion of the scanning, contractor shall submit a report to Engineer summarizing the testing procedures and the locations of under slab voids, if detected. Based on the results, the Engineer will develop a grouting plan.

3.02 SITE EXAMINATION

A. Prior to submitting a bid price for the compaction grouting, the GPR and grouting contractors shall conduct a site inspection.

3.03 COMPACTION GROUTING

A. Compaction grouting shall be performed in accordance with the approved grout injection point layout scheme to achieve the following acceptance criteria in the in situ soil between the injection points:

1. Post-grouting average, Standard Penetration Test (SPT) blow count values exceeding 10 in the grouting zone as shown on Drawings. Locations to be agreed upon between the grouting contractor and the Owner/Engineer. Averaging shall be with values above and below each value.

B. The grout shall be injected at a stage depth until one of the following occurs:

1. Grout flow ceases at a header pressure reading of 400 psi.
2. Surface ground heave of 1 inch is observed.
3. An injected grout volume equal to 25 percent of the soil volume being treated by that injection stage is reached.

C. Contractor shall complete grouting at each grout hole before the end of the working hour.

3.04 FIELD QUALITY CONTROL

A. All GPR scanning shall be performed under the observation of Engineer

B. All compaction grouting shall be performed under the observation of Engineer.

C. Contractor shall monitor and log compaction grouting operations for both test areas and production Work.

D. Contractor shall perform slump tests of grout and take measurements of grout mix quantities to verify the grouting contractor's grout mix, as follows:

1. Slump Tests will be performed:
   a. Once for every 200 cubic feet of grout injected; or
   b. At any change in mix design; or
   c. At least twice during each grout shift.
2. Grout mix proportions will be checked at least once daily.

E. Contractor shall cast minimum size 3-inch by 6-inch grout test cylinders or 2-inch by 2-inch cube molds for strength testing. One set of four cylinders or molds will be cast during each slump test.

F. Layout of grout injection points shall be by the grouting contractor and checked by the Engineer.

G. Grouting contractor shall monitor nearby structures, and ground surface heaving as follows:

1. Monitoring shall be carried out on a continuing basis whenever compaction grouting is occurring within a horizontal distance equal to the depth of treatment.
2. After completion of the compaction grouting program, the monitoring system and grout pipes will be removed and all holes will be filled and patched.

3.05 TESTING AND INSPECTION

A. The effectiveness of the proposed grouting layout scheme shall be verified as follows:

1. The Contractor shall use a steel probe to locate and confirm the voids under the slab as directed by the Engineer. The probing shall be performed before and after the production work.
2. Based on the probing results, Engineer may request additional grouting be made at no additional mobilization cost to the Owner.

B. Contractor shall monitor and log compaction grouting operations and submit the results to Engineer.

3.06 RESTRICTIONS

A. The Specialty Contractor shall be responsible for obtaining any State and municipal permits (if required) and conforming to all State and local regulations.

END OF SECTION

SECTION 31 32 19.16
GEOTEXTILE

PART 1 GENERAL

1.01 REFERENCES

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

a. ASTM International (ASTM):

1) D737, Standard Test Method for Air Permeability of Textile Fabrics.
2) D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
3) D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
4) D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
5) D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
6) D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
7) D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
8) D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
9) D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
10) D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
11) D4886, Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
12) D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
13) D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
14) D6193, Standard Practice for Stitches and Seams.

1.02 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

G. Standard Specifications: When referenced in this section, shall mean the current edition of the Standard Specifications for Highway Construction, Oklahoma Department of Transportation. Parts of these Standard Specifications that are specifically referenced shall become a part of this section as though stated herein in full. In case of a discrepancy between the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer material specifications and product literature.
   b. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
   c. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
2. Samples:
   a. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.

b. Field Sewn Seam: 5-foot length of seam, 12 inches wide with seam along center, for each type and weight of geotextile.
c. Securing Pin and Washer: One each.

B. Informational Submittals:

1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.
2. Field seam efficiency test results.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

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

1.05 SCHEDULING AND SEQUENCING

A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation, first.

B. Notify Engineer whenever geotextiles are to be placed. Do not place geotextile without Engineer's approval of underlying materials.

PART 2 PRODUCTS

2.01 WOVEN GEOTEXTILE

A. Composed of polymeric yarn interlaced to form planar structure with uniform weave pattern.

B. Calendared or finished so yarns will retain their relative position with respect to each other.

C. Polymeric Yarn: Long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

D. Sheet Edges: Selvaged or finished to prevent outer material from separating from sheet.

E. Unseamed Sheet Width: Minimum 6 feet.

F. Nominal Weight per Square Yard: 4 ounces per ASTM D5261.

G. Physical Properties: Conform to requirements in Standard Specifications Section 712.06 Filter Fabric For Silt Fence.

2.02 NONWOVEN GEOTEXTILE

A. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.

B. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.

C. Unseamed Sheet Width: Minimum 6 feet.

D. Nominal Weight per Square Yard: 4 ounces per ASTM D5261.

E. Nominal Thickness (mils): 60 per ASTM D5199.

F. Physical Properties: Conform to requirements in Table No. 1.

TABLE NO. 1
PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE

Property	Requirement	Test Method
Water Permittivity	1.0 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Vertical Waterflow Rate	140 gal/min/SF MinARV	ASTM D4491
Apparent Opening Size (AOS)	70-100 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength	160 lb, MinARV	ASTM D4632
Grab Elongation	50-90 percent, MaxARV	ASTM D4632
Puncture Strength	90 lb, MinARV	ASTM D4833

TABLE NO. 1
PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE

Property	Requirement	Test Method
Trapezoid Tear Strength	75 lb, MinARV	ASTM D4533
Ultraviolet Radiation Resistance	80 percent strength retention, MinARV after 500 hours	ASTM D4355

2.03 SEWING THREAD

A. Polypropylene, polyester, or Kevlar thread.

B. Durability: Equal to or greater than durability of geotextile sewn.

2.04 SECURING PINS

A. Steel Rods or Bars:

1. 3/16-inch diameter.
2. Pointed at one end.
3. With head on other end sufficiently large to retain washer.
4. Minimum Length: 12 inches.

B. Steel Washers for Securing Pins:

1. Outside Diameter: Not less than 1.5 inches.
2. Inside Diameter: 1/4 inch.
3. Thickness: 1/8 inch.

C. Steel Wire Staples:

1. U-shaped.
2. 10 gauge.
3. Minimum Length: 6 inches.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 SHEET ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

3.03 JOINTS

A. Unseamed Joints:

1. Overlapped.
2. Overlap, unless otherwise shown:
   a. Foundation/Subgrade Stabilization: Minimum 18 inches.
   b. Riprap: Minimum 18 inches.
   c. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
   d. Underdrains and Perimeter Drains: Minimum 24 inches.
   e. Other Applications: Minimum 12 inches.

B. Sewn Seams: Made wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam Efficiency:
   a. Minimum 70 percent.
   b. Verified by preparing and testing minimum of one set of nondestructive Samples per acre of each type and weight of geotextile installed.
   c. Tested according to ASTM D4884.
2. Types:
   a. Preferred: “J” type seams.
   b. Acceptable: Flat or butterfly seams.
3. Stitch Count: Minimum three to maximum seven stitches per inch.
4. Stitch Type: Double-thread chainstitch according to ASTM D6193.
5. Sewing Machines: Capable of penetrating four layers of geotextile.
6. Stitch Location: 2 inches from geotextile sheet edges, or more, if necessary to develop required seam strength.

3.04 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sandbags or other means approved by Engineer.

B. Secure Geotextile with Securing Pins or Staples:

1. Insert securing pins with washers through geotextile.

2. Securing Pin Alignment:
   a. Midway between edges of overlaps.
   b. 6 inches from free edges.
3. Spacing of Securing Pins:

Slope	Maximum Pin Spacing
Steeper than 3:1	2 feet
3:1 to 4:1	3 feet
Flatter than 4:1	5 feet

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
6. Where staples are used instead of securing pins, install in accordance with alignment and spacing above. Push in to secure geotextile firmly to subgrade.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify Engineer. Do not cover installed geotextile until after Engineer provides authorization to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way to completely envelope Drain Gravel to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After Drain Gravel is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 SILT FENCE APPLICATIONS

A. Install woven geotextile in one piece, or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

C. Securely fasten geotextile to wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

D. Promptly repair or replace silt fence that becomes damaged.

3.08 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

B. Repair Procedure:

1. Place patch of undamaged geotextile over damaged area and at least 24 inches in all directions beyond damaged area.
2. Remove interfering material as necessary to expose damaged geotextile for repair.
3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Engineer.

3.09 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in Engineer's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

END OF SECTION

SECTION 31 41 00
SHORING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals: Excavation support plan.

1.02 QUALITY ASSURANCE

A. Provide surveys to monitor movements of critical facilities.

1.03 DIFFERENTIAL EARTH LOADING

A. The existing Sludge Pump Station No. 2 and Raw Water Controller Vaults are subject to sliding if subjected to excessive differential earth loading. Requirements are provided herein to limit unbalanced earth loading to acceptable levels.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

B. Sludge Pump Station No. 2 and Raw Water Controller Vaults:

1. Do not use existing structure for shoring to existing grade.
2. Excavate existing backfill around entire perimeter of the structure to the elevation shown before advancing excavation to expose existing floor slab.
3. Protect existing facilities, adjacent property, and completed work.
4. Include discussion of excavation approach in Excavation Support Plan.
5. At Contractor's option: segregate backfill materials for reuse during final structure backfilling; otherwise backfill entire excavation with imported material as described in Section 31 23 23, Fill and Backfill.

3.02 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:

1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
2. Excavation plan for Sludge Pump Station and Raw Water Control Vaults incorporating minimum excavation requirements shown.
3. Design assumptions and calculations.
4. Methods and sequencing of installing excavation support.
5. Proposed locations of stockpiled excavated material.
6. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
7. Anticipated difficulties and proposed resolutions.

3.03 REMOVAL OF EXCAVATION SUPPORT

A. Remove excavation support in a manner that will maintain support as excavation is backfilled.

B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

C. Remove excavation support in a manner that does not leave voids in the backfill.

3.04 TRENCHES

A. For trench excavation exceeding 4 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and federal requirements.

END OF SECTION

SECTION 35 20 16.25
FABRICATED SLIDE GATES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA): C561, Fabricated Stainless Steel Slide Gates.
2. ASTM International (ASTM):
   a. A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
   c. A276, Standard Specification for Stainless Steel Bars and Shapes.
   d. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
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 and cylinder rod length to the stem or rod 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. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment associated therewith.
   d. Gate operator and stem calculations for each gate and service condition.
   e. Gate opening and closing thrust forces that will be transmitted to the support structure with operator at extreme positions and load.
   f. External utility requirements such as air, water, power, drain, etc., for each component.
   g. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
   h. Power and control wiring diagrams, including terminals and numbers.
   i. Performance Test Procedures.
   j. 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.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's written/printed installation instructions.
5. Routine maintenance requirements prior to plant startup.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
7. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
8. Service records for maintenance performed during construction.

1.04 SYSTEM DESCRIPTION

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

1.05 EXTRA MATERIALS

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

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

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

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 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 316L.
2. Bars and Shapes: ASTM A276, Type 316L stainless steel.
3. Fasteners: ASTM A276, F593, ASTM F594, GR2, Type 316 stainless steel.

2.04 PERFORMANCE REQUIREMENTS

A. Leakage shall not exceed 0.1 gallon per minute per foot of gate periphery under either seating or unseating head conditions.

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 concrete structures.
2. Style B: Downward acting type for wall surface mounting on concrete structures.

B. Guide Frames:

1. Stainless steel of one-piece design with gussets provided to accommodate unseating head. Sandwich type and two-piece guide designs are not acceptable. The portion of the wall-mounted frame, where the anchors penetrate, shall have a minimum thickness of 1/2 inch.
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 for stainless steel.
    b. Incorporate a replaceable, self-adjusting, UV-stabilized UHMW polyethylene seal with nitrile compression cord. Seal shall be mechanically fastened in the guide slot on both the upstream to downstream sides of the disc. No wedges, pressure pads or similar wedging devices are allowed.
    c. J-bulb, P-seals, or similar rubber seals are not acceptable.

3. Frame Invert: For flush bottom gate, furnish an EPDM insert to function as a seating surface for the gate disc.
   a. Weight: Not less than 13 pounds per linear foot for wall-mounted frames, and not less than 6.5 pounds per linear foot for channel-mounted inverts.
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 plate. 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.
3. The portion of the slide that engages the frame shall have a minimum thickness of 1/2-inch.

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. 2-inch minimum diameter, ASTM A276, Type 316 stainless steel.
2. Threads: Acme type with RMS surface roughness of 63 microinches or less on the flanks for manually operated gates and 32 microinches or less on the flanks for electrically operated gates. Extend threaded portion of stem 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 shall have dual stems. For downward opening weir type gates, locate stems near outside edges of gate.

F. Stem Guides: Type 316 stainless steel stem guides, mounted on fabricated wall brackets or mounted directly to the frame, and spaced so that L/r ratio of stem does not exceed 200. Guides mounted to the wall shall be adjustable in two directions.

G. Stem Covers:

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

H. Manufacturers:

1. Stainless Steel:
   a. Rodney Hunt Co.
   b. H. Fontaine, Ltd.
   c. Whipps, Inc.
   d. Hydro Gate Corp.
   e. Waterman.

I. No “or-equal” or substitute products will be considered.

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. Stainless steel input pinions with needle or ball bearings.
6. Lubrication: Furnish rising stem gates with an insert lubricator flange in lift, with grease fitting for greasing stem threads below stem nut.
7. Manual Operator Limit Switches:
   a. Mounted on an angle adjacent to stem and actuated through limit switch wands by stop collar.
   b. Single-pole, double-throw type, with contacts rated 5 amps at 120V ac.
   c. Provide two switches, one for gate full OPEN, and one for gate full CLOSED, where indicated.

B. Type 4, Electric Motor Operators:

1. 28-inch-high steel pedestal or direct yoke-mounted, totally enclosed weatherproof electric drive unit, and a totally enclosed gear box that operates a two-piece, bronze stem nut, which lifts the gate stem.
2. Gears: Heat treated alloy steel, supported throughout by antifriction ball or roller bearings and grease lubricated.
3. Automatic double-acting geared limit switches and double-acting torque switches.
   a. Gear directly to the operating gear train and shall be “in step” at all times, whether in motor or manual operation.
   b. Wire geared limit switches internally to stop the motor at the fully OPEN and fully CLOSED positions.
   c. Wire torque switches internally so that, in the event of a mechanical overload in either direction, the motor will be stopped.
4. Equip with side mounted handwheel for manual operation.
   a. Include an automatic clutch to positively disengage the handwheel at any time the drive motor control is energized.
   b. Design handwheel operator so that failure of the motorized gearing will not prevent hand operation of the gate.
5. Drive Unit:
   a. TENV, 480-volt, three-phase electric motor as specified in Section 26 05 01, Electrical, 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.
   b. Furnish motor enclosure with drainage and breathing holes.

c. Self-locking, with approximately 12 inches per minute gate travel speed, and a rated running torque equal to 20 percent of the motor starting torque at a rated running time of 5 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:

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

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

8. Manufacturers and Products:
   a. Flowserve Limitorque.
   b. No “or-equal” or substitute products will be considered.

C. Identification Tagging Requirements:

1. For each gate operator, 1-1/2-inch minimum diameter stainless steel or 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.

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.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each slide gate.

B. Performance Test:

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

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 1 person-day for installation assistance and inspection.
   b. 1 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 Section 01 91 14, Equipment Testing and Facility Startup.

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

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
   a. International Building Code (IBC).
   b. International Mechanical Code (IMC).
5. 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. 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.

1.04 DESIGN REQUIREMENTS

A. General:

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

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes.
3. Wind loads in accordance with governing codes.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
   a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
   b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

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

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

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

PART 2 PRODUCTS

2.01 GENERAL

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

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

C. Materials: In accordance with Table 1, attached as a Supplement at end of section.

2.02 HANGERS

A. 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.

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

C. Channel Type:

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

2.04 PIPE SADDLES

A. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
   b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.

3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
   b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

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

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

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

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.

b. Grouped Pipes: Trapeze hanger system.

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

C. Standard Attachments:

1. 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.

2. Existing Concrete Ceilings:
   a. Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
      1) Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
      2) 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.
3. Steel Beams: I-beam clamp or welded attachments.
4. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
5. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Accessories:

1. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

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

3.03 SUPPLEMENT

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

1. Table 1: Nonchemical Areas.

END OF SECTION

Table 1
Nonchemical Areas

Exposure Conditions	Support Material
Process Areas: Inside of vaults or pump station dry wells	Stainless steel
Process Areas: Wetted or Submerged	Stainless steel

Notes:

1. Stainless steel to be Type 316.

SECTION 40 05 33
PIPE HEAT TRACING

PART 1 GENERAL

1.01 REFERENCES

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

1. Factory Mutual.
2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
4. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.
3. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN REQUIREMENTS

A. Design Heating Load:

1. Heating load to be calculated based upon a 50 degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 40 42 13, Process Piping Insulation, pipe as specified in Section 40 27 00, Process Piping—General, and shall include a 10 percent safety factor.
2. Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

2.02 ELECTRICAL HEATING TAPE

A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

B. UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

C. Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

E. Service Voltage: As indicated by branch circuits provided for heat tracing on Drawings.

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.

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, 120V ac to 240V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-F5.
2. Thermon; E4X-1.
3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
4. Thermon; E7-25325 for hazardous areas.

2.06 AMBIENT THERMOSTAT

A. Type: Adjustable setting (15 degrees F 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, 125V ac to 250V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-1A.
2. Thermon; B4X-15140.
3. Raychem; DigiTrace Model AMC-1H for hazardous areas.
4. Thermon; B7-15140 for hazardous areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install in accordance with the manufacturer's instructions and recommended practices.
2. Provide insulation as specified in Section 40 42 13, Process Piping Insulation, over all pipe heat tracing.
3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.

B. Electrical Heating Tape:

1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. Derate heating tape capacity when installed on plastic piping.
4. Install on services as follows:

Service	Piping Material	Placement	Location
Aluminum Chlorohydrate (ACH)	CPVC		Exposed Outdoors
Coagulant Aid Polymer (CAP)	CPVC		Exposed Outdoors
Sample	CPVC		Exposed Outdoors

Service	Piping Material	Placement	Location
Water (W1 or W2)	CPVC		Exposed Outdoors

5. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:

1. Install in accordance with manufacturer's instructions and as approved by Engineer.
2. For each group of heat traced circuit, install one ambient thermostat.

3.02 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION

SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Force: A-A-58092, Tape Antiseize, Polytetrafluorethylene.
2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   f. B16.9, Factory-Made Wrought Buttwelding Fittings.
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   i. B16.25, Butt Welding Ends.
   j. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   k. B31.1, Power Piping.
   l. B31.3, Process Piping.
   m. B31.9, Building Services Piping.
   n. B36.10M, Welded and Seamless Wrought Steel Pipe.
   o. B36.19M, Stainless Steel Pipe.
5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.
6. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings for Water.

d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
f. C116/A21.16, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
g. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
h. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
i. M11, A Guide for Design and Installation.

7. ASTM International (ASTM):
   a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   d. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   e. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   f. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   g. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
   h. A197/A197M, Standard Specification for Cupola Malleable Iron.
   i. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   j. A276, Standard Specification for Stainless Steel Bars and Shapes.
   k. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   m. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   n. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
   o. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   p. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

q. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
r. A536, Standard Specification for Ductile Iron Castings.
s. A563, Standard Specification for Carbon and Alloy Steel Nuts.
t. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
u. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
v. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
w. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
x. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
y. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
z. B464, Standard Specification for Welded UNS N08020, UNS N08024, and UNS N08026 Alloy Pipe.
aa. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
bb. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
cc. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension.
dd. D413, Standard Test Methods for Rubber Property Adhesion to Flexible Substrate.
ee. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
ff. D1330, Standard Specification for Rubber Sheet Gaskets.
gg. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
hh. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ii. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

jj. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
kk. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ll. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
mm. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
nn. F436, Standard Specification for Hardened Steel Washers.
oo. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
pp. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

8. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought Stainless Steel Butt-Welding Fittings.
9. NSF International (NSF): 61 Drinking Water System Components—Health Effects.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
   a. Top face of channel walls and cover slabs.
   b. Top face of clarifier walkways.
   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:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.

1.04 SUBMITTALS

A. Action Submittals:

1. Product data on Piping Systems.
2. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
3. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
4. Pipe Corrosion Protection: Product data.

B. Informational Submittals:

1. Manufacturer's Certification of Compliance in accordance with Section 01 61 00, Common Product Requirements.
   a. Pipe and fittings.
   b. Welding electrodes and filler materials.
   c. Factory applied resins and coatings.
2. Flanged Pipe and Fittings: Manufacturer's product data sheets for gaskets including torqueing requirements and bolt tightening procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 PIPING

A. As specified on Piping Data Sheet(s) located at the end of this section as Supplement and Piping Schedule on Drawings.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.02 JOINTS

A. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

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

C. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with breakoff tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than 2-1/2 degrees.
4. UL and FMG approved.

D. Flexible Mechanical Compression Joint Coupling:

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

2.03 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

2.04 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

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 ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
   b. Galvanically compatible with piping.
   c. Resistant for intended exposure, operating temperatures, and products in pipeline.
2. Union Type, 2 Inches and Smaller:
   a. Screwed or solder-joint.
   b. O-ring sealed with molded and bonded insulation to body.
3. Flange Type, 2-1/2 Inches and Larger: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts. Bolt insulating sleeves shall be provided full length between insulating washers. Contractor shall be responsible for fit-up of all components of insulated flange assembly to provide a complete functioning installation. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of all required washers, flanges and gasket.
4. Flange Insulating Kits:
   a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
   b. Insulating Sleeves: Full-length mylar.
   c. Insulating Washers: High-strength phenolic.
   d. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
      1) Provide two washers per bolt for flange diameters equal to or less than 36-inch.
      2) Provide four washers per bolt for flange diameters larger than 36-inch.

5. Manufacturers and Products:
   a. Dielectric Flanges and Unions:
      1) PSI, Houston, TX.
      2) Advance Products and Systems, Lafayette, LA.
   b. Insulating Couplings:
      1) Dresser; STAB-39.
      2) Baker Coupling Company, Inc.; Series 216.

2.05 THRUST TIES

A. 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.

2.06 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. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.

2.07 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule on Drawings.

B. Galvanizing:

1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
2. Electroplated zinc or cadmium plating is unacceptable.
3. Stainless steel components may be substituted where galvanizing is specified.

2.08 IDENTIFICATION LABELS

A. Pipe Labels:

1. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
2. Provided with ties or straps for pipes of 6 inches and over diameter.
3. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
4. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
5. Letters and Arrows: Black on OSHA safety yellow background.
6. Color Field and Letter Height: Meet ASME A13.1.
7. Message: Piping system name as indicated on Piping Schedule.
8. Manufacturers and Products:
   a. Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.
   b. Seton Identification Products; Ultra-mark Pipe Markers

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.

C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.02 PREPARATION

A. See Piping Schedule on Drawings, and Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer’s instructions.

3.03 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
6. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
7. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
8. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
9. Manufacturer: Same as pipe manufacturer.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

F. 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.

G. 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, and Flanged Coupling Adapters: As recommended by the coupling or adapter manufacturer.

3.04 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.

3.05 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 shown on Drawings.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day’s work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.

9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    a. Shorter pipe lengths.
    b. Special mitered joints.
    c. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. Tolerances:

1. Deflection from Horizontal Line: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/2 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.06 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.

3.07 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 on Drawings.
2. Buried: Wrap with polyethylene bagging.
3. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating System No. 2. If in potable water service, use NSF 61 approved epoxy.

B. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

C. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
   b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
2. Buried:
   a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
   b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
   c. Flexible Couplings and Similar Items: Wrap with heat shrink wrap.
   d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.

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

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

F. 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 Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.08 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. Ductile Iron Pipe: Attach with socket clamps anchored against a grooved joint coupling or flange.
2. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through the 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.

3.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

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

3.10 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 the 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 a tapping boss of a fitting, valve body, or equipment casting.
2. Limitations: Threaded taps in pipe barrel are unacceptable.

3.11 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.12 PIPE IDENTIFICATION

A. As specified in Section 09 90 00, Painting and Coating.

3.13 FIELD QUALITY CONTROL

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

3.14 CLEANING AND DISINFECTION

A. Following assembly and testing, and prior to final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

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

C. Pipes containing potable water shall be disinfected per AWWA C651. Neutralize chlorinated water prior to disposal.

3.15 SUPPLEMENTS

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

1. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar-Lined Ductile Iron Pipe and Fittings
40 27 00.03	Carbon Steel Pipe and Fittings—General Service
40 27 00.08	Stainless Steel Pipe and Fittings—General Service

Number	Title
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.11	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings
40 27 00.13	Copper and Copper Alloy Pipe, Tubing, and Fittings

END OF SECTION

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of 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).
Pipe	Buried Liquid Service Using 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 Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	Cement-mortar: AWWA C104/A21.4.
Fittings	Lined and coated same as pipe. 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. 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. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Joints	Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Flange: Class 125 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.
Bolting	Proprietary Restrained: Manufacturer's standard. 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.
Gaskets	General: Gaskets in contact with potable water shall be NSF 61 certified. Proprietary Restrained Joints; Water and Sewage Service: Rubber conforming to AWWA C111/A21.11. Flanged, Water, Sewage Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000 4CA 415 A25 B35 C32 EA14 F19. Full face for Class 125 flat-faced flanges. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	All	Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:
	Screwed:	
	2" & smaller	Schedule 40.
	Welded:	
	2-1/2" thru 10"	Schedule 40.
	Grooved:	
	2-1/2" thru 6"	Schedule 40.
	8" thru 12" inch	Schedule 30.
Joints	2" & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.
	2-1/2" & larger	Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.
Fittings	2" & smaller	Threaded: 150-pound malleable iron, ASTM A197/A197M, 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.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
	2-1/2" & larger	Butt Welded: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting schedule to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47/A47M, ductile iron ASTM A536, forged steel ASTM A234/A234M, or factory fabricated from ASTM A53/A53M pipe. Grooved ends to accept couplings without field preparation. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products.
Branch Connections	2" & smaller	For Threaded Pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet, ASTM A105/A105M, CL3000, meeting the requirements of MSS SP-97.
	2-1/2" & larger	Butt-welding or grooved end tee in conformance with Fittings specified above.
Flanges	2" & smaller	Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 socket-weld or threaded, 1/16-inch raised face.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
	2-1/2" & larger	Butt-Welded Systems: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 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. Grooved End Adapter Flange: 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. Cast Iron Mating Flange: 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.
	All	Blind Flange: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 blind flange, raised face.
Unions	2" & smaller	Threaded malleable iron, ASTM A197/A197M, integral brass seats, Class 150, meeting the requirements of ASME B16.39.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Couplings	2-1/2" & larger	Grooved End: 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, meeting the requirements of ASME B16.3.
Bolting	All	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. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength.

SECTION 40 27 00.03
CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE

Item	Size	Description
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

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2” & smaller	Schedule 40S: ASTM A312/A312M, Type 316 seamless, pickled and passivated.
	2-1/2” thru 6”	Schedule 10S: ASTM A778, “as-welded” grade, Type 316L.
	8” & larger	Schedule 5S: ASTM A778, “as-welded” grade, Type 316L.
Joints	2” & smaller	Threaded or flanged at equipment as required or shown.
	2-1/2” & larger	Butt-welded or flanged at valves and equipment.
Fittings	2” & smaller	Threaded Forged: 1,000 CWP, ASTM A182/A182M, Grade F316L.
	2-1/2” & larger	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.
Branch Connections	2” & smaller	Tee or reducing tee in conformance with Fittings above.
	2-1/2” & larger	Butt-welding tee or reducing tee in accordance with Fittings above.
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ANSI B16.5 Class 150 or Class 300, slip-on weld neck or raised face.
Unions	2” & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Bolting	All	Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	All Flanges	Flanged, Water and Sewage Service: 1/8 inch thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	2” & smaller	Teflon tape.

END OF SECTION

SECTION 40 27 00.10
POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 2% titanium dioxide for ultraviolet protection. Pipe in contact with potable water shall be NSF-61 approved. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2% titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.-0.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 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.
Fittings	All	Schedule to Match Pipe Above: Conforming to the requirements of ASTM F439 for socket weld type and Schedule 80 ASTM F437 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

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

Item	Size	Description
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	All socket type joints shall be made employing primer and solvent cements that meet or exceed the requirements of ASTM F493 and primers that meet or exceed the requirements of ASTM F656, resistant to the fluid service, and as recommended by the pipe and fitting manufacturer, except solvent weld cement for CPVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724 or approved equal. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance.
Tubing	Seamless, conforming to ASTM B88 as follows: Buried .....Type K, O50 temper All other exposures .....Type L, H58 temper
Fittings	ASTM B75 wrought copper, UNS C12200, H58 temper, socket joint, conforming to ASME B16.22.
Unions	ASTM B75 wrought copper, UNS C12200, H58 temper, socket joint x male NPT, conforming to MSS SP-104.
Flanges	Class 150, ASTM B61 bronze, threaded, flat face, conforming to ASME B16.24. Lead free casting when used in potable water service.
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

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF): NSF 61, Drinking Water System Components—Health Effects.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

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.

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 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF 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 except stainless steel coupling.
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. Stainless 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. Coupling material to match pipe material.

C. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.
2. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 913.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 912.

D. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and wrap-applied neoprene cover.
3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.
4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
   a. Goodall Rubber Co.; Specification E-1462.
   b. Garlock; Style 204.
   c. Unisource Manufacturing, Inc.; Style 1501.
   d. Proco Products, Inc.; Series 220.

E. Restrained Flange Adapter:

1. Pressure Rating:
   a. Minimum Working Pressure Rating: Not less than 150 psi.
   b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer’s proof testing.

2. Thrust Restraint:
   a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
   b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

2.03 EXPANSION JOINTS

A. Metal Bellows:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ASME 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of eight convolutions and minimum axial compression of 3/4 inches.
6. Manufacturers and Products:
   a. U.S. Bellows, Inc.; Universal Tied expansion joint.
   b. Metraflex, Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

2.04 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
   a. Body: Malleable or ductile iron.
   b. Straps: Galvanized steel.
   c. Hex Nuts and Washers: Steel.
   d. Seal: Rubber.
5. Manufacturers and Products:
   a. Smith-Blair; Series 313 or 366.
   b. Dresser; Style 91.

2.05 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. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
   a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
   b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer’s instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.06 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, 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. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
3. Manufacturer: Hayward.

C. Pump Seal Water Sight Flow Indicators:

1. Bronze body, 1/2-inch, horizontal, ball action with tempered glass.
2. Rated 125 psi with NPT screwed ends.
3. Operate with a minimum flow of 0.25 gpm.
4. Manufacturers and Products:
   a. Eugene Ernst Co.; Series E-57-4.
   b. Jacoby Tarbox Co.

PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved Shop Drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures: Install 18 inches or less from face of structures; joint may be flush with face.

3.03 PIPING EXPANSION

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

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.

C. Anchors: Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.04 COUPLINGS

A. General:

1. Install in accordance with manufacturer's written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Do not remove pipe coating. If damaged, repair before joint is made.
4. Application:
   a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
   b. Concrete Encased Couplings: Flexible coupling.

3.05 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.

3.06 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations: Wall pipes with thrust collars.
2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
3. Existing Walls: Rotary drilled holes.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.
3. Ductile Iron Wall Pipe:
   a. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
   b. Thickness: Equal to or greater than remainder of pipe in line.
   c. Fittings: In accordance with applicable Pipe Data Sheet.
   d. Thrust Collars:
      1) Rated for thrust load developed at 250 psi.
      2) Safety Factor: Two, minimum.
      3) Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
   e. Manufacturers:
      1) American Cast Iron Pipe Co.
      2) U.S. Pipe and Foundry Co.
4. Steel or Stainless Steel Wall Pipe:
   a. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
   b. Lining: Same as connecting pipe.
   c. Thrust Collar:
      1) Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
      2) Continuously fillet welded on each side all around.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   c. C542, Electric Motor Actuators for Valves and Slide Gates.
   d. C550, Protective Interior Coatings for Valves and Hydrants.
3. ASTM International (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
   e. D429, Standard Test Methods for Rubber Property—Adhesion to Rigid Substrates.
   f. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
4. FM Global (FM).
5. Food and Drug Administration (FDA).
6. International Association of Plumbing and Mechanical Officials (IAPMO).
7. Manufacturers Standardization Society (MSS):
   a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
   b. SP-88, Diaphragm Valves.
   c. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
8. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

9. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
10. UL.

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 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 43 33, Manufacturers' Field Services, for:
   a. Electric actuators; full compliance with AWWA C542.
   b. Butterfly valves; full compliance with AWWA C504.
3. Tests and inspection data.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.03 WARRANTY

A. Warranty as required in Section 01 61 00, Common Product Requirements.

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 Actuator Schedule located on Drawings.

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:
   a. 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 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 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
2. Type V100 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, nonrising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 438, NPT threaded ends.
      2) Stockham; Figure B103, NPT threaded ends.
      3) Crane; Figure 1324, soldered ends.
      4) Stockham; Figure B104, soldered ends.

B. Globe Valves:

1. Type V208 Needle Disc Type Globe Valve 1/8 Inch to 3/4 Inch:
   a. All-bronze, threaded bonnet, packed gland, rising stem, bronze body and stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80.
   b. Manufacturers and Products:
      1) Crane Cat.; No. 88.
      2) Stockham; B-64.

C. Ball Valves:

1. Type V330 PVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double

union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

b. Manufacturers and Products:
   1) Nibco; Chemtrol Tru-Bloc.
   2) ASAHI/America; Type 21.
   3) Spears; True Union.

D. Plug Valves:

1. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
   a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1, 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, refer to Contract Drawings for actuator modification and reuse:
      1) 6-Inch to 12-Inch Valves: Totally enclosed, geared operator. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For exposed or submerged service provide electric operator with extension stem, floor stand, and manual override as scheduled and shown on Drawings. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut with extension stem and valve box at surface.
   e. Manufacturers and Products:
      1) Pratt; Ballcentric.
      2) DeZurik; Style PEC.
      3) Milliken; Millcentric Series 600.
      4) Kennedy.
2. Type V404 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, buried service mechanical joint ends, unless otherwise shown.
   b. Plug Type 316 stainless steel with round or rectangular port of no less than 80 percent of connecting pipe area, seats Type 316 stainless steel, PTFE thrust bearings, stem seal multiple V-rings,

or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.

c. Operators:
   1) 6-Inch to 12-Inch Valves: Totally enclosed, geared operator. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For exposed or submerged service provide electric operator with extension stem, floor stand, and manual override as scheduled and shown on Drawings.

d. Manufacturers and Products:
   1) Pratt; Ballcentric Series 6015.
   2) DeZurik; Style PEC.
   3) Milliken; Millcentric Series 6015.

E. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
      4) No travel stops for disc on interior of body.
      5) Self-adjusting V-type or O-ring shaft seals.
      6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
      8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
      9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
      10) Valves to be in full compliance with NSF/ANSI 61. (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, 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.

F. Check and Flap Valves:

1. Type V632 Ball Check Valve 3 Inches and Larger:
   a. Flanged end, iron body valve with cleanout and floating 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.
      2) Flowmatic Corp.
      3) Golden Anderson.

G. Self-Regulated Automatic Valves:

1. Type V711 Pressure-Reducing Valve 2 Inches and Smaller:
   a. Direct diaphragm, spring controlled, bronze body, spring case, FKM elastomer seat and diaphragm, stainless steel valve stem, NPT threaded ends, 250 psig rated.
   b. Size/Rating: As shown in Valve Schedule as shown on Drawings.
   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. Refer to Valve Schedule as shown on Drawings, for initial set point.
d. Manufacturers and Products:
1) Plast-O-Matic; Series RVDT.
2) Griffco; Series BPV.
3) Primary Fluid Systems; TOP Valve.

H. Diaphragm Valves:

1. Type V903 Diaphragm Valve 1/2 Inch to 4 Inches:
a. Weir type with CPVC Type 4, Grade 1 body, Viton (FKM) diaphragm, double union design, 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.

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 OPENED and CLOSED indication 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 dc 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 OPENED and CLOSED indication 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 dc 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 dc 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.
6. Manufacturer and Product:
   a. Flowserve Limitorque.
   b. No “or-equal.”

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 multiturn valves, as applicable.
   b. Manual override handwheel.
   c. Valve position indication.
   d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Actuated Valve Schedule.
   e. Nonintrusive Electronic Control: Local controls, diagnostics, and calibration, including limit and torque settings, shall be accomplished nonintrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two minimum.
3. Open-Close(O/C)/Throttling(T) Service:
   a. The actuators shall be furnished and sized by the valve supplier and shall be factory mounted. Actuators shall be mounted to minimize the valve and actuator assembly height to permit installation in piping trenches where required.
   b. The actuators shall be sized to produce at least 1.5 times the operating torque required.
   c. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
   d. Actuator suitable for throttling operation of valve at intermediate positions.

e. 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.
f. OPEN and CLOSED indicating lights.
g. Integral reversing motor starter with built-in overload protection.

4. Modulating (M) Service:
   a. The actuators shall be furnished and sized by the valve supplier and shall be factory mounted. Actuators shall be mounted to minimize the valve and actuator assembly height to permit installation in piping trenches where required.
   b. The actuators shall be sized to produce at least 1.5 times the operating torque required.
   c. Size actuators for continuous modulating duty.
   d. Feedback potentiometer, or equivalent, and integral electronic positioner/comparator circuit to maintain valve position.
   e. 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 dc to 20 mA dc input signal to control valve in AUTO (Remote) position.
      3) Auxiliary contact that closes in AUTO (Remote) position.
   f. OPEN and CLOSED indicating lights.
   g. 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.
   h. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
   i. Valve position output converter that generates isolated 4 mA dc to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24V dc.
5. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120V ac.
   b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   c. Housed in actuator control enclosure.

6. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
7. Manufacturers and Products:
    a. Flowserve Limitorque.
    b. No “or-equal.”

2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve operator, bearing valve tag number shown in Electric Motor Actuator Schedule on Drawings.

B. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120V ac.

C. T-Handled Operating Wrench:

1. One each galvanized operating wrenches, 4 feet long.
2. Manufacturers and Products:
    a. Mueller; No. A-24610.
    b. Clow No.; F-2520.

D. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

1. Manufacturers:
    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.

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. 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 when valve is installed in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finished floor, unless otherwise shown.

3. Install valves per manufacturer's recommendations.
4. 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).

C. 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.

D. 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.

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

F. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finished floor. Install chain to within 3 feet of finished 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.

3.03 MANUFACTURER'S SERVICES

A. Valve(s) as listed below require manufacturer's field services: V405.

B. Manufacturer's Representative: Present at Site 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.

C. See Section 01 43 33, Manufacturers' Field Services.

END OF SECTION

SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
   c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   g. C552, Standard Specification for Cellular Glass Thermal Insulation.
   h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
   i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. UL.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's descriptive literature.

B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 1—Elastomeric:

1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
3. Nominal Density: 3 pcf to 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
6. Joints: Manufacturer's adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
   a. Nomaco; K-Flex.
   b. Armacell; AP Armaflex.

B. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.

4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer’s recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.02 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.03 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
   a. Knauf Insulation; Proto 1000.
   b. Johns Manville; Zeston 2000 or 300.
   c. Speedline; 25/50 Smoke-Safe.

B. Type F2—Paint:

1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
   a. Manufacturer and Product: Armacell; WB Armaflex finish.
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 and Products:
   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. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, Process Piping—General.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

F. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.

G. Roof Drains and Overflow Drains: Insulate entire pipe runs. Where roof and overflow drains exist through an exterior wall ensure annular space between pipes and walls are properly sealed prior to insulating.

H. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.

I. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

J. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):

1. Aluminum or color coded PVC jacketing does not require painting.
2. If insulated piping system is indicated to be painted in Section 40 27 00, Process Piping—General, piping shall receive the following:
   a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
   b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

3.04 SUPPLEMENT

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

1. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness								
					Finish Systems			
Service Type	**Pipe Legend**	**Thickness**	**Fluid Temperature (degrees F)***	**Insulation**	**Concealed from View**	**Indoors Exposed**	**Outdoors**	**Buried**
Chemical piping	ACH, CAP	Pipe Size: Insulation Thickness Inches:* 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5	40 - 100	Type 2	NA	NA	F3 (and located in pipe trenches)	NA
Water Piping	W1, W2, SA	Pipe Size: Insulation Thickness Inches:* 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5	40 - 100	Type 2	NA	NA	F3 (and located in pipe trenches)	NA
PE–Personnel Exposure		ASHRAE 90.1 or IECC whichever results in the thickest insulation	>140	Type 2 Minimum 1.5" thick	No insulation or finish	F3 below 8'	F3	NA

*Use these fluid temperatures unless otherwise noted in the Piping Schedule.
Inches*: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding. Matches the watts per foot in Section 40 05 33, Pipe Heat Tracing. 2012 IECC requires 1-inch minimum thickness.

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

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 blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, 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: Piping between wetwells and wetwell isolation valves.
6. Test Pressure: As indicated on Piping Schedule.

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. Empty pipe of water prior to final cleaning or disinfection.

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:

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

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 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 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. 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 WC.

D. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

F. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.04 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

SECTION 40 90 01
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM): A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   a. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
   b. A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   c. B32, Standard Specification for Solder Metal.
   d. B88, Standard Specification for Seamless Copper Water Tube.
3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. International Conference on Energy Conversion and Application (ICECA).
6. International Society of Automation (ISA):
   a. RP12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
   b. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
   c. S5.4, Standard Instrument Loop Diagrams.
   d. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   e. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   f. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
7. National Electrical Code (NEC).

8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, General Standards for Industrial Control and Systems.
9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. National Institute of Standards and Technology (NIST).
11. UL: 508A, Standard for Safety, Industrial Control Panels.

B. See the following Specification Sections for additional material, equipment and installation requirements for Package Systems.

1. Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
2. Section 43 22 56, Rapid Mixers.
3. Section 44 42 63, Hose-less Solids Collection System.
4. Section 44 44 36, Horizontal Paddle Flocculation System.

1.02 SUMMARY

A. Work Includes:

1. Engineering, furnishing, installing, demolishing, calibrating, adjusting, testing, documenting, starting up, and Owner training for complete Process Instrumentation and Control (PIC) as defined on Drawings and within the Specifications.
2. Retag any existing modified equipment with the new tag numbers as indicated within these Contract Documents.
3. Major parts are primary elements, transmitters, and control devices.

B. PICs Contractor and Package System Supplier Scope of Work Description (minimum requirements):

1. Each remote mounted four-wire transmitter shall come with a means to disconnect the power locally (housed in a weatherproof enclosure), upstream of its corresponding Type SS-4 surge suppressor and shall be padlockable in either the OFF or ON position.
   a. Outdoor Installation: Each four-wire transmitter shall be mounted in a Type 316 Stainless Steel, NEMA 4X, powder coated white enclosure mounted on a Type 316 stainless steel, back-to-back unistrut rack shrouded by a Type 316 stainless steel, powder coated white sunshield with a hinged glare shield.
   b. Indoor Installation: Each four-wire transmitter shall be wall or rack mounted (mounted in a Type 316 stainless steel, NEMA 4X enclosure or as indicated).

c. Furnish a power supply and interposing relays for all flow indicating transmitter discrete I/O which are rated at 24V dc.

2. Each Control Panel that is furnished with a PLC shall have the following housed within each control panel:
   a. Type SS-1 surge suppressor for incoming power.
   b. UPS bypass switch.
   c. UPS:
      1) In-line, double conversion UPS (1,500VA minimum), mounted and secured to a shelf at the bottom of the control panel or rack-mounted (as required by control panel requirements).
      2) Each UPS shall be furnished with a relay I/O card. Route I/O contacts through interposing DC relays.
      3) UPS shall be sized to operate the control panel for thirty minutes at full load (all devices energized within the enclosure and field devices connected to and/or subfed from the enclosure). Furnish additional battery expansion modules as required.
         a) Note: De-rate batteries to the interior control panel temperature setpoint (both heating and cooling setpoint) for UPS runtime calculations. UPS must be able to meet the runtime conditions for the worst-case temperature scenario.
      4) UPS shall power all devices and field devices within or connected to the control panel with the exception of the following:
         a) The courtesy receptacle.
         b) Control panel heating elements (if present).
         c) Control panel cooling system (if present).
         d) Control panel interior lights.
      5) UPS and its corresponding battery expansion module(s) are not to reside on the bottom of the enclosure. Provide a stand to offset the UPS and battery expansion module(s) from sitting on the floor of the enclosure. Secure stand to the control panel. Secure UPS and expansion battery modules (if present) to the UPS stand.
      6) UPS shall be “Ultra-Wide Temperature UPS” (Component Specification Code: Y40O, no exceptions).
         a) Each PLC shall monitor (and transfer to the Plant SCADA System not shown on Drawings) the following I/O:
            (1) Utility Power OK (via interposing relay upstream of the UPS).

(2) Control Panel Intrusion (via door mounted intrusion switches for each door of the control panel).
(3) DC Power Supplies OK (from the monitoring contact of each power supply and active redundancy module in the control panel – wired in series to an interposing relay).

7) Ethernet Switch OK (from the monitoring contact of the managed Ethernet switch located within the PLC control panel – wired to an interposing relay).
8) Each PLC shall monitor (and transfer to the Plant SCADA System not shown on Drawings) the following I/O from the UPS relay I/O card:
a) UPS Fault Status (wired to an interposing relay).
b) Power Failure Status (wired to an interposing relay).
c) UPS Battery Low Status (wired to an interposing relay).
d) UPS on Bypass Status (wired to an interposing relay).
9) Control Panel Temperature (for outdoor panels, panels with heating and cooling units for maintaining an interior temperature setpoint of the control panel; or for indoor panels mounted in an unconditioned space) (via a temperature transmitter mounted to the interior of the control panel sending a 4 mA dc to 20 mA dc signal to the PLC).

d. Furnish 20 percent spare discrete I/O (wired to interposing relays).
e. All discrete I/O shall be wired to interposing relays.
f. Furnish twenty percent spare analog I/O (wired to Type SS-2 surge suppressors).
g. All analog I/O shall be wired to Type SS-2 surge suppressors.
h. In PLCs With Rack: Furnish 20 percent spare rack spaces (a minimum of four). Cover empty rack spaces with blank covers.
i. In PLCs Without Rack: Furnish 20 percent spare subplate space for future expansion of the PLC (minimum space for four additional cards and a power supply).

3. Each Control Panel furnished shall have the following operating interface devices mounted on the face of the control panel:
a. UTILITY POWER OK: 30.5 mm, NEMA 4X, White, Push-to-Test, LED type, pilot light. Illuminates when incoming power to control panel is present.
b. DC POWER OK: 30.5 mm, NEMA 4X, Blue, Push-to-Test, LED type, pilot light. Illuminates when DC power (used within the control circuits of the control panel) is present. (Only if power supplies are present within the control panel.)

c. ETHERNET SWITCH OK: 30.5 mm, NEMA 4X, Blue, Push-to-Test, LED type, pilot light. Illuminates when Ethernet switch is not faulted. (Only if an Ethernet Switch is present within the control panel.)
d. UPS OK: 30.5 mm, NEMA 4X, Blue, Push-to-Test, LED type, pilot light. Illuminates when the UPS is not in an alarm state. (Only if a UPS is present within the control panel.)

4. Each control panel that utilizes 24V dc or 12V dc power supplies shall use redundant power supplies with active redundancy modules, each sized to handle the full load of all devices it feeds while reaching a maximum of 50 percent capacity of the power supply. Furnish load calculations for each DC power supply in the control panel.
5. Each temperature controlled outdoor panel shall monitor its interior temperature and send to the nearest PLC via a 4 mA dc to 20 mA dc signal.

C. PICs Contractor Scope of Work Description (minimum requirements, but not limited to):

1. Provide new Flow Element to match existing Flow Element. Replace all existing tubing and all associated appurtenances to existing flow meter. Contractor is also responsible for having the existing flow element inspected and providing the Engineer/Owner with a test report for restoring the flow element to its original condition.
2. Furnish cables and re-install signals from the existing devices at the Raw Water Meter Vault:
   a. Type SS-3 surge suppressor on the existing venturi flow indicating transmitter (FIT-10002).
   b. One Type SS-3 surge suppressor on the flow control valve (VLV-10205).
   c. Update existing tag plates and for details of number of I/Os; see relevant supplement I/O List document.
3. Furnish and install the following at Clarifier No. 02:
   a. New SCADA interface control panel (Clarifier 02 CPN-10211 located at Clarifier No. 02); Type 316 stainless steel, NEMA 4X, powder coated white finish) which shall include (but not limited to) the following:
      1) Type SS-1 surge suppressor for incoming power.
      2) PLC with Allen-Bradley ControlLogix 1756-L73 processor.
      3) Allen-Bradley 1756-EN2T Ethernet modules, as required.
      4) I/O cards and power supply as defined in the Specifications.
      5) UPS requirements as listed above.
      6) UPS Bypass Switch.
      7) Power Supply requirements as listed above.

8) Managed Ethernet Switch:
   a) Stratix 1783-BMS20CGP 20 with 16 FE 2 GE ports (minimum).
   b) Furnish SFP modules as required with a minimum of two spare (installed) of each type.
9) Fiber optic patch panel to terminate all active and dark fibers plus a minimum of six spare ports (utilizing LC connectors).
10) Copper patch panel for interconnecting CAT6 cables as required.
11) Interposing relays on all discrete I/O.
12) Type SS-2 surge suppressors for all analog I/O.
13) Furnish a minimum of 20 percent spare I/O and PLC slots in the PLC chassis for future use.
14) All blank PLC slots shall be furnished with slot fillers installed.
15) All spare discrete I/O shall be wired to interposing relays.
16) All spare analog I/O shall be wired to Type SS-2 surge suppressors.
17) All discrete output cards shall be isolated relay output type.
18) All analog I/O shall be individually isolated channels.
19) Interior lights in the control panel shall be wired to intrusion type door switches mounted toward the hinge of each door in the control panel.

b. These panels shall interface all engineered control systems, instruments and package control systems within Clarifier No. 02 into the Plant SCADA network (as indicated within these Contract Documents). These panels shall interface field mounted controls and instrumentation located within Clarifier No. 02 into the Plant SCADA network (as indicated within these Contract Documents) respectively.
c. One turbidity submersible probe (analytical element EFLL-TRB-10008 Clarifier No. 02 North Basin Monitoring).
d. One pH submersible probe (analytical element EFLL-PHH-10003 Clarifier No. 02 North Basin Monitoring).
e. One remote mounted analytical indicating transmitter (EFLL-CTL-10201 Clarifier No. 02 North Basin Monitoring) mounted in a Type 316 stainless steel, NEMA 4X, powder coated white enclosure with Type SS-4 surge suppressor mounted in Type 316 stainless steel, NEMA 4X, powder coated white enclosure. Enclosures shall be shrouded in a Type 316 stainless steel, powder coated white sun shield with hinged glare shield.
f. One Turbidity submersible probe (analytical element EFLL-TRB-10009 Clarifier No. 02 South Basin Monitoring).

g. One pH submersible probe (analytical element EFLL-PHH-10004 Clarifier No. 02 South Basin Monitoring).
h. One remote mounted analytical indicating transmitter (EFLL-CTL-10202 Clarifier No. 02 South Basin Monitoring) mounted in a Type 316 stainless steel, NEMA 4X, powder coated white enclosure with Type SS-4 surge suppressor mounted in Type 316 stainless steel, NEMA 4X, powder coated white enclosure. Enclosures shall be shrouded in a Type 316 stainless steel, powder coated white sun shield with hinged glare shield.
i. Type 316 stainless steel, back-to-back unistrut equipment rack to mount the above enclosures.

4. Ref P&ID: 09-N-007, Replace two existing pumps with new pumps (P-10301 & P-10302) and associated AFDs. Furnish and install the following at the existing Sludge Pump Station No. 2: (Reference markup on Drawing 24381 - Sludge Pump Station 2 Panel).
5. Contractor shall use following PLC I/O slot. For exact I/O points, refer to markup on Drawing 24381- Sludge Pump Station 2 Panel):
   a. DI:
      1) Total I/O 08.
      2) PLC I/O Slot 05.
      3) Use spares.
   b. DO:
      1) Total I/O 02.
      2) PLC I/O Slot 07.
      3) Use spares.
   c. AI:
      1) Total I/O 02.
      2) PLC I/O Slot 02.
      3) Use spares.
   d. AO:
      1) Total I/O 02.
      2) New AO Card required.
   e. One sludge pump suction pressure indicators with annular seals (Tag No. PI-10301A/PE-10301A).
   f. One sludge pump discharge pressure indicators with annular seals (Tag No. PI-10301B/PE-10301B).
   g. One sludge pump suction pressure indicators with annular seals (Tag No. PI-10302A/PE-10302A).
   h. One sludge pump discharge pressure indicators with annular seals (Tag No. PI-10302B/PE-10302B).
6. Network Interface:
   a. Clarifier 02 Fiber Panel to CPN-10211: Furnish and install 12-pair multi-mode fiber optic cable between the panels.

b. CPN-10211 (Clarifier No. 02 Control Panel) to CPN-10218 (Clarifier No. 02 Sludge Collection Control Panel): Furnish and install two pair multi-mode fiber optic cable between the panels.
c. CPN-10218 (Clarifier No. 02 Sludge Collection Control Panel) to Sludge Collector System Field Panels (CPN-102(XX) 12 through 17): Furnish and install two pair CAT6 Ethernet cables between the each panel and CPN-10218 (Clarifier No. 02 Sludge Collection Control Panel).

7. PICS shall procure and install new mechanical valves (12-inch eccentric plug valves) in pump station room but re-use existing actuator on them. Provide new adaptors or re-use existing for actuator mounting.

D. PICS shall be responsible for programming all new PLCs as shown on Drawings and described within these Contract Documents and existing Plant SCADA HMI screens to accommodate the inclusion of all SCADA I/O within and as described within these Contract Documents. See Section 40 90 01, Instrumentation and Control for Process Systems, Supplement Loop Specifications, for additional programming requirements.

E. Package System Suppliers shall be responsible for all PICS requirements within these Specifications and Supplements to this Specification section for both components, instruments and PLC programming requirements (if part of the supplier's package system).

F. Package System Suppliers shall be responsible for programming all new PLCs and new HMI screens within their associated package systems to accommodate the inclusion of all SCADA I/O within and as described within these Contract Documents. See this Section, Supplement Loop Specifications, and the package system supplier's corresponding Specification Section for additional programming requirements.

G. Fault Status Monitoring (PICS and Package System Supplier): All devices (including but not limited to valve actuators, transmitters (two and four-wire), etc.) which have the capability of monitoring the FAULT status of the device, shall be monitored by the SCADA system via a HARD-WIRED interlock to a Plant PLC and/or SCADA interface device.

H. Process Instrumentation and Control System (PICS) SCADA Integrator Qualifications:

1. The Process Instrumentation and Control System (PICS) SCADA System Integrator shall be a "Systems Integrator" regularly engaged in the design, installation and maintenance of instrumentation and control

systems specifically for the Water and Wastewater industry. Subject organizations shall meet or exceed all of the following requirements:

a. Have been in business under the same ownership/management for a minimum of 10 years.
b. Have adequate financial resources to successfully execute the work.
c. Have and maintain adequate insurance to meet the City's liability insurance requirements ($2,000,000 combined, $1,000,000 single).

2. Employ an adequate number of full-time degreed engineers and technicians who have a minimum of 10 years' experience working on projects and systems of similar size and complexity.
3. Employ an adequate number of full-time engineers and technicians who have been factory certified on the proposed major products and software.
4. Have successfully completed at least five projects of similar size and complexity in the last five most recent years.
5. Have and maintain a permanent, fully staffed and equipped service facility with full-time employees capable of designing, fabricating, installing, calibrating, programming and testing of the actual products and systems anticipated to be utilized for this Project.
6. Have and maintain a permanent, fully staffed and equipped service facility capable of providing on-site response within 24 hours.
7. Have and maintain a stand-alone "Service Department/Division" with a proven history of actively pursuing and executing on-going maintenance service contracts including emergency services 24/7. Organizations which do not have a history of providing and successfully maintaining on-going support services shall not be considered for pre-bid approval.
8. Capable of furnishing IT services capable of performing and supporting IT and related networking/communications project requirements.
9. Have and maintain a minimum of 10,000 square feet of environmentally controlled space dedicated to the production, assembly and check-out of custom control panels. Organization must be a certified UL-508A control panel facility.
10. The system integrator must have the following experience:
    a. Rockwell Automation Programming utilizing Studio 5000 and FactoryTalk ME (at least five comparable projects).
    b. Experience in the following products (at least five comparable projects):
        1) InTouch for System Platform.
        2) InTouch.
        3) Wonderware Historian.
        4) Industrial Application Server.

11. All above requirements must be met by the PICS Contractor (listed as an approved system integrator in this Specification) prior to bidding this Project. If the above qualifications are not met by the successful PICS Contractor, the PICS Contractor shall be responsible for procuring the required services (and that Contractor shall meet the qualifications of Specification) at no additional cost to the Owner.
12. Approved Systems Integrators:
    a. Prime Controls.
    b. Englobal.
    c. Bauman Instrument Corporation.
13. Listing of system integrators does not dismiss them from having to meet the above listed requirements. The successful PICS contractor is required to submit qualifications to ensure the meet the minimum requirements.

1.03 DEFINITIONS

A. Abbreviations:

1. FAT: Factory Acceptance Test.
2. FC: Fail Closed.
3. FO: Fail Open.
4. LCP: Local Control Panel.
5. MCC: Motor Control Center.
6. NO/FC: Normally Open / Fail Closed.
7. NC/FO: Normally Closed / Fail Open.
8. NOTC: Normally Open / Timed Closed.
9. NOTO: Normally Open / Timed Open.
10. NCTC: Normally Closed / Timed Closed.
11. NCTO: Normally Closed / Timed Open.
12. OIU: Operator Interface Unit.
13. ORT: Operational Readiness Test.
14. PAT: Performance Acceptance Test.
15. PIC: Process Instrumentation and Control.
16. PLC: Programmable Logic Controller.
17. PMP: Pump.
18. PoE: Power over Ethernet.
19. PoE+: High-Power over Ethernet.
20. PTZ: Pan, Tilt, Zoom.
21. SCADA: Supervisory Control and Data Acquisition.
22. SS-1: Surge Suppressor, 120V ac Single-Phase.
23. SS-2: Surge Suppressor, 24V dc Analog Signals within a control panel.
24. SS-3: Surge Suppressor, 24V dc two-wire field mounted transmitter.

25. SS-4: Surge Suppressor, 120V ac power and signal for field mounted four-wire transmitter.
26. SS-5: Surge Suppressor, Category 6 Ethernet surge suppressor.
27. SSPS: Secondary Sludge Pump Station.
28. UFT: Unwitnessed Factory Test.
29. VLV: Valve.

B. Rising/Falling: Terms used to define actions of discrete devices about their setpoints.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

C. Signal Types:

1. Analog Signals, Current Type:
   a. 4 mA dc to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC Subsystem components, use the following ISA 50.1 options:
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
3. 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 as indicated.
   c. Power source less than 30V dc.
4. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

D. Ranges:

1. Instrument Range: This indicates the minimum and maximum possible measurement the instrument is capable of sensing (expressed in engineering units as defined by process).
2. Process Range: This indicates the minimum and maximum conditions which will be present under normal operating conditions (expressed in engineering units as defined by process).

3. Span: This is the calibrated range of the instrument (minimum and maximum defined by a 4 mA dc to 20 mA dc signal).

E. Space Types:

1. Conditioned Space: A temperature controlled space, using mechanical equipment to control the ambient space temperature to a setpoint either fixed or determined by the Operator. This includes both cooling and heating of the space temperature. Cooling and heating setpoints may or may not vary.
2. Indirectly Conditioned Space: An enclosed area that is not heated or cooled directly but is heated or cooled indirectly by being connected to an adjacent conditioned space.
3. Unconditioned Space: A space in which there is no cooling present. Heating may or may not be present. If heating is present, the space is temperature controlled to maintain a setpoint either fixed or determined by the Operator.

1.04 SUBMITTALS

A. Action Submittals:

1. General:
   a. PICS Contractor and Package System Supplier must refer to and comply with “Substitution of equipment, instruments or devices listed within the Specifications” section (within this Specification Section) for submitting equipment, instruments or devices not listed within these Specifications and all associated Supplements or indicated on Drawings.
   b. PICS Contractor shall field verify all interconnecting wiring to existing field and SCADA equipment prior to submitting Shop Drawings.
   c. Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.
   d. Identify proposed items and options. Identify installed spares and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
   e. Legends and Abbreviation Lists: Complete definition of symbols and abbreviations used on this Project (for example, engineering units, flow streams, instruments, structures, and other process items used in nameplates, legends, and data sheets).

2. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) I&C 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.
3. Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices.
   a. Catalog information, mark 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.
4. Component Data Sheets: Data sheets for I&C components.
   a. Format and Level of Detail: In accordance with ISA-S20.
   b. Include component type identification code and tag number on data sheet.
   c. Specific features and configuration data for each component:
      1) Location or service.
      2) Manufacturer and complete model number.
      3) Size and scale range.
      4) Setpoints.
      5) Materials of construction.
      6) Options included.
   d. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
5. Spare Equipment:
   a. Furnish a list of spare items, components and instruments for this project in a spreadsheet. List the following:
      1) Quantity.
      2) Description.
      3) Manufacturer.
      4) Part Number.
6. Sizing and Selection Calculations:
   a. Primary Elements: Complete calculations plus process data used. Example, for flow elements, minimum and maximum values, permanent head loss, and assumptions made.

b. Controlling, Computing and Function Generating Modules: Actual scaling factors with units and how they were computed.
c. Submit panel internal heat rise and cooling calculations for all UL 508A and UL 698A labeled panels at full load rating (cooling calculations) and partial load rating (heating calculations).
d. DC Power Supply Sizing: Submit a detailed spreadsheet indicating each DC component within the control panel and powered by the panel externally and its DC current draw (for sizing DC power supply).
    1) DC Power Supplies shall be redundant with an active redundancy module.
    2) Total load (including future devices, if applicable) shall not exceed 50 percent of the capability of a single DC power supply.
e. UPS Runtime: Submit a detailed spreadsheet indicating each AC component within the control panel powered by the UPS and powered by the panel externally and its load in watts.
    1) UPS runtime is to take account for all devices running at full load.
    2) UPS runtime is to last a minimum of 30 minutes with all devices powered at their corresponding full load rating.
    3) Furnish battery expansion modules (as required) to achieve Specified runtime requirements.
    4) PS runtime calculations shall be de-rated to the maximum control panel interior temperature setpoint as determined by the “Temperature Control” section of this Specification Section.
f. Submit a detailed spreadsheet indicating each component within the control panel and it’s “Heat Load” (in watts) at full load (for cooling calculations) and operating load / partial load (for heating calculations).
    1) Note: Operating Load / partial load is defined as all heat generating sources are de-energized except the panel transformers and power supplies.
g. Submit heating and cooling calculations; based on panel location; to maintain 40 degrees F in winter and 10 degrees below the lowest rated maximum operating temperature of all the devices and equipment housed within the control panel) in summer, unless otherwise noted.

7. Control Panel Drawing Numbering Scheme:
    a. The last four digits of the control panel drawing number shall be as follows (Note: “XX” is defined as numbers in sequence starting from “01” to “99”.):
        1) 10XX: Title Sheet with index.

2) 12XX: Communication Diagram.
3) 20XX: Bill of Material and General Notes.
4) 30XX: Scaled Enclosure Layout and Panel Cutout Layout Diagrams.
5) 31XX: Scaled Subpanel Layout, PLC Enlarged Details and Terminal Block Rotation (Details).
6) 40XX: AC and DC Power Distribution Wiring Diagrams.
7) 41XX: PLC Discrete Input (Digital Input) Module Wiring Diagrams.
8) 42XX: PLC Discrete Output (Digital Output) Module Wiring Diagrams.
9) 43XX: Analog Input Module Wiring Diagrams.
10) 44XX: Analog Output Module Wiring Diagrams.

b. Alternative drawing numbering scheme can be submitted for approval.

8. Panel Construction Drawings:
   a. Drawing Size: Individual 11-inch by 17-inch sheet.
   b. Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
   c. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   d. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   e. 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.
   f. Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.
   g. Show each construction drawing individually. Each panel shall be tagged with its unique tag number as indicated on Drawings. Each panel device shall be tagged with its unique tag number as indicated on Drawings. “Typical” drawings will be permitted if drawings per panel are identical and a table showing unique tag numbers is provided.
9. Panel Control Diagrams: For discrete control and power circuits.
   a. Typical Control Panel Drawings shall be strictly forbidden. All Control Panel Drawings and Diagrams shall be unique to the installation of the equipment furnished, to include unique equipment tag and wiring numbers.
   b. Drawing Size: Individual 11-inch by 17-inch sheet.

c. Diagram Type: Ladder diagrams. Include devices, related to discrete functions that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung. Spacing between rungs shall be equidistant. The rung numbers shall relate to the sheet number. Wire numbers shall be designated by the rung number on which they first appear in the wiring diagrams followed by a subsequent digit ("1", "2", "3", etc.) or by a subsequent letter ("A", "B", "C", etc.). Terminal numbers shall be the same as the wire numbers which terminate to them. See below for additional detailed requirements.

d. Item Identification: Identify each item with attributes listed.
   1) Wires: Wire number and color. Cable number if part of multi-conductor cable.
   2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
   3) Discrete 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).
      c) Field devices with discrete contacts shall be shown utilizing their proper ISA symbol (see the latest version of ANSI/ISA-5.1, Instrumentation Symbols and Identification). See also the Control Diagram Legend in the General sheets of Drawings.
   4) Relay Coils:
      a) Tag number and its function.
      b) Relay coils shall be tagged by the rung on which they are located.
      c) On right side of run where coil is located, list contact location by rung number and sheet number – if rung number does not indicate sheet number reference as well. Underline reference for normally closed contacts.
   5) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
   6) Timer Coils: Indicate to the right side of the timer coil, the timer type and preset timing setpoint. Underline normally

closed timed contact reference. List timer contact location by rung number.

a) Timer coils shall be tagged by the rung on which they are located.
b) Indicate "^" centered and beneath each contact rung number cross reference for all "On-Delay" timing contacts.
c) Indicate "v" centered and beneath each contact rung number cross reference for all "Off-Delay" timing contacts.

7) Timed Contacts: Indicate timed contacts as NOTC, NOTO, NCTC or NCTO.
a) NOTC: "Normally-Open, Timed-Closed".
b) NOTO: "Normally-Open, Timed-Open".
c) NCTC: "Normally-Closed, Timed-Closed".
d) NCTO: "Normally-Closed, Timed-Open".

e. Show each circuit individually. "Typical" drawings will be permitted if drawings per panel are identical and a table showing unique tag numbers is provided.
f. Ground wires, surge protectors, and connections.
g. Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.
h. Refer to this Section, Supplement Wiring Diagram Examples, for additional detail for the following:
1) AC Power Distribution.
2) DC Power Distribution.
3) Discrete Inputs to PLC.
4) Discrete Outputs from PLC.
5) Analog Inputs to PLC (both two and four-wire).
a) Note: Configure spare inputs to be easily changeable between a two-wire and four-wire transmitter type input.
6) Analog Outputs from PLC.
i. Rungs:
1) Rungs shall be equidistant from each other.
2) Horizontal rung shall line up with its corresponding rung number indicated on its left.

j. Rung Numbers:
   1) Rung numbers shall incorporate the last four digits of the sheet number and be followed by "01-99" (as required).
      a) Example:
         (1) The first rung of the first power distribution drawing shall be 400101.
         (2) The fifteenth rung of the second discrete input drawing shall be 410215.

k. Wire Numbers:
   1) Wire numbers shall be the same as the first rung number that the wire originates on.
   2) When more than one wiring segment exists on the same rung, it shall be followed by a digit or letter (as described above).
   3) Wire numbers shall be the same for all wiring that is continuous (same wiring node).
   4) Wire numbers shall change when the wire terminates on an item which can be used as a disconnecting means.
      a) Example: Fuse, Circuit Breaker, Relay Contact, etc.
   5) PLC wire numbers shall follow this format (RXXSXXPXX – where "XX" is "00 – 99") and be tagged as follows:
      a) RXX – Defines the PLC Rack Number.
      b) SXX – Defines the slot of the PLC in which the I/O card resides.
      c) PXX – Defines the point on the I/O card on which the wire terminates.
   6) Alternative wire numbers may be submitted for prior approval.

l. Device Identification:
   1) Disconnect Switches: DISC-XXXXX (where "XXXXX" is the rung number on which the disconnect switch resides).
   2) Transformers: XMFR-XXXXX (where "XXXXX" is the rung number on which the transformer resides).
   3) Motor Starters: M-XXXXX (where "XXXXX" is the rung number on which the motor starter resides).
   4) Reversing Motor Starter:
      a) Forward Coil: MF-XXXXX (where "XXXXX" is the rung number on which the motor starter forward coil resides).
      b) Reverse Coil: MR-XXXXX (where "XXXXX" is the rung number on which the motor starter reversing coil resides).
   5) Circuit Breakers: CB-XXXXX (where "XXXXX" is the rung number on which the circuit breaker resides).

6) Fuses: FU-XXXXX (where "XXXXX" is the rung number on which the fuse resides).
7) Terminal Numbers: TB-XXXXXX (where "XXXXXX" is the wire number which terminates on the terminal block).
8) Surge Suppressors: SS-XXXXX (where "XXXXX" is the rung number on which the surge suppressor resides).
9) Simplex Receptacles: SREC-XXXXX (where "XXXXX" is the rung number on which the simplex receptacle resides).
10) Duplex Receptacles: DREC-XXXXX (where "XXXXX" is the rung number on which the duplex receptacle resides).
11) GFCI Receptacles: GFCI-XXXXX (where "XXXXX" is the rung number on which the GFCI receptacle resides).
12) Panel Lights: LT-XXXXX (where "XXXXX" is the rung number on which the panel light resides).
13) Ground: Gnd.
14) Power Supplies: PWS-XXXXX (where "XXXXX" is the rung number on which the power supply resides).
15) Power Supply Redundancy Module: RM-XXXXX (where "XXXXX" is the rung number on which the redundancy module resides).
16) Control Relay Coils: CR-XXXXX (where "XXXXX" is the rung number on which the control relay resides).
17) Logic Relay Coils: LR-XXXXX (where "XXXXX" is the rung number on which the logic relay coil resides).
18) Timing Coils: TR-XXXXX (where "XXXXX" is the rung number on which the timing coil resides).
19) Heating Element: HTR-XXXXX (where "XXXXX" is the rung number on which the heater resides).
20) Air Conditioning System: AC-XXXXX (where "XXXXX" is the rung number on which the air conditioning system resides).
21) Pilot Lights: YL-XXXXX (where "XXXXX" is the rung number on which the pilot light resides).
22) If a device is not listed here use the corresponding ISA equipment code (see the latest version of ANSI/ISA-5.1 – Instrumentation Symbols and Identification). See also the Instrument Identification Legend in the General sheets of the Drawings.
23) Alternative Device Identification may be submitted for prior approval.

10. Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.

11. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency 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. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
    d. Divide each loop diagram into areas for panel face, back-of-panel, and field.
    e. Analog signal wiring shield shall be grounded at the PLC panel to a shield drain terminal block rail which shall be grounded to the ground bus of the control panel.
    f. Each DC circuit shall be individually fused.
    g. Each DC loop shall be individually fused.
    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 shall be strictly forbidden.
        3) Tabular Summary on Each 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.
            f) Signal Type.
            g) Indicate signal flow direction.
        4) Circuit and raceway schedule names.
    i. Loop drawings shall be unique. Each loop device shall be tagged with its unique tag number as indicated on Drawings. No “typical” drawings and loops will be permitted.
    j. Loop drawings shall contain the following (as a minimum):
        1) Field device with terminations indicated.
            a) Indicate the following:
                (1) Field device tag number (as indicated on Drawings).
                (2) Field device description.
                (3) Field device manufacturer.
                (4) Field device model number.
                (5) Field device instrument range and identify the correct engineering units.
                (6) Field device calibrated span and identify the correct engineering units.

(7) Four-wire Transmitters: Indicate where the source of power originates and the corresponding circuit number.

2) Field mounted surge suppressor.
3) Interface with control panel.
   a) Terminal block tag numbers.
   b) Shield terminal block.
4) Panel mounted surge suppressor.
5) Blade type disconnection fuse block.
   a) Fuse rating.
6) Interface with PLC, internal instrument and/or panel mounted instrument.

12. Interconnecting Wiring Diagrams:
    a. Diagrams, device designations, and symbols in accordance with NEMA ICS 1.
    b. Diagrams shall bear electrical Subcontractor's signature attesting diagrams have been coordinated with Division 26, Electrical.
    c. Show:
       1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
       2) Component and panel terminal board identification numbers, and external wire and cable numbers.
       3) Circuit names matching Circuit and Raceway Schedule.
       4) Intermediate terminations between field elements and panels (for example, to terminal junction boxes and pull boxes).
       5) Pull boxes.
13. Installation Details: Include modifications or further details required to adequately define installation of I&C components.
14. List of spares, expendables, test equipment and tools.
15. Additional Equipment Recommended: List of, and descriptive literature for, additional spares, expendables, test equipment and tools recommended. Include unit prices and total costs as specified in Section 01 29 00, Payment Procedures.

B. Informational Submittals: For PIC and Package System equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.

1. Owner Training Plan: Reference Section 01 43 33, Manufacturers' Field Services.
2. Operation and Maintenance (O&M) Manuals: In accordance with Section 01 78 23, Operation and Maintenance Data, unless otherwise specified in this section.
   a. Content and Format:
      1) Complete sets O&M manuals.

2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PIC component.
3) Final versions of Legend and Abbreviation Lists.
4) Manual format in accordance with Section 01 78 23, Operation and Maintenance Data.
5) Complete written Sequence of Operation describing how to operate the control system in MANUAL, REMOTE MANUAL and AUTOMATIC modes of operation.
6) Trouble shooting guide to assist operators to diagnose common failure conditions of the system.

b. Include:
1) Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PIC design.
2) Refer to Paragraph Shop Drawings for the following items:
a) Bill of Materials.
b) Catalog Cuts.
c) Component Data Sheets.
d) Panel Control Diagrams.
e) Panel Wiring Diagrams, one reproducible copy.
f) Panel Plumbing Diagrams, one reproducible copy.
g) Loop Diagrams, one reproducible copy.
h) Interconnecting Wiring Diagrams, one reproducible copy.
i) Application Software Documentation.
3) Device O&M manuals for components, electrical devices, and mechanical devices include:
a) Operations procedures.
b) Installation requirements and procedures.
c) Maintenance requirements and procedures.
d) Troubleshooting procedures.
e) Calibration procedures.
f) Internal schematic and wiring diagrams.
g) Component Calibration Sheets from field quality control calibrations.
h) Hard Copy of the fully documented PLC code and three copies of the fully documented PLC program written to DVD-R or Flash Drive media.
4) List of spares, expendables, test equipment and tools provided.
5) List of additional spares, expendables, test equipment and tools recommended.

3. Unwitnessed Factory Tests (UFT) Submittals:
    a. Control panel / control system testing procedures shall include testing of all operational states of the system and also include the testing of all possible failure conditions within the operational states.
    b. Submit checklist identifying all operational states of the control system. Checklist shall identify all operational states during normal operation (with no failures).
    c. Submit checklist identifying all failure conditions in each operational state of the control system. Checklist shall identify all operational states during operation and each failure condition within those states. System shall be tested for failure of all possible states and proper system response and/or recovery.
    d. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
    e. Final Test Procedures: Proposed test procedures, forms, and checklists.
    f. Proposed test procedures shall be submitted and reviewed and approved by both the Engineer and Owner prior to scheduling UFT.
    g. Test Documentation: Copy of signed off test procedures when tests are completed.
    h. Signed off.
4. Operational Readiness Tests (ORT) Submittals:
    a. Control panel / control system testing procedures shall include testing of all operational states of the system and also include the testing of all possible failure conditions within the operational states.
    b. UFT must be completed and associated UFT documentation must be approved by both the Engineer and Owner prior to shipping the control panels and scheduling the ORT.
    c. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
    d. Submit checklist identifying all operational states of the control system. Checklist shall identify all operational states during normal operation (with no failures).
    e. Submit checklist identifying all failure conditions in each operational states of the control system. Checklist shall identify all operational states during operation and each failure condition within those states. System shall be tested for failure of all possible states and proper system response and/or recovery.
    f. Final Test Procedures: Proposed test procedures, forms, and checklists.

g. Test Documentation: Copy of signed off test procedures when tests are completed.
h. Submit instrument calibration reports for review and approval by both the Engineer and Owner for all instruments involved in the ORT. Instrument calibration reports shall be per ISA S20 standards.
i. Test Documentation: Copy of signed off test procedures when tests are completed.
j. PICS Contractor and Package System Supplier must coordinate for support requirements during the ORT.

5. Performance Acceptance Tests (PAT) Submittals:
   a. ORT must be completed and associated ORT documentation must be approved by both the Engineer and Owner prior to scheduling the PAT.
   b. Control panel / control system testing procedures shall include testing of all operational states of the system and also include the testing of all possible failure conditions within the operational states.
   c. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
   d. Furnish checklist identifying all operational states of the control system. Checklist shall identify all operational states during normal operation (with no failures).
   e. Furnish checklist identifying all failure conditions in each operational states of the control system. Checklist shall identify all operational states during operation and each failure condition within those states. System shall be tested for failure of all possible states and proper system response and/or recovery.
   f. Proposed test procedures shall be submitted and reviewed and approved by both the Engineer and Owner prior to scheduling PAT.
   g. Final Test Procedures: Proposed test procedures, forms, and checklists.
   h. Submit instrument calibration reports for any instrument that has been recalibrated since the PAT for review and approval by both the Engineer and Owner for all instruments involved in the PAT. Instrument calibration reports shall be per ISA S20 standards.
   i. Test Documentation: Copy of signed off test procedures when tests are completed.
   j. PICS Contractor and Package System Supplier must coordinate for support requirements during the PAT.

C. Testing (required for all tests listed below):

1. Control panel / control system testing procedures shall include testing of all operational states of the system and include the testing of all possible failure conditions within the operational states.
2. Unwitnessed Factory Tests (UFT) Submittals:
    a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
    b. Final Test Procedures: Proposed test procedures, forms, and checklists.
    c. Proposed test procedures shall be submitted and reviewed and approved by both the Engineer and Owner prior to scheduling UFT.
    d. Test Documentation: Copy of signed off test procedures when tests are completed.
    e. Signed off.
3. Witnessed Factory Acceptance Tests (FAT) Submittals:
    a. UFT must be completed and associated UFT documentation must be approved by both the Engineer and Owner prior to scheduling the FAT.
    b. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
    c. Final Test Procedures: Proposed test procedures, forms, and checklists.
    d. Test Documentation: Copy of signed off test procedures when tests are completed.
    e. Coordinate with ASP for PLC / HMI software testing.
4. Operational Readiness Tests (ORT) Submittals:
    a. FAT must be completed and associated FAT documentation must be approved by both the Engineer and Owner prior to shipping the control panels and scheduling the ORT.
    b. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
    c. Proposed test procedures shall be submitted and reviewed and approved by both the Engineer and Owner prior to scheduling ORT.
    d. Final Test Procedures: Proposed test procedures, forms, and checklists.
    e. Submit instrument calibration reports for review and approval by both the Engineer and Owner for all instruments involved in the ORT. Instrument calibration reports shall be per ISA S20 standards.
    f. Test Documentation: Copy of signed off test procedures when tests are completed.

g. Coordinate with ASP Contractor for support requirements during the ORT.

5. Performance Acceptance Tests (PAT) Submittals:
   a. ORT must be completed and associated ORT documentation must be approved by both the Engineer and Owner prior to scheduling the PAT.
   b. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
   c. Proposed test procedures shall be submitted and reviewed and approved by both the Engineer and Owner prior to scheduling PAT.
   d. Final Test Procedures: Proposed test procedures, forms, and checklists.
   e. Submit instrument calibration reports for any instrument that has been recalibrated since the ORT for review and approval by both the Engineer and Owner for all instruments involved in the PAT. Instrument calibration reports shall be per ISA S20 standards.
   f. Test Documentation: Copy of signed off test procedures when tests are completed.
   g. Coordinate with ASP Contractor for support requirements during the PAT.

1.05 QUALITY ASSURANCE

A. Calibration Instruments: Each instrument used for calibrating PIC equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the NIST.

B. Coordination Meetings:

1. In accordance with Section 01 31 13, Project Coordination.
2. Location: TBA.
3. Attended By: Engineer, Owner, and Contractor.
4. Minimum of four are required. Specific dates will be established in Progress Schedule.
5. First Meeting: TBA.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide Site and warehouse storage facilities for PIC equipment.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

C. PICS/Package System Contractor must install delivered equipment within seven days of arriving onsite.

D. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

E. Cover panels and other elements that are exposed to dusty construction environments.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Standard Environmental Requirements:

1. Unless otherwise noted, design equipment for continuous operation in these environments:
   a. Freestanding Panel and Consoles:
      1) Inside, Air Conditioned, noncorrosive or wet environment: NEMA 12.
      2) Inside, Unconditioned Space: NEMA 12.
      3) Inside or Outside, Corrosive or Wet Environment: Type 316 stainless steel, NEMA 4X.
   b. Smaller Panels and Assemblies (that are not freestanding):
      1) Inside, Air Conditioned, Noncorrosive or Wet Environment: NEMA 12.
      2) All Other Locations: Type 316 stainless steel, NEMA 4X.
   c. Field Elements: Outside.

B. Environmental Design Requirements: Following defines the types of environments referred to in the above.

1. Inside, Air Conditioned:
   a. Temperature:
      1) Normal: 50 degrees F to 90 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.
2. Inside, Unconditioned Space:
   a. Temperature: Minus 20 degrees F to 120 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. NEC Classification: Nonhazardous.

3. Inside, Corrosive, Unconditioned Space:
   a. Temperature: Minus 20 degrees F to 120 degrees F.
   b. Relative Humidity: 10 percent to 100 percent.
   c. Corrosive Environment: Chlorine gas, H_2S, etc.
   d. NEC Classification: Nonhazardous.
4. Outside:
   a. Temperature: Minus 20 degrees F to 120 degrees F.
   b. Relative Humidity: 10 percent to 100 percent, rain, snow and freezing rain.
   c. NEC Classification: Nonhazardous.
5. Outside, Corrosive:
   a. Temperature: Minus 10 degrees F to 115 degrees F.
   b. Relative Humidity: 10 percent to 100 percent, rain, snow and freezing rain.
   c. Corrosive Environment: Chlorine gas. NEC Classification: Nonhazardous.

1.08 SEQUENCING AND SCHEDULING

A. Activity Completion:

1. The following is a list of key activities and their completion criteria:
   a. Shop Drawings: Reviewed and approved.
   b. Quality Control Submittals: Reviewed and accepted.
   c. UFT: Completed and required test documentation accepted.
   d. Hardware Delivery: Hardware delivered to Site and inventoried by Owner.
   e. ORT: Completed and required test documentation accepted.
   f. PAT: Completed and required test documentation accepted.

B. PIC and/or Package System Supplier Substantial Completion: When Engineer issues Certificate of Substantial Completion.

1. Prerequisites:
   a. All PIC and/or Package System Supplier Submittals have been completed.
   b. PIC and/or Package System Supplier has successfully completed ORT.
   c. PIC and/or Package System Supplier has successfully completed PAT.
   d. Owner training plan is on schedule.
   e. All spares, expendables, and test equipment have been delivered to Owner.

C. PIC and/or Package System Supplier Acceptance: When Engineer issues a written notice of Final Payment and Acceptance.

1. Prerequisites:
   a. Certificate of Substantial Completion issued for PIC and/or Package System Supplier.
   b. Punch-list items completed.
   c. Final revisions to O&M manuals accepted.
   d. Maintenance service agreements for PIC and/or Package System Supplier accepted by Owner.

D. Prerequisite Activities and Lead Times:

1. Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

Activity	Prerequisites and Lead Times
Submittal reviews by Engineer	Engineer acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly	Associated Shop Drawing Submittals completed.
UFT	Completion and approval of Shop Drawing Submittals.
Shipment	Completion of PIC Shop Drawing Submittals, UFT and preliminary O&M manuals.
Owner Training	Owner training plan completed.
ORT	Startup, Owner training, and ORT procedures completed; notice 4 weeks prior to start.
PAT	Startup, Owner training, and PAT procedures completed; notice 4 weeks prior to start.

PART 2 PRODUCTS

2.01 GENERAL

A. PIC functions as shown on Drawings and as required for each loop. Furnish equipment items as required. Furnish all materials, equipment, and software, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment and materials.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with Article Submittals.
2. If using proposed item requires other changes, provide work and equipment to implement these changes. Changes that may be required include, but are not limited to: different installation, wiring, raceway, enclosures, connections, isolators, intrinsically safe barriers, software, and accessories. These shall be provided at no additional cost to the Owner.
3. If an item (including but not limited to control panels, junction boxes, terminal boxes, conduit, wiring, instruments, operator interface devices, control panel devices, etc.) is used on this Project that deviates from the Specification and Contract Document requirements and has not been Approved for use on this Project in writing by both the Engineer and the Owner; the item shall be disconnected and removed from the Project Site and replaced with the Specified item at no additional expense to the Owner and no delay to the approved Project Schedule.
4. If using proposed item, all functionality of the first listed manufacturer's item must be met by the proposed item. This may include, but not limited to, external components to meet the functional requirements. These shall be provided at no additional cost to the Owner.

C. Substitution of equipment, instruments or devices listed within the Specifications:

1. If the PICS or Package System Supplier proposes to submit equipment, instruments or devices not listed or specified within these Contract Documents, the PICS or Package System Supplier must complete a spreadsheet itemizing all performance characteristics of the first named manufacturer listed within these Specifications and compared to the same performance characteristics of the alternate product. All performance requirements of the alternate product must equal or exceed the performance characteristics of the first named manufacturers' item

as indicated within these Specifications. Failure to submit this comparison form shall result in immediate rejection of the alternate product submitted for approval on this Project.

2. The PICS or Package System Supplier must submit the technical cut sheets of both the first named manufacturer listed within the Specifications and well as the alternate product.
3. The PICS or Package System Supplier must submit the cost of the listed manufacturers product and the cost of the proposed substitute product.
4. The decision to accept alternate products shall be at the sole discretion of the Engineer.

D. 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 all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

2.02 LOOP SPECIFICATIONS

A. Location: Article Supplements.

B. Organization: By unit process and loop number.

C. Functional Requirements for Control Loops:

1. Shown on Drawings 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.
2. Supplemented by Loop Specifications.

D. Subheadings for Each Loop:

1. Functions: Clarifies functional performance of loop, including abstract of interlocks.
   a. Components: Lists major components for each loop. Information listed include: Tag numbers.
   b. Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article Supplements.
   c. Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, setpoints, and controller options.

2.03 I&C COMPONENTS

A. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish all equipment that is necessary to achieve required loop performance.

B. Component Specifications: Generalized specifications for each type of component are located in Article Supplements.

2.04 PLC/SCADA HMI PROGRAMMING REQUIREMENTS:

A. To assure compliance to Owner's standard SCADA programming requirements, a SCADA Standards Document shall be given to Contractor to be used for both PLC and SCADA HMI programming. The following are minimum requirements that shall also be implemented:

1. Contractor shall use the following PLC programming languages and structures:
   a. Ladder Logic and Function Blocks: Basic combinational and sequential logic.
   b. PLC programming to follow modular programming techniques, well documented code (i.e., comments on instructions, rungs and routines, etc.).
   c. Programming utilizing sequential function charts, structured text or any other method other than ladder logic or Function Block shall be strictly prohibited.
2. Provide logical data tables with assigned blocks of registers for each on data type (input/output designations, internal relay storage, timers and counters, alarm points, block transfer allocation, etc.).
   a. The Contractor shall include as part of his initial submittal his proposed data table configuration. Data table configuration shall be approved before Contractor proceeds with the task of programming.
   b. The Owner/Owner's Representative or Engineer shall provide specific ranges for these register assignments.
3. Contractor to perform all required modifications to existing Plant SCADA HMI to achieve specified functionality. All modifications shall be programmed to match existing HMI programming and conform to all requirements in SCADA Standards Document provided by Owner. Owner will allow access to an onsite SCADA engineering workstation for Contractor to perform all HMI programming. Notify the Owner two weeks in advance to schedule the use of the Engineering Workstation. Languages used are Rockwell Automation Studio 5000 for PLC programming, Rockwell Automation FactoryTalk ME for panel PCs and

Wonderware (InTouch for System Platform, InTouch, Wonderware Historian and Industrial Application Server) for SCADA HMI.

4. The Contractor shall provide enough time to do all programming as required in order for the PLC and HMI to perform all functions as described in Supplement Loop Specifications and as shown on Drawings.
5. Contractor shall allot forty hours of programming for Owner requested and approved programming modifications to be used during the commissioning phase of the Project.
6. After the facilities have been accepted by both the Owner and the Engineer (after substantial completion) for 12 months, the PICS and/or package system supplier shall provide an additional (as listed below) hours of programming time to make adjustments to the PLC and/or OIU programming as required by the Owner. This time shall not include travel to and from the project site for implementation of the programming changes. If PICS and/or package system supplier is not local the time listed below shall be done during one continuous trip.
   a. PICS: 40 hours.
   b. Section 44 42 63, Hose-less Solids Collection System: 16 hours.

2.05 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on the enclosure face.

1. Location and Inscription: As shown.
2. Materials: Laminated plastic attached to panel with double-adhesive tape (3M VHB™ Tape 4936, tesa® 4970; “or-equal”).
3. Letters: 1/2-inch black on white 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.
2. Materials: Laminated plastic attached to panel with double-adhesive tape (3M VHB™ Tape 4936, tesa® 4970; “or-equal”).
3. Letters: 3/16-inch black on white background, unless otherwise noted.

C. Component Nameplates—Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Laminated plastic attached to panel with double-adhesive tape (3M VHB™ Tape 4936, tesa® 4970; “or-equal”).
3. Letters: 3/16-inch black on white background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription: Refer to:
   a. Table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Table under Paragraph Standard Light Colors and Inscriptions.
   c. 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.
2. Materials: Laminated plastic attached to panel with double-adhesive tape (3M VHB™ Tape 4936, tesa® 4970; “or-equal”).
3. Letters: 3/16-inch black on white background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 316 stainless steel.
3. Letters: 3/16-inch imposed.
4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.06 CONTROL PANEL

A. Panel Construction and Interior Wiring:

1. For a panel in a non-hazardous location:
2. Control panels shall be UL 508A listed.
3. In accordance with the National Electrical Code (NEC), UL 508A, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.
4. Serialized UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.

B. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.

3. Circuit Breakers:
   a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
   b. Branch Circuit Breakers: 15 amps at 250V ac.
   c. Breaker Manufacturers and Products:
      1) Heineman Electric Co.; Series AM.
      2) Airpax/North American Philips Controls Corp.; Series 205.
      3) "Or-equal."

C. 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. Ampere RMS symmetrical rating (as defined in Division 26, Electrical, series Specifications), minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
   e. Tripping: Indicate with operator handle position.
3. Magnetic Motor Starters (if applicable):
   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. Adjustable Frequency Drives (if applicable): Refer to Specification Section 26 29 23, Low-Voltage Adjustable Frequency Drive System, for requirements.
5. 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.

6. Power Monitoring Relay (for each motor):
    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 (via a hard-wired latching circuit) during abnormal conditions.
    c. Transient Voltage Protection: 10,000 volts.
    d. Manufacturer and Product: Furnas; Class 47.
7. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
8. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Conform to NEMA ratings as specified in individual equipment sections.

E. Minimum Metal Thickness: 14-gauge.

F. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.

G. Disconnects: Padlockable, flange-mounted disconnects only. Rotary disconnects shall be strictly forbidden for use on this Project.

H. Doors:

1. Free Standing Panels:
    a. Full height, fully gasketed access doors where shown on Drawings.
    b. Latches: Three-point, Southco Type 44.
    c. Handles: “D” ring, foldable type.
    d. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
    e. Front and Side Access Doors: As shown on Drawings.
2. Nonfree-Standing Panels:
    a. Rubber-gasketed with continuous hinge.
    b. Control panels equal or exceeding 16 inches in height:
        1) Padlockable 3-point lockable latch.
    c. Control panels less than 16 inches in height:
        1) Stainless steel, padlockable quick-release luggage-type latches. Latches shall not require the use of tools to open and close. Latches requiring the use of tools to open or close are not acceptable for use on this Project.

I. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

J. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

K. Entry (penetrations) into the top of the panel or enclosure is strictly prohibited.

L. OIU in outdoor enclosures shall be mounted behind a gasketed hinged access enclosure.

M. UPS and expansion battery modules (if furnished) shall be placed on a UPS shelf within the control panel. The UPS shelf must be secured to the enclosure. The UPS and expansion battery modules (if furnished) must be secured to the UPS shelf to meet UL 508A requirements. Subplate mounted devices, terminals, wiring ducts, etc. shall not be permitted to be mounted to the subplate behind the UPS and expansion battery modules (if furnished).

N. The UPS may also be mounted to a nineteen-inch rack assembly within the control panel if a rack-mounted UPS is furnished. Leave adequate space to access plugs and cords in the back of the UPS.

O. Any specialty item (tool/software) needed to operate, maintain, or troubleshoot the system/equipment, shall be furnished by Contractor.

P. Temperature Control:

1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
2. Furnish self-contained, sealed (NEMA 4X) cooling system with air filters if required to dissipate heat.
3. For panels outdoors or in unconditioned spaces, furnish the following devices:
    a. Temperature transmitter with a range of 32 degrees F to 158 degrees F. Output shall be 4 mA dc to 20 mA dc.
        1) Transmitter shall be Dwyer Model 650-1.
4. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.
    a. In humid areas, seasonally increase the setpoint to reduce condensation that results when nighttime temperatures fall below the dew point.
5. For panels that has a calculated interior temperature higher than the cooling setpoint as calculated by the method listed below; furnish thermostatically controlled cooling system to maintain temperature ten degrees below the lowest maximum operating temperature rating of any

device housed within the enclosure. Cooling system shall maintain the NEMA rating of the enclosure.

a. If the device (within the control panel) with the lowest maximum temperature rating exceeds the calculated interior temperature of the control panel by 10 degrees F, then no cooling shall be required.
    1) Example: If five devices have the upper temperature threshold of the following:
        a) 160, 175, 180, 200 and 220 degrees F; the equipment with the lowest temperature rating (160 degrees F) would be used to determine if cooling is required. If the interior ambient temperature of the control panel is determined to be 150 degrees F or less with the solar load and ambient outdoor temperature of 115 degrees F, then no cooling shall be required. If the interior panel temperature were determined to be greater than 150 degrees F, then cooling shall be required.

6. Control Panels Mounted in Outdoor Environments: Calculate and submit cooling and heating load of all enclosures between ambient temperatures of minus 10 degrees F to 115 degrees F. Solar load shall be taken into account.
7. Control Panels Mounted in Indoor Environments in an Unconditioned Space without Heating: Calculate and submit cooling and heating load of all enclosures between ambient temperatures of minus 10 degrees F to 115 degrees F.
8. Control Panels Mounted in Indoor Environments in an Unconditioned Space with Heating: Calculate and submit cooling and heating load of all enclosures between ambient temperatures of maintained space temperature heating setpoint to 115 degrees F.
9. Control Panels Mounted in Indoor Environments in a Conditioned Space with Heating and Cooling: Calculate and submit cooling and heating load of all enclosures between ambient temperatures of maintained space temperature heating setpoint to the maintained space temperature cooling setpoint (as defined by the heating and cooling mechanical equipment).
10. Heating calculations shall be done utilizing operating-load (partial load) condition of the equipment housed within the control panel. No solar load shall be used for this calculation. Furnish a detailed spreadsheet of each component housed within the enclosure and indicate its operating-load condition (in Watts), and the enclosure total internal heat load.
    a. Only the heating load of the transformers and power supplies in the control panel shall be utilized for the heating calculation.

11. Cooling calculations shall be done utilizing full-load condition of the equipment housed within the control panel and taking into account the solar load. Furnish a detailed spreadsheet of each component housed within the enclosure and indicate its full-load condition (in Watts), and the enclosure total internal heat load.
12. If a solar shield is used to protect a panel, assume that it reduces panel solar radiation by no more than 50 percent.
13. Furnish the equations used in the heating and cooling calculations.
14. Note: In cases where a component's (housed within the control panel) maximum temperature rating is below the required temperature setpoint (as calculated above) furnish an alternate component (subject to review and approval by the Engineer) with a higher temperature rating to raise the required temperature setpoint and / or help reduce the cooling load.

Q. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

R. Lighting: Minimum of one door switch controlled internal fluorescent or LED light for panels 12 cubic feet and larger.

S. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

T. Finish:

1. Indoor Installations: Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer's standard gray unless otherwise specified.
2. Outdoor Installations: Factory applied powder coated white.
3. Internal Surfaces: White enamel.

U. Panel Manufacturers:

1. Hoffman.
2. Rittal.

V. Combination Breather and Drains: Furnish with NEMA 250, Type 4 and Type 4X panels.

1. Manufacturer and Product:
   a. Cooper Crouse-Hinds: ACDPES/075NPT/15.
   b. Pentair: H2OMIT Stainless Steel Vent Drain (AVDR4SS4).

W. Pressure Compensation Device (if required):

1. Manufacturer and Product: Hoffman; APCDSS6.

2.07 ELECTRICAL REQUIREMENTS

A. In accordance with Division 26, Electrical.

B. I&C and Electrical Components, Terminals, Wires, and Enclosures: UL listed.

C. 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 14 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
   c. PLC Analog I/O: All analog I/O shall be (used and spare) shall be prewired to loop isolators, surge suppressors and terminal blocks to allow field wiring modifications between both a two-wire, three-wire and four-wire type circuit.
3. Other dc Circuits.
   a. Type: 300-volt, Type MTW, stranded copper.
   b. Size: For current carried, but not less than 16 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 PermaSleeve.
      2) Tyco Electronics.

D. Wires entering or leaving enclosures, terminate and identify 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 Section 26 05 01, Electrical.

E. Terminal Blocks for Enclosures:

1. Refer to Section 26 05 01, Electrical, for terminal blocks and / or wiring exceeding 120V ac line voltage.
2. Quantity:
   a. Accommodate present and spare indicated needs.

b. Wire spare PLC discrete I/O points to terminal blocks via interposing relays.
c. Wire spare PLC analog I/O points to optical isolators and surge suppressors. Furnish terminals to allow the point to be easily configured to accept/be both sourcing and loop powered signals.
d. One wire per terminal for field wires entering enclosures.
e. Maximum of two wires per terminal for 16 AWG wire for internal enclosure wiring.
f. Spare Terminals: 20 percent of all connected terminals, but not less than 10 per terminal strip.

3. General:
   a. All terminal blocks and fuse blocks shall be "Finger-Safe."
   b. Connection Type: Screw compression clamp.
   c. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   d. Screws: Hardened steel, captive and self-locking.
   e. Current Bar: Copper or treated brass.
   f. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funneled shaped inputs to facilitate wire entry.
   g. Mounting:
      1) Raised 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.
   h. Wire Preparation: Stripping only permitted.
   i. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   j. 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.
   k. Test Plugs: Soldered connections for 18 AWG wire.
      1) Pin Diameter: 0.079 inch.
      2) Quantity: Two per panel.
      3) Manufacturer and Product: Entrelec; Type FC2.

4. Terminal Block, General-Purpose:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 30 amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Grey 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.
5. Terminal Block, Ground:
    a. Wire Size: 22 AWG to 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.
6. Terminal Block, Blade Disconnect Switch:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 10-amp.
    c. Wire Size: 22 AWG to 12 AWG.
    d. Rated Wire Size: 12 AWG.
    e. Color: Grey body, orange switch.
    f. Spacing: 0.25 inch, maximum.
    g. Manufacturer and Product: Entrelec; Type M4/6.SN.T.
7. Terminal Block, Fused, 24V dc:
    a. Rated Voltage: 600V dc.
    b. Rated Current: 16-amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Grey 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 M10/13T.SFL.
8. Terminal Block, Fused, 120V ac:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 16-amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Grey 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 M10/13T.SFL.

9. 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: Grey.
   f. Fuse: 13/32-inch by 1.5 inches.
   g. Spacing: 0.95-inch, maximum.
   h. Manufacturer and Product: Entrelec; Type MB10/24.SF.
10. Terminal Block, PLC Discrete Output, 120V ac:
   a. Rated Coil Voltage: 120V ac.
   b. Rated Contact Voltage: 250V ac/dc.
   c. Rated Current: 6 amps.
   d. Relay Configuration: SPDT.
   e. Wire Size: 26 AWG to 14 AWG.
   f. Rated Wire Size: 14 AWG.
   g. Color: Green Terminal with white relay module.
   h. Spacing: 6.2 mm.
   i. Manufacturer and Product: Phoenix Contact PLC-RSC-120UC/21.
11. Terminal Block, PLC Discrete Input, 120V ac:
   a. Rated Coil Voltage: 120V dc.
   b. Rated Contact Voltage: 250V ac/dc.
   c. Rated Current: 2 amps at 24 dc.
   d. Relay Configuration: One normally open contact.
   e. Wire Size: 26 AWG to 14 AWG.
   f. Rated Wire Size: 14 AWG.
   g. Color: Green Terminal with white relay module.
   h. Spacing: 6.2 mm.
   i. Manufacturer and Product: Phoenix Contact PLC-RSC-120UC/21.
12. Terminal Block, PLC Discrete Output, 24V dc:
   a. Rated Coil Voltage: 24V dc.
   b. Rated Contact Voltage: 250V ac/dc.
   c. Rated Current: 6 amps.
   d. Relay Configuration: SPDT.
   e. Wire Size: 26 AWG to 14 AWG.
   f. Rated Wire Size: 14 AWG.
   g. Color: Green Terminal with white relay module.
   h. Spacing: 6.2 mm.
   i. Manufacturer and Product: Phoenix Contact; PLC-RSC-24UC/21.

13. Terminal Block, PLC Discrete Input, 24V dc:
    a. Rated Coil Voltage: 24V dc.
    b. Rated Contact Voltage: 250V ac/dc.
    c. Rated Current: 6 amps at 24V dc.
    d. Relay Configuration: One normally open contact.
    e. Wire Size: 26 AWG to 14 AWG.
    f. Rated Wire Size: 14 AWG.
    g. Color: Green Terminal with white relay module.
    h. Spacing: 6.2 mm.
    i. Manufacturer and Product: Phoenix Contact; PLC-RSC-24UC/21.
14. Terminal Block, PLC Analog I/O:
    a. Rated Voltage: 300V dc.
    b. Rated Current: 10-amp.
    c. Wire Size: 24 AWG to 12 AWG.
    d. Rated Wire Size: 16 AWG.
    e. Color: Grey body with green and yellow shield terminal.
    f. Fuse: 9.9 mm by 33.1 mm.
    g. Indication: LED diode 24V dc.
    h. Spacing: 6.2 mm.
    i. Manufacturer and Product: Phoenix Contact; DOKD 1,5-TG.
15. Terminal Block, PLC Analog I/O Signal Conditioner/Isolators:
    a. Maximum Input Voltage: 33V dc.
    b. Maximum Input Current: 24mA dc.
    c. Nominal Supply Voltage: 24V dc.
    d. Wire Size: 24 AWG to 12 AWG.
    e. Color: Gray.
    f. Input: Dip switchable analog voltage and current signals (4 mA dc to 20 mA dc normal).
    g. Output: Dip switchable analog voltage and current signals (4 mA dc to 20 mA dc normal).
    h. Power Consumption: Plus or minus 800 mW.
    i. Maximum Load: 600Ω.
    j. Electrical Isolation: Reinforced insulation in accordance with IEC 61010-1.
    k. Rated Insulation Voltage: 300V.
    l. Power Supply: Phoenix Contact; MINI-SYS-PS-100-240AC/24DC/1.5.
    m. Manufacturer and Product: Phoenix Contact; MINI MCR-2-UI-UI.

F. Grounding of Enclosures:

1. Ground bus and/or grounding lug (if applicable) shall be copper.

2. Furnish isolated copper grounding bus for signal and shield ground connections. Shield bus should be tied to ground bus by separate path.
3. Ground bus grounded at a common signal ground point in accordance with National Electrical Code requirements.
4. Single Point Ground for Each Analog Loop:
    a. Locate at dc power supply for loop.
    b. Use to ground wire shields for loop.
    c. Group and connect shields in following locations: PLC panel.
    d. Each shield shall be terminated on a separate terminal block.
    e. Shield drain terminal block rails shall be grounded to the ground bus of the control panel.
5. Ground terminal block rails to ground bus.
6. Ground panel doors to the enclosure ground.

G. Analog Signal Wiring Shields:

1. Shields should be ungrounded at field device and continuous to the PLC input.
2. Shield should be grounded at first termination point within the control panel housing the PLC to the isolated shield bus.
3. When a signal isolator is used, the shield should not be continuous across the isolator.
    a. The shield on the line side of the isolator should be terminated at the shield bus and the shield on the load side of the isolator should terminate on its own isolated shield bus.
4. Do not terminate the shield on a surge suppressor ground terminal unless the terminal is an isolated pass-through terminal.

H. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Instruments in/on different panels, cabinets, enclosures or the field shall not be wired in series.

1. Shield drain wires upstream and downstream of the analog signal isolator shall be isolated from each other and have a separate path to the ground bus of the control panel.
2. Manufacturer and Model: Acromag; 633T.

I. Power Distribution within Panels:

1. In panels with voltages present greater than 50V ac, the following shall apply:
    a. All devices utilizing voltages greater than 50V ac shall have finger-safe terminals.

b. All devices utilizing voltages greater than 50V ac without finger-safe terminals shall have a lexan shield secured to the panel subplate with insulated stand-offs covering all terminals and equipment.

2. Feeder Circuits:
   a. One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
   b. Make provisions for feeder circuit conduit entry.
   c. Furnish terminal board for termination of wires.
3. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
   a. Locate to provide clear view of and access to breakers when door is open.
   b. Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
      1) Branch Circuit Breaker: 15 amps at 250V ac.
   c. Breaker Manufacturers and Products: Refer to Division 26, Electrical.
4. Circuit Wiring:
   a. P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
      1) Devices on Single Circuit: 20, maximum.
      2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
      3) Branch Circuit Loading: 12 amperes continuous, maximum.
      4) Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
      5) Provide 120V ac plugmold for panel components with line cords.

J. Signal Distribution:

1. Within Panels: 4 mA dc to 20 mA dc signals may be distributed as 1V dc to 5V dc if kept separate by AC conductors a minimum of 6 inches.
2. Outside Panels: Isolated 4 mA dc to 20 mA dc only.
3. All signal wiring twisted in shielded pairs.
4. All signal wiring shields shall be continuous from the instrument to the PLC and/or loop isolator. The shield shall be terminated at the PLC panel shield ground bus.
5. Each analog signal outside the control panel shall utilize a three-pair, shielded twisted pair cable.

K. 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 inch and 1/4 inch.
   c. Include engraved legend plates with service markings.
   d. Finger-safe terminals.
   e. Potentiometer Resistance: To match device it is connecting to.
   f. Manufacturer and Product: Allen-Bradley; Bulletin 800HC.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test LED 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. Finger-safe terminals.
   d. Manufacturers and Products:
      1) Allen-Bradley; Type 800HC.
      2) Square D; Type SK.
3. Cluster Pilot Lights, Watertight:
   a. Heavy-duty, LED type, NEMA 250, Type 4/13 watertight, industrial type with integral transformer for 120V ac applications.
   b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
   c. Finger-safe terminals.
   d. Lens Colors and Engraved Legend:
      1) Green: “Lead”, left position.
      2) Blue: “Lag 1”, top position.
      3) Red: “Lag 2”, right position.
      4) White: “Standby”, bottom position.
   e. Manufacturer and Product: Allen-Bradley; Type 800TC.
4. 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. Finger-safe terminals.

d. Manufacturers and Products:
   1) Allen-Bradley; Type 800HC.
   2) Square D; Type SK.

5. Pushbutton, Maintained (Red Illuminated Jumbo Mushroom Head – Twist-to-Release):
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with maintained 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. Finger-safe terminals.
   d. Manufacturers and Products:
      1) Allen-Bradley; Type 800HC.
      2) Square D; Type SK.
6. 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 inch to 1/4 inch.
   e. Finger-safe terminals.
   f. Manufacturer and Products:
      1) Allen-Bradley; Type 800HC.
      2) Square D; Class 9001, Type SK.

L. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide hold-down clips.
   f. Finger-safe terminals.
2. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general-purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).

g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Push to test button.
k. Manufacturer and Product: Tyco Electronics (Potter and Brumfield); Series KUP.

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: Tyco Electronics (Potter and Brumfield); Series KB/KBP.
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.
      1) Contact Material: Silver cadmium oxide alloy.
   d. Coil Voltage: As noted or shown.
   e. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   f. Repeatability: Plus or minus 2 percent.
   g. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   h. Time Delay Setpoint: As noted or shown.
   i. Mode of Operation: As noted or shown.
   j. Adjustment Type: Integral potentiometer with knob external to dust cover.
   k. Manufacturer and Products: Tyco Electronics (Potter and Brumfield):
      1) Series CB for 0.1 second to 100 minute delay time ranges.
      2) Series CK for 0.1 second to 120 second delay time ranges.
   l. One-Shot Time Delay Relay:
      1) Type: Adjustable time delay relay.
      2) Contact Arrangement: 1 Form C contact.
      3) Contact Rating: 3A at 240V ac.
      4) Coil Voltage: 120V ac.
      5) Operating Temperature: Minus 25 degrees C to 60 degrees C.
      6) Repeatability: Plus or minus 0.2 percent.

7) Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
8) Time Delay Setpoint: 0.5 second to 10 seconds.
9) Mode of Operation: One Shot.
10) Adjustment Type: Integral potentiometer external to dust cover.
11) Manufacturer and Products: Allen-Bradley: Series 700-FSD3CU23.

5. Control Circuit Switching Relay, Repeat Cycle Time Delay:
   a. Type: Adjustable repeat cycle time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 120V ac.
   d. Coil Voltage: 120V ac.
   e. Operating Temperature: Minus 20 degrees F to 140 degrees F.
   f. Repeatability: 1/2 of 1 percent of dial.
   g. Delay Time Range: 60 minutes.
   h. Time Delay Setpoint: 15 minutes, energized; 45 minutes, de-energized.
   i. Mode of Operation: Repeat Cycle.
   j. Adjustment Type: Individually adjustable knobs on face of the timer.
   k. Mounting: Mount in the door of an enclosure.
   l. Environmental rating: None.
   m. Manufacturer and Products: Danaher:
      1) Eagle Signal Brand; Series HG1 Flexopulse.
   n. Control Circuit Switching Relay, Repeat Cycle Time Delay:
      1) Type: Adjustable repeat cycle time delay relay.
      2) Display: 4-1/2 digit (19999) liquid crystal display, 0.5-inch-high.
   o. Contact Arrangement: 2 Form C contacts (timed contacts), one Form C contact (instantaneous contact).
   p. Timed Contact Rating: 10A at 120V ac.
   q. Instantaneous Contact Rating: 10A at 120V ac.
   r. Coil Voltage: 120V ac.
   s. Operating Temperature: Minus 20 degrees F to 140 degrees F.
   t. Repeat Accuracy: Plus or minus 0.001 percent of setting or 35 ms, whichever is larger (0 degrees C to 60 degrees C).
   u. Delay Time Range: Individually programmable for four time ranges from 199.99 seconds to 199 hours and 59 minutes.
   v. Mode of Operation: Repeat Cycle.
   w. Adjustment Type: Membrane buttons on face of the timer.
   x. Mounting: Mount in the door of an enclosure.
   y. Environmental Rating: Water sealed housing.

z. Manufacturer and Products:
1) Danaher: Eagle Signal Brand; Series CX100 Repeat Cycle Timer.

6. Control Circuit Switching Relay, Duty Cycle Time Delay:
a. Type: Adjustable duty cycle time delay relay.
b. Contact Arrangement: 1 Form C contacts.
c. Contact Rating: 20A at 120V ac.
d. Coil Voltage: 120V ac.
e. Operating Temperature: Minus 40 degrees F to 165 degrees F.
f. Timing Accuracy: Line frequency.
g. Duty Cycle: 24 hours.
h. Minimum ON Setting: 15 minutes.
i. Mode of Operation: Duty Cycle.
j. Adjustment Type: 96 captive tabs.
k. Mounting: Subplate mounted in interior of control panel.
l. Manufacturer and Product:
1) NSi Industries: TORX; 8001.

M. Power Supplies:

1. Furnish redundant power supplies and an active redundancy module to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
a. Protect instruments from damage due to power supply failure.
b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1 in accordance with NEMA 250.
5. Mount such that dissipated heat does not adversely affect other components.
6. Size power supply that a single power supply rating is at least half of the power supply load.
7. 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.
c. Furnish redundant 120V ac to dc power supplies with an active redundancy module.
8. Manufacturer:
a. Allen-Bradley; 1606 Series (with active redundancy module).
b. Phoenix Contact; Quint Series (with active redundancy module “ORING” series).

N. Internal Panel Lights for Freestanding Panels:

1. Mounting: Inside and in the top of back-of-panel area.
2. Switching: Switched via door intrusion switches (one switch for each door to the enclosure). Note: All fixtures shall be switched on if any of the intrusion switches in a multi-door enclosure detects the door has been opened.
3. Lighting Type:
   a. LED Top-of-panel Type Fixture:
      1) Quantity: Minimum one fifteen inch fixture per control panel section.
      2) Fixture shall not reside behind mullion of a multi-door enclosure.
   b. Fluorescent Top-of-panel Type Fixture.
      1) Quantity: Minimum one 18-inch light fixture per control panel section.
      2) Fixture shall not reside behind mullion of a multi-door enclosure.
4. Protective metal shield for lights.

O. Service Outlets for Freestanding Panels:

1. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
2. Quantity:
   a. For Panels 4 Feet Wide and Smaller: One.
   b. For Panels Wider Than 4 Feet: One for every 4 feet of panel width, two minimum per panel.
3. Mounting: Evenly spaced along back-of-panel area.

P. Internal Panel Lights and Service Outlets for Smaller Panels:

1. Mounting: Inside and in the top of back-of-panel area.
2. Switching: Switched via door intrusion switches (one switch for each door to the enclosure).
   a. Note: All fixtures shall be switched on if any of the intrusion switches in a multi-door enclosure detects the door has been opened.
3. Lighting Type:
   a. LED top-of-panel type fixture:
      1) Quantity: Minimum one fifteen inch fixture per control panel section.
      2) Fixture shall not reside behind mullion of a multi-door enclosure.

b. Fluorescent top-of-panel type fixture.
   1) Quantity: Minimum one eighteen inch light fixture per control panel section.
   2) Fixture shall not reside behind mullion of a multi-door enclosure.

4. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle.

Q. Standard Pushbutton / Selector Switch Colors and Inscriptions: Use following color code and inscriptions for pushbuttons and/or selector switches, unless otherwise noted in Instrument List Article Supplements.

Tag Function	Inscription(s)	Color
F	Fault	Amber
LOR	LOCAL OFF REMOTE	Black Black
OO	ON OFF	Black Black
OC (Spring return to center)	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SP	STOP	Black
SS	START STOP	Black Black
ST	START	Black
ROA	RUN OFF AUTO	Black Black
ROR	RUN OFF REMOTE	Black Black
RESET	RESET	Black
E-STOP	EMERGENCY STOP	Red

1. Lettering Color:
   a. Black on white and yellow buttons.
   b. White on black, red, and green buttons.

J. Standard Light Colors and Inscriptions: Use following color code and inscriptions for service legends and lens colors for indicating

lights, unless otherwise noted in Instrument List Article Supplements.

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
UTILITY POWER OK	UTILITY POWER OK	White
ETHERNET SWITCH OK	ETHERNET SWITCH OK	Blue
POWER SUPPLIES OK	POWER SUPPLIES OK	Blue

1. Lettering Color:
   a. Black on white and amber lenses.
   b. White on red and green lenses.

2.08 ELECTRICAL TRANSIENT PROTECTION

A. General:

1. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
2. Implementation:
   a. Furnish, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, and field mounted analog transmitters and receivers.

2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.

3. 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.
4. Response: 5 nanoseconds maximum.
5. Recovery: Automatic.
6. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

B. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE 587 Category B test waveform.
2. First-Stage Clamping Voltage: 350-volts or less.
3. Second-Stage Clamping Voltage: 210-volts or less.
4. Continuous Operation:
   a. Power supplies for one four-wire transmitter or receiver:
      1) 5 amps minimum at 130V ac. All other applications 30 amps minimum at 130V ac.

C. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8 microsecond rise in current form 0 amps 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: Less than plus or minus 10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

D. Physical Characteristics:

1. Mounted in Enclosures: Encapsulated inflame retardant epoxy.
2. For Analog Signals Lines: EDCO PC-642 or SRA-64 Series.
3. For 120V ac Lines: EDCO HSP-121.
4. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. EDCO SS64 Series.

5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
   a. Enclosure: NEMA 4X Type 316 stainless steel with door.
      1) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Manufacturer and Product: EDCO; SLAC series.
6. Panel Mounted Ethernet Cat. 6+: Phoenix Contact, DT-LAN-CAT.6+ (2881007).

E. Installation and Grounding of Suppressors: As shown. See Surge Suppressor Installation Details. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

F. See Section 40 90 01, Instrumentation and Control for Process Systems, Supplement for Surge Suppressor Products Table, for additional information.

G. Fur surge suppressors rated greater than 120V ac, refer to Division 26, Electrical, for requirements.

2.09 SPARE PARTS

Description	Percent of Each Type and Size Used	No Less Than
Fuses	20	10
Relays	20	5
Terminal Blocks	10	10
Circuit Breakers	10	Two of each type used
Signal Converter	Two of each type used	Two of each type used

2.10 EXPENDABLES

Item	Quantity
Corrosion-inhibiting vapor capsules	Manufacturer’s recommended 2-year supply

2.11 FABRICATION

A. General:

1. Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.

2. Fabricate panels, install instruments, wire, and plumb, at the PIC / Package System Supplier factory.
3. Electrical Work: In accordance with Division 26, Electrical.

B. Factory Assembly: Assemble panels at the manufacturer's factory. No fabrication other than correction of minor defects or minor transit damage shall be done on panels at Site.

C. Off-the-shelf enclosure shall be UL 508A listed prior to fabrication.

D. The fabricated control panel shall be UL 508A listed upon completion of fabrication.

E. For Panels in unrated areas without intrinsically safe circuits: Serialized UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" in accordance with UL 508A.

F. Wiring Within PIC Panels:

1. Restrain by UL listed plastic ducts or metal raceways.
2. Hinge Wiring: Secure at each end so that 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. Abrasion protection for wire bundles which 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.
    a. Where 6 inch separation is not possible, use shielded wiring duct or noise shield for DC and communication wiring.
        1) Minimum 20 dB noise reduction (equivalent to 6 inch separation in air).
10. Isolation Barrier: Where 480V ac is present in a control panel (if applicable); furnish an isolation barrier between the 480V ac side (high-voltage – housing motor starter, disconnect switch and power distribution) and the 120V ac/24V dc (low voltage – control circuitry and devices) side of the enclosure.
    a. All terminals and/or fuse blocks shall be finger-safe.
    b. All 480V ac (and/or voltages greater than 50V ac) terminals that do not have guarded or finger-safe terminals shall be covered with a lexan shield mounted on insulated stand-offs.
    c. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
    d. Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.
    e. Analog signal and communication wiring shall be in UL approved shielded wiring ducts.
    f. Plastic Wire Duct Colors:
        1) Black Duct: 480V ac Wiring.
        2) Grey Duct: 24V dc Wiring.
        3) White Duct: 120V ac Wiring.
        4) Shielded Duct (Metallic foil finish): Analog Signal Wiring and Communication Wiring.
            a) UL recognized.
            b) Equivalent to 6 inches of separation.
            c) Up to 20 dB of noise reduction.
        5) Blue Duct: Intrinsically Safe Wiring.

G. Freestanding Panel Construction:

1. Based on environmental design requirements required and referenced in Article Environmental Requirements, provide the following:
    a. For panels listed as inside, air conditioned and unconditioned (noncorrosive environment):
        1) Enclosure Type: NEMA 12 in accordance with NEMA 250.
        2) Materials: Mild steel.
        3) Finish: ANSI 61 Gray.

b. For panels listed as inside, air conditioned and unconditioned (corrosive environment):
   1) Enclosure Type: NEMA 4X in accordance with NEMA 250.
   2) Materials: Type 316 stainless steel.
c. For all other panels:
   1) Enclosure Type: NEMA 4X in accordance with NEMA 250.
   2) Materials: Type 316 stainless steel.
   3) Finish: Factory applied white powder coating.

2. Materials: Sheet steel, unless otherwise shown on Drawings with minimum thickness of 10-gauge, unless otherwise noted.
3. Panel Fronts:
   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.
4. Internal Framework:
   a. Structural steel for instrument support and panel bracing.
   b. Permit panel lifting without racking or distortion.
5. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
6. Adjacent Panels: Securely bolted together so front faces are parallel.
7. Doors: Full height, fully gasketed access doors where shown on Drawings.
   a. Latches: Three-point, Southco Type 44.
   b. Handles: “D” ring, foldable type.
   c. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
   d. Front and Side Access Doors: As shown on Drawings.

H. Nonfreestanding Panel Construction:

1. Based on environmental design requirements required and referenced in Article Environmental Requirements, provide the following:
   a. For panels listed as inside, air conditioned and unconditioned (non-corrosive environment):
      1) Enclosure Type: NEMA 12 in accordance with NEMA 250.
      2) Materials: Mild steel.
      3) Finish: ANSI 61 Gray.

b. For panels listed as inside, air conditioned and unconditioned (corrosive environment):
   1) Enclosure Type: NEMA 4X in accordance with NEMA 250.
   2) Materials: Type 316 stainless steel.
c. For all other panels:
   1) Enclosure Type: NEMA 4X in accordance with NEMA 250.
   2) Materials: Type 316 stainless steel.
   3) Finish: Factory applied white powder coating.

2. Metal Thickness: 14-gauge, minimum.
3. Drip Shield.
   a. Materials: Match enclosure material and finish.
4. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Control panels equal or exceeding 16 inches in height: Padlockable 3-point lockable latch.
   c. Control Panels Less Than 16 Inches in Height: Stainless steel, padlockable quick-release luggage-type latches. Latches shall not require the use of tools to open and close. Latches requiring the use of tools to open or close are not acceptable for use on this Project.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Rittal.

I. Factory Finishing:

1. Enclosures:
   a. Indoor Enclosures:
      1) Stainless Steel and Aluminum: Not painted.
      2) Steel Panels (NEMA 250 Type 12, where indicated):
      3) Sand panel and remove mill scale, rust, grease, and oil.
      4) Fill imperfections and sand smooth.
      5) Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two- component type epoxy enamel.
      6) Sand surfaces lightly between coats.
      7) Dry Film Thickness: 3 mils, minimum.
      8) Color: ANSI 61 Light Gray.
   b. Outdoor Enclosures: Powder Coated White NEMA 4X, Type 316 stainless steel.
2. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

2.12 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering Co; Model A-HCI.

2.13 SOURCE QUALITY CONTROL

A. Unwitnessed Factory Tests (UFT):

1. Complete Shop Drawing approval process (both the Owner and Engineer).
2. Submit and get approval on testing process (both the Owner and Engineer).
3. Notify Engineer of test schedule 2 weeks prior to start of test.
4. Scope:
   a. Test entire PIC and/or Package System, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
   b. The Engineer and/or Owner shall have the right to attend the UFT if desired.
5. Location: PIC System Integrator's and/or Package System Supplier's facility.
6. 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.
7. Prove all logic of hard-wired control circuits.
8. Operation of communications between PLCs and remote I/O and between PLCs and computers.
9. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications for all loops and functions.
   a. All required and shown functions for 100 percent of loops.
10. Non-loop Specific Functions:
    a. Capacity: Demonstrate that PIC and/or Package System Supplier 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.
11. Test each mode of operation and each possible failure condition of each mode of operation for proper system response.

12. Furnish a checklist documenting the successful test and result for all modes of operation and failure tests as indicated above.
13. Correct deficiencies found and complete prior to shipment to Site.
14. Failed Tests:
    a. Repeat and witnessed by Engineer and Owner (if required).
    b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and/or Package System Supplier and witnessed by Engineer as part of Functional Test.
15. Make following documentation available to Engineer at test site both before and during UFT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of UFT 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.
16. Daily Schedule for UFT:
    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.

B. Scope: Inspect and test entire PIC and/or Package System Supplier to ensure it is ready for shipment, installation, and operation.

C. Test: Exercise and test all functions.

D. Temporary PLC software configuring to allow PLC testing.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC and/or Package System Supplier, but that directly interfaces with the PIC and/or Package System Supplier, verify the following conditions and document in the O&M:

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: Retain a copy of manufacturers' instructions at Site, available for review at all times.

B. Electrical Wiring: As specified in Division 26, Electrical.

C. Mechanical Systems:

1. Drawings for PIC and/or Package System Supplier Mechanical Systems are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.
2. Enclosure Lifting Rings: Remove rings following installation and plug holes.

D. Removal or Relocation of Materials and Equipment:

1. Remove from Site materials that were part of the existing facility but are no longer used, unless otherwise directed by Engineer to deliver to Owner.
2. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

3.03 FIELD FINISHING

A. Refer to Section 09 90 00, Painting and Coating, if applicable.

3.04 FIELD QUALITY CONTROL

A. Startup and Testing Team:

1. Thoroughly inspect installation, termination, and adjustment for components and systems.
2. Complete onsite tests.
3. Complete onsite training.
4. Provide startup assistance.

B. Operational Readiness Inspections, Calibrations and Testing: Prior to startup, inspect and test to ensure that entire PIC and/or Package System Supplier is ready for operation.

1. Loop/Component Inspections and Calibrations:
   a. Check PIC and/or Package System Supplier for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.
   b. Prepare a check list to document the testing of the control system in every mode of operation and test each failure condition while in each mode of operation.
   c. Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).
      1) Project name.
      2) Loop number.
      3) Component tag number.
      4) Component code number.
      5) Manufacturer for elements.
      6) Model number/serial number.
      7) Summary of functional requirements, for example:
         a) Indicators and recorders, scale and chart ranges.
         b) Transmitters/converters, input and output ranges.
         c) Computing elements' function.
         d) Controllers, action (direct/reverse) and control modes (PID).
         e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
      8) Calibrations, for example:
         a) Analog Devices: Actual inputs and outputs at 0, 25, 50, 75 and 100 percent of span, rising and falling.
         b) Discrete Devices: Actual trip points and reset points.
         c) Controllers: Mode settings (PID).
      9) Space for comments.
   d. These inspections and calibrations will be spot checked by Engineer.
2. Test Requirements:
   a. All field elements must be properly calibrated by the PICs Contractor prior to the start of the testing.
   b. Once facility has been started up and is operating, perform a witnessed ORT on complete control system to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.

c. Each loop shall be tested at 0, 25, 50, 75 and 100 percent of span (4, 8, 12, 16 and 20 milliamps), rising and falling (to include broken loop, under-range and over-range states).
d. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
e. 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.
f. Make updated versions of documentation required for ORT available to Engineer at Site, both before and during tests.
g. Make one copy of O&M manuals available to Engineer at the Site both before and during testing.

3. Leak Test: In accordance with Section 40 80 01, Process Piping Leakage Testing (if applicable).
4. Test each mode of operation and each possible failure condition of each mode of operation for proper system response.
5. Furnish a checklist documenting the successful test and result for all modes of operation and failure tests as indicated above.
6. Prior to PAT, submit calibration sheets and operational checklist, as indicated above, for approval by the Engineer and Owner.

C. Performance Acceptance Tests (PAT): These are the activities that Section 01 91 14, Equipment Testing and Facility Startup, refers to as Performance Testing.

1. General:
   a. PAT shall be scheduled two weeks after the ORT testing documents have been approved by both the Engineer and Owner.
   b. Test all PIC and/or Package System Supplier elements to demonstrate that PIC satisfies all requirements.
   c. Test Format: Cause and effect.
      1) Person conducting test initiates an input (cause).
      2) Specific test requirement is satisfied if correct result (effect) occurs.
   d. Procedures, Forms, and Checklists:
      1) Conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
      2) Describe each test item to be performed.
      3) Have space after each test item description for sign off by appropriate party after satisfactory completion.

e. Required Test Documentation: Test procedures, forms, and checklists. All signed by Engineer and Contractor.
f. Conducting Tests:
    1) Provide special testing materials, equipment, and software.
    2) Wherever possible, perform tests using actual process variables, equipment, and data.
    3) If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
    4) Define simulation techniques in test procedures.
g. Coordinate PIC and/or Package System testing with Owner and affected Subcontractors.
    1) Excessive Test Witnessing: Refer to Supplementary Conditions.

2. Test Requirements:
    a. Once facility has been started up and is operating, perform a witnessed PAT on complete PIC and/or Package System to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.
    b. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
    c. 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.
    d. Test each mode of operation and each possible failure condition of each mode of operation for proper system response.
    e. Furnish a checklist documenting the successful test and result for all modes of operation and failure tests as indicated above.
    f. If a test has failed and requires modification to the PLC code, the tests leading up to that point shall be considered void and the system shall be retested at no additional cost to the Owner or delay in Project Schedule.
    g. If an instrument needs to be recalibrated, all prior tests involving that instrument shall be considered void and the tests involving that instrument shall have to be retested at no additional cost to the Owner or delay in Project Schedule.
    h. Make updated versions of documentation required for PAT available to Engineer at Site, both before and during tests.
    i. Make one copy of O&M manuals available to Engineer at the Site both before and during testing.

j. Refer to referenced examples of PAT procedures and forms in Article Supplements.

3.05 TRAINING

A. General:

1. Provide an integrated training program to meet specific needs of Owner's personnel.
2. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
3. Provide instruction on three working shift(s) as needed to accommodate the Owner's personnel schedule.
4. Owner reserves the right to make and reuse video tapes of training sessions.

B. Operations and Maintenance Training:

1. Include a review of O&M manuals and survey of spares, expendables, and test equipment.
2. Use equipment similar to that provided or currently owned by Owner.
3. Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

C. Operations Training:

1. Training Session Duration: Two 8-hour instructor days.
2. Number of Training Sessions: Two.
3. Location: Site.
4. Content: Conduct training on loop-by-loop basis.
   a. Loop Functions: Understanding of loop functions, including interlocks for each loop.
   b. Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
   c. Interfaces with other control systems.

D. Maintenance Training:

1. Training Session Duration: Two 4-hour instructor days.
2. Number of Training Sessions: Two.
3. Location: Project Site.

4. Content: Provide training for each type of component and function provided.
    a. Loop Functions: Understanding details of each loop and how they function.
    b. Component calibration.
    c. Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
    d. Troubleshooting and diagnosis for components.
    e. Replacing lamps, chart paper, fuses.
    f. Component removal and replacement.
    g. Periodic maintenance.

3.06 CLEANING/ADJUSTING

A. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

B. Cleaning:

1. Prior to closing system using tubing, clear tubing of interior moisture and debris.
2. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 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. Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

3.08 SUPPLEMENTS

A. Supplements listed below, following "End of Section," are part of this Specification.

1. Component Specifications.
2. Instrument List.
3. Control Panel Schedule.
4. I/O Lists.
5. Loop Specifications.
6. Surge Suppressor Products Table.

7. Wiring Diagram Examples.
8. Forms:
    a. Performance Acceptance Test Sheet: Describes the PAT for a given loop. The format is mostly free form.
        1) Lists the requirements of the loop.
        2) Briefly describes the test.
        3) Cites expected results.
        4) Provides space for check off by witness.
9. Drawing 24381, Markup on Sludge Pump Station Wiring.

END OF SECTION

COMPONENT SPECIFICATIONS

I&C COMPONENTS

A. A7 pH Element:

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: Minus 2 pH to 14 pH.
      2) Operating Temperature: 32 degrees F to 122 degrees F.
      3) Operating Pressure: 100 psig maximum at 158 degrees F.
      4) Drift: 0.03 pH per 24 hours; noncumulative.
      5) Repeatability: Plus or minus 0.05 pH.
      6) Sensitivity: Plus or minus 0.01 pH.
      7) Temperature Accuracy: Plus or minus 0.9 degrees F.
      8) Temperature Sensor: NTC 300 ohm thermistor for automatic temperature compensation.
   b. Analyzer/Transmitter:
      1) Range: Minus 2 pH to 14 pH.
      2) Accuracy: Plus or minus 0.02 pH units.
      3) Repeatability: Plus or minus 0.1 percent of range.
      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: 1/2-inch NPT.
   b. Body Style: Submersible / Stainless Steel.
   c. Process Fluid: Activated Sludge.
   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:
1) As shown on Drawings or as noted from among the following:
a) Submersion:
(1) Sensor handrail assembly.
(2) Handrail mounting kit.
i. Suitable for installation in Class I Division 2 hazardous locations: If noted or shown.
1) Install in accordance with manufacturer's instructions and applicable codes.

4. Accessories:
a. Junction Box: If noted.
1) NEMA 4X box for cable extension.
5. Transmitter: Refer to Component Code A150 Analytical Indicating Transmitter, Two-Channel.
6. Manufacturer and Product:
a. Hach; pHD sc Online Process pH sensor, DPD1P1.
b. No substitution allowed.

B. A16D Turbidity Element; Immersion Type:

1. General:
a. Function: Measure, indicate and transmit turbidity in either water or wastewater.
b. Type:
1) Immersion in open tanks.
2) Dual infrared scattered light photometer for color-independent measurement and added back scatter detector.
2. Performance:
a. Measurement Range:
1) Turbidity: 0.001 NTU to 4,000 NTU.
2) Suspended Solids: 0.001 NTU to 50,000 mg/L.
b. Response Time: Less than 1 second, adjustable.
c. Accuracy (up to 1,000 NTU):
1) With Calibration: Less than one percent of the measured value; plus or minus 0.01 NTU.
2) Without Calibration: Less than 5 percent of the measured value; plus or minus 0.01 NTU.
d. Repeatability: Less than 1 percent.
e. Calibration Method: Formazin or STABILCAL Standard (at 800 NTU).

3. Service:
   a. Immersion in open tanks, water or wastewater.
   b. Operating Temperature:
      1) Probe: 32 degrees F to 104 degrees F.
      2) Transmitter: Minus 4 degrees F to 140 degrees F.
4. Element:
   a. TS-Line Probe:
      1) Stainless steel housing.
      2) Back-scatter photo receptor to detect light at 140 degrees to the transmitted light beam; to measure suspended solids in heavily located sample streams.
      3) Self-cleaning wiper system.
5. Cable Length: As required.
6. Miscellaneous:
   a. Service Interval: 12 months.
   b. Calibration: Sample specific, based on gravimetric TS analysis.
7. Accessories (for each unit provided):
   a. Provide submersion mounting hardware and handrail mounting bracket as required to perform appropriate installation.
   b. Provide with cleaning unit for the probe.
   c. Replacement wiper blades, four packages of five per unit supplied.
   d. Provide digital termination box for quick termination of probe.
8. Transmitter: Refer to Component Code A150 Analytical Indicating Transmitter, Two-Channel.
9. Manufacturer and Product Model:
   a. Hach: SOLITAX®sc Turbidity sensor; t-line sc; LXV423.99.00100.
   b. No substitution allowed.

C. A150 Analytical Indicating Transmitter, Two-Channel:

1. General:
   a. Function: Interface with analytical probes provided by same vendor. Transmit probe readings to SCADA system.
2. Transmitter:
   a. Display:
      1) Display: Graphic LCD, with LED backlighting / Transreflective.
         a) Display primary readout of probe data in engineering units.
      2) Auxiliary Readout:
         a) Temperature.
         b) Diagnostic warnings.

c) Error messages.
d) Other information.

b. Ambient Conditions:
1) Temperature minus 20 degrees C to 60 degrees C (minus 4 degrees F to 140 degrees F).
2) Humidity: 0 percent to 95 percent, relative, noncondensing.

c. Signal Interface:
1) Analog Output:
a) Two isolated 4 mA dc to 20 mA dc for load impedance up to 500 ohms.
b) Outputs configured as needed to transmit readings from interfaced probes.
2) Relay Outputs:
a) Four SPDT (Form C); 5 amps resistive, 1200W, 250V ac.
b) Function:
(1) Control: Settings for fail safe on/off, high/low phasing, setpoint, deadband, and on/off displays.
(2) Alarm: Settings for fail safe on/off, high alarm point, high alarm point deadband, low alarm point, low alarm point deadband, and on/off relays.
3) Serial Communication: If and as noted.

d. Enclosure: NEMA 4X/IP66 polycarbonate/aluminum.
e. Mounting: Subplate-mount; remote from sensor.
f. Mounting Hardware: Type 316 stainless steel hardware suitable to support transmitter and/or control panel subplate to equipment rack.
g. Power Requirements: 110V ac to 240V ac plus or minus 10 percent, 50/60-Hz.
h. Stainless steel equipment tag.

3. Accessories:
a. Mount transmitter in a NEMA 4X, powder coated white, Type 316 stainless steel enclosure. Rack mount enclosure to equipment rack utilizing Type 316 stainless steel hardware and Type 316 stainless steel double unistrut. Enclosure shall comply with Section 40 90 01, Instrumentation and Control for Process Systems, control panel requirements.
b. Furnish a Type 316 stainless steel, hinged sun shield (powder coated white) for transmitter enclosure.
c. Surge suppressor per Section 40 90 01, Instrumentation and Control for Process Systems requirements.

4. Manufacturer and Product:
   a. Hach sc200.
   b. No substitution allowed.

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 degrees F to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
      2) Storage: 15 degrees F 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 feet 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 Type 316 stainless steel, unless otherwise noted.
    b. Liner Material: Hard rubber or elastomer, unless otherwise noted.
    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: Hastelloy C.
    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) Continuous (up to 10 feet depth), NEMA 6P/IP68.
    i. Direct Buried (3 feet to 10 feet): If noted.
9. Transmitter:
    a. Mounting: Remote mounted.
    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 nonintrusive 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 dc 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.
11. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations plus 50 feet.
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: Original meter parameter values available from vendor by request.
15. Accessories:
    a. In situ Verification System:
        1) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
        2) Physical access to the flow-tube not required.
        3) Meet standards established by the National Testing Laboratory.

4) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
5) 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.
6) Windows-based software.

b. Primary Simulation System:
1) Quantity: Two complete systems 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 percent to 99 percent (0 feet 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. Warranty: Provide 10 year full factory warranty for each meter and all accessories provide under this Specification.
17. Manufacturers:
a. Endress + Hauser, Inc. Flow Measuring System with Promag 400 Flow Indicating Transmitter (remote wall-mounted):
1) Promag 400H (size: 1/12 inch to 4 inches).
2) Promag 400W (size: 1 inch to 78 inches).
b. Siemens: MAG 3100 Flow Tube with MAG 6000 Flow Indicating Transmitter (remote wall-mounted) with Verificator accessory.
c. Toshiba (includes Model LF620 Transmitter, where the transmitter is integral and LF622 Transmitter, where the transmitter is mounted remotely):
1) Model LF430 (size: 1/2 inch to 16 inches).
2) Model LF150 (size: 20 inches to 120 inches).

E. L18 Level Switch, Nonmercury:

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): Sludge, 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.
   c. No substitution allowed.

F. 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.
    b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantage.
    c. WIKA, Type 2XX.34.
    d. No substitution allowed.

G. 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 185 degrees F, with integral meter.
d. Process Operating Temperature: Minus 40 degrees F to plus 212 degrees F.
e. Humidity: 0 percent 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 or ceramic disc 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: Inert filling liquid / ceramic diaphragm (if applicable).
4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/Remote Diaphragm Seal: As required per temperature and corrosive nature of medium requirements.
5. Signal Interface:
   a. 4mA dc to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 1,100 ohms.
   b. Foundation Fieldbus Protocol: If noted.
   c. Profibus: If noted.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
   a. Two-valve (isolate and vent) Manifold: Required.
      1) Type 316 stainless steel.

8. Manufacturers and Products:
    a. Siemens: SITRANS P310 Series.
    b. Endress+Hauser: PMC71 (where indicated).
    c. No substitution allowed.

H. 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:
a. Red Valve Company; Series 40, Series 42/742, Series 48.
b. Dover/OPW Engineered Systems; Iso-Ring.
c. No substitution allowed.

I. Y50B Remote I/O:

1. Manufacturers:
a. Allen-Bradley:
1) Remote I/O Modules:
a) Discrete Input: Model 1756-IA16I.
b) Discrete Output: Model 1756-OA16I.
c) Analog Input: Model 1756-IF8I.
d) Analog Output: Model 1756-OF4.
2) Power Supply: Model 1756-PA XX.
3) Ethernet Communication Module: 1756-EN2T.

J. Y375 Programmable Logic Controller System, Chassis Unit:

1. General:
a. Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, current switches, calculation modules, PID controllers, stepping switches, and drum programmers.
b. Type:
1) Microprocessor based device programmable using ladder logic.
2) PLC, Hot-backup PLC or Remote I/O (RIO) Drop: As shown on Drawings.
c. Parts: Central processing unit (CPU), power supply, local and remote input/output modules, local and remote base (chassis/rack) controllers, I/O bases (chassis/rack), and factory assembled interconnecting cables. Provide components required to make a complete and totally operational system. Reference PLC system block diagram on Drawings.

2. Environmental:
   a. Temperature: Operating range minus 13 degrees F to plus 158 degrees F; storage range minus 40 degrees F to 185 degrees F.
   b. Humidity: Operating range 5 percent to 95 percent noncondensing.
   c. Vibration:
      1) Sinusoidal: IEC 68-2-6, Test Fc; 0.15 mm peak-to-peak, 2 g at 10-Hz to 500-Hz.
   d. Noise: IEC 801, Part 3, Level 3 and Part 4, Level 3; MIL STD-461B.
   e. Isolation: 30V continuous, USB port to backplane.
3. Central Processing Unit (CPU):
   a. Type: Microprocessor, 16-bit minimum.
   b. Scan Time: Less than 1 ms/K words of relay ladder logic.
   c. PLC Communications: Integrated USB.
   d. Remote I/O Communication Links.
   e. Instruction Set:
      1) Timers and Counters: Quantity 1,024 minimum; minimum timer resolution 0.1 second; minimum counter count range 0 to 32,000.
      2) Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, and compare.
      3) Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.
      4) Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation, remote access to controller tuning constants; minimum of 64 PID loops.
      5) Real Time Clock: Date and time set and compare.
      6) Miscellaneous: Jump or skip to a label, quantity 255 one shot, quantity 1,024 drums, quantity 64 preconfigured analog alarm functions, quantity 128 subroutines, quantity 128.
   f. Diagnostics:
      1) Indicators: ESM status, PLC status, PLC operation mode, remote I/O communication status and primary PLC state for redundant PLC systems.
      2) Status Word: With failure status for PLC battery, scan overrun, communications, I/O, special functions.

3) Power Up: PLC runs self-diagnostics on power-up; periodically runs self-diagnostics while in RUN mode, halts logic processor and sets outputs to configured state if fatal error is detected.
4) Diagnostic Tables: Tables, displayable by programming computer, that describe nature and location (address) existing faults and errors.

g. Agency Approvals and Standards:
1) UL listed.
2) CSA certified.
3) DIN Standard 41494.
4) IEC-65A/WG6 draft proposal.
5) Factory Mutual approved.

h. Manufacturer and Product: Allen-Bradley; Model 1756-L73.

4. Random Access Memory (RAM):
a. Type: CMOS type.
b. Word Size: 16 bits, minimum.
c. Battery Backup: 3 months, minimum.
d. Memory Size: Sufficient to implement all applications software plus 100 percent spare.
e. Memory Size: 32 K words of ladder logic memory 8 K words of variable memory, plus required overhead for standard functions.
f. Read only memory (ROM) for controller's operating system and diagnostics.
g. Memory Protection: Keylock switch.

5. Power Supply: One unit for each input/output base assembly:
a. Voltage: 120/240 volts (user selectable), 47-Hz to 63-Hz input; 75 VA max volts output.
b. Mounting: Chassis slot.
c. Manufacturer: Allen-Bradley; Model 1756-PA.

6. Input/Output: Complete input/output system, including remote I/O with distances up to 5,000 feet minimum; a minimum of 1024 I/O points in up to 15 remote I/O racks.
a. Isolated Discrete Input Modules:
1) Voltage: 120V ac, 60-Hz.
2) Operating Power: 0.71 watts.
3) Points per Module: 16.
4) LED status indicator for each point.
5) Isolation: 125V continuous, inputs-to-backplane and input group-to-group.
6) Manufacturer and Product: Allen-Bradley; Model 1756-IA16I.

b. Isolated Discrete Output Modules:
   1) Voltage: 120V ac, 60-Hz.
   2) Operating Power: 1.59 watts.
   3) Load Rating: 10 mA continuous per point.
   4) Isolation: 250V continuous, outputs-to-backplane and output-to-output.
   5) Points per Module: 16.
   6) LED status indicator for each point.
   7) Manufacturer: Allen-Bradley; Model 1756-OA16I.

c. Analog Input Modules:
   1) Power: 2.33 watts.
   2) Analog Inputs: Eight.
   3) Input: 4 mA to 20 mA.
   4) Isolation: 250V continuous, inputs-to-backplane.
   5) Analog Input Resolution: 16 bits.
   6) Manufacturer: Allen-Bradley; Model 1756-IF8I.

d. Isolated Analog Output Modules:
   1) Power: 5.8 watts.
   2) Analog Outputs: Six.
   3) Output: 4 mA to 20 mA.
   4) Isolation: 250V continuous, output channels-to-backplane.
   5) Analog Output Resolution: 15 bits.
   6) Manufacturer: Allen-Bradley; Model 1756-OF6CI.

7. Remote Input/Output Bases:
   a. Power Supply: Same power supply as described in subparagraph Power Supply, above.
   b. Base Controller: One remote I/O adapter module required for each remote base.
8. Communication Modules:
   a. EtherNet/IP Module:
      1) Connection Port: One Ethernet R-J45 Cat 5 Port.
      2) Connection Cable: 802.3 compliant shielded or unshielded twisted pair.
      3) Communication Speed: 10/100 Mbps.
      4) TCP/IP Communication Connection: 128.
      5) Logix Communication Connections: 256.
      6) Mounting: Chassis slot.
      7) Manufacturer: Allen-Bradley; Model 1756-EN2TXT.
9. Terminal Block Assembly: Provide terminal blocks for all I/O modules. Use the following products based on the module type.
   a. Digital Input Modules: Allen-Bradley; Model 1756-TBNH screw-type terminal block housing.
   b. Digital Output Modules: Allen-Bradley; Model 1756-TBCH cage-clamp-type terminal block housing.

c. Analog Input Modules: Allen-Bradley; Model 1756-TBCH cage-clamp-type terminal block housing.
d. Analog Output Modules: Allen-Bradley; Model 1756-TBNH screw-type terminal block housing.
e. Refer to Section 40 90 01, Instrumentation and Control for Process Systems, for additional approved manufacturers.

10. Identification:
    a. Nameplates installed above/below each PLC component (CPU, I/O rack, power supply).
    b. Label configured I/O points as they have been configured (addressed) in the system, as approved by the Engineer.
11. Spares:
    a. CPU: One size equals large.
    b. Memory (or memory expansion) cards, size equals 2GB RAM.
    c. Base controller card, quantity equals one.
    d. Spare I/O Cards Installed in I/O Racks: For each type of I/O card, quantity equals 15 percent of each type and size used, minimum one each.
    e. Spare I/O Cards Provided Loose (Shelf Spares): For each type of I/O card, quantity equals 10 percent of each type and size used, minimum one each.
    f. Power supply one each of each type and size used, minimum one each.
    g. Cables.
    h. Communication Module: One.
    i. I/O Rack: One.
12. Manufacturer and Product:
    a. Allen-Bradley; ControlLogix 1756-L73 series processor.
    b. No substitution allowed.

K. Y400 Uninterruptible Power Supply System (for outdoor panels or indoor panels in an unconditioned space):

1. General:
    a. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power. On-line double-conversion rack-mount UPS.
    b. Major Parts: Inverter, battery charger, sealed battery.
2. Performance:
    a. Capacity: 1,500 VA (minimum size).
    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: 88 percent minimum, unless otherwise noted.
e. Backup Runtime:
   1) Full Load: 45 minutes minimum, unless otherwise noted.
   2) Half Load: 90 minutes minimum, unless otherwise noted.
f. Battery Life: 10-Year rated batteries, maintenance-free, sealed VRLA batteries, 12V dc, 5AH.
g. Continuous no break power with no measurable transfer time.
h. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Less than three percent (less than 3 percent) for a linear load and less than five percent (less than 5 percent) for a nonlinear load.
i. Input Voltage Range: 80V ac to 138V ac.
j. Output Voltage Regulation: Plus or minus 2 percent nominal.
k. Operating Temperature: Minus 40 to plus 100 and plus 149 degrees F / minus 40 degrees C to plus 80 degrees C.
l. Operating Relative Humidity: 10 percent to 95 percent, noncondensing.
m. Voltage Regulation: Online, double-conversion power conditioning.
n. Overvoltage Correction: 2 percent output voltage regulation during overvoltages to 150V ac.
o. Undervoltage Correction: 2 percent output voltage regulation during undervoltages to 80V ac.
p. Overload:
   1) 110 percent for 40 seconds.
   2) 125 percent for 18 seconds.
   3) 150 percent immediate.

3. Features:
   a. Enclosure: Tower.
   b. Contact Closure Interface Card: UA88376-SSG.
      1) Monitor the following:
         a) Loss of Utility Power.
         b) UPS Fault.
         c) UPS Low Battery.
         d) UPS on Bypass.
4. Manufacturer and Product:
   a. Falcon SSG Industrial Ultra-Wide Temperature UPS (Model: SSG1.5KRP-1T for minimum size UPS) with relay I/O card.
   b. No substitution allowed.

L. Y41 Maintenance Bypass / Power Output Bypass Switch:

1. General:
   a. This Specification defines the electrical and mechanical characteristics and requirements for a continuous-duty, single phase, maintenance bypass / power output distribution system. This system provides high-quality maintenance bypass capability for all micro UPS products up to and including 2 kVA.
   b. Modes of Operation:
      1) Normal: The UPS is continuously supplied available utility power by the maintenance / bypass switch. The UPS output power is returned to the maintenance / bypass switch and distributed to the critical AC load through the maintenance / bypass switch output receptacles.
      2) Maintenance Bypass: The bypass switch allows a transfer of the critical AC load from the UPS inverter to the utility source; to allow for service to or replacement of the UPS, without interrupting the load.
2. Performance:
   a. Capacity: 2,000 VA.
   b. AC Input to Maintenance/Bypass Switch:
      1) Voltage Configuration:
         a) 120V Units: 120V ac nominal (range is UPS dependent), 50/60-Hz, single-phase, two-wire plus ground.
      2) Frequency: 50/60-Hz nominal, UPS dependent.
   c. AC Output:
      1) Voltage Configuration:
         a) 120V Units: 120V ac nominal (range is UPS dependent), 50/60-Hz, single-phase, two-wire plus ground.
      2) Output Load Capacity: 12A.
   d. Frequency: 50/60-Hz nominal, UPS dependent.
   e. Bypass Switch: The bypass switch is capable of switching up to 20 amps or 30 amps, based on the model of the POD. The switch is a break before make type, with a maximum transfer time of 6 ms.
3. Environmental Conditions:
   a. Ambient Temperature:
      1) Operating: Plus 32 degrees F to plus 104 degrees F (0 degree C to plus 40 degrees C).
      2) Storage: Minus 20 degrees C to plus 60 degrees C (minus 4 degrees F to plus 140 degrees F).

b. Relative Humidity:
   1) Operating: 0 percent to 95 percent noncondensing.
   2) Storage: 0 percent to 95 percent noncondensing.

4. Installation Connections:
   a. Utility Input: Input terminal blocks for connection to utility.
   b. UPS Output: 6-foot cord with plug for connection to UPS output.
5. Display and Controls:
   a. Status Indicators: Shall be equipped with two status indicators designed for convenient and reliable user operation. The "Utility/Mains" indicator illuminates amber to indicate that utility/mains power is available for the load and UPS. The "UPS" indicator illuminates green to indicate the presence of UPS output power for the load.
   b. Bypass: The bypass is a spring-loaded rotary switch that ensures a maximum transfer time of less than 6 ms.
6. Output Distribution:
   a. Terminal blocks (8 AWG maximum).
   b. Output Protection: 15A circuit breaker (furnished by panel fabricator).
7. Manufacturer and Product:
   a. Liebert (a division of Emerson Network Power):
      1) Model: MicroPod 2 MP2-115HW.
      2) No substitution allowed.

M. Y175A Industrial Ethernet Switch:

1. As defined by the Panel Schedule in Article Supplements.
2. Full compliance with IEC 61000 6-2 and 6-4.
3. Supports 10 Mbit/s Ethernet, 100 Mbit/s Fast Ethernet and 1.000 Gbit/s Gigabit Ethernet via RJ 45 connectors (IEC 60603-7).
4. Power: 120V ac, 40 Watts.
5. Operating Temperature: Minus 40 degrees C to 60 degrees C (Sealed Enclosure Operating).
6. Relative Humidity: In accordance with IEC 60068-2-3 and 2-30; 5percent to 95 percent noncondensing.
7. Quantity of Ethernet Ports (Total of 20 ports minimum):
   a. Furnish 20-port, Gigabit Ethernet (RJ-45 connectors and Power over Ethernet +) managed switch, unless otherwise noted. Stratix 5700 Series - 1783-BMS20CGP.
   b. Furnish 10-port, Gigabit Ethernet combo uplink ports (both RJ-45 and SFP ports). Stratix 5700 Series - 1783-BMS10CGP.
8. Mounting: DIN-rail.
9. Software: Full Version.

10. Key Software Features:
    a. Layer 2 Switching: IEEE 802.1, 802.3, 802.3at, 802.3af standard, VTPv2, NTP, UDLD, CDP, LLDP, Unicast Mac filter, Flexlink, Resilient Ethernet Protocol (REP), Parallel Redundancy Protocol (PRP), VTPv3, EtherChannel, Voice VLAN, qinq tunneling.
    b. Security: SCP, SSH, SNMPv3, TACACS+, RADIUS Server/Client, MAC Address Notification, BPDU Guard, Port-Security, Private VLAN, DHCP Snooping, Dynamic ARP Inspection, IP Source Guard, 802.1x, Guest VLAN, MAC Authentication Bypass, 802.1x Multi-Domain Authentication, Storm Control, Trust Boundary, Cisco TrustSec® security, FIPS 140-2.
    c. Layer 2 Multicast: IGMPv1, v2, v3 Snooping, IGMP filtering, IGMP Querier.
    d. Management: Fast Boot, Express Setup, Web Device Manager, Cisco Network Assistant1, Cisco Prime™ platform1, MIB, SmartPort, SNMP, syslog, Storm Control - Unicast, Multicast, Broadcast, SPAN Sessions, RSPAN, DHCP Server, Customized TCAM/SDM size configuration, DOM (digital optical management).
    e. Industrial Ethernet: CIP Ethernet/IP, Profinet v2 MRP (IEC 62439-2), IEEE 1588 PTP v2, NTP to PTP translation, CIP Time Sync.
    f. Quality of Service: Ingress Policing, Rate-Limit, Egress Queueing/shaping, AutoQoS, Modular QoS CLI (MQC).
    g. Layer 2 IPv6: IPv6 Host support, HTTP over IPv6, SNMP over IPv6.
    h. Layer 3 Routing: IPv4 Static Routing.
    i. Industrial Management: Layer 2 switching with 1:1 static Network Address Translation (NAT).
    j. Utility: Power Profile, dying gasp, GOOSE messaging, SCADA protocol classification, MODBUS TCP/IP, utility SmartPort macro, BFD, Ethernet OAM, IEEE 802.3ah, CFM (IEEE 802.1ag).
    k. IP Multicast: PIM sparse mode (PIM-SM), PIM dense mode (PIM-DM), and PIM sparse-dense mode.
    l. Industrial Management: Embedded Event Manager (EEM).
    m. IP Unicast Routing Protocols: OSPF, EIGRP, BGPv4, IS-IS, RIPv2, Policy-Based Routing (PBR), HSRP.
    n. Cisco Express Forwarding: Hardware routing architecture delivers extremely high-performance IP routing.
    o. IPv6 Routing: RIPng, OSPFv6, and EIGRPv6 support.
    p. Security: IEEE 802.1AE MACsec, Security Group Access Control Lists (SGACL).

q. Virtualization: VRF-lite.

11. SFP Modules: Furnish (as a minimum) with two 1000 Base-FX multi-mode transceiver modules (GLC-SX-MM-RGD 1000BASE-T^2 – 550 meter maximum) with type “LC” multi-mode fiber optic connectors. Furnish additional SFP modules as required for Gigabit connectivity to the Plant SCADA Network.
12. Each switch shall be furnished with two additional SFP ports of each type used as spares (installed in the switch).
13. Alarm Configuration:
    a. The switch shall be configured to alarm on a detected fault within the switch via a relay contact closure (SPDT contact, 1 amp @ 24V dc).
14. Manufacturer and Product:
    a. Stratix 5700 Series - 1783-BMSXXCGP.
    b. Full Firmware.
    c. Supports DLR
    d. Supports CIP Sync.
    e. No substitution allowed.

N. Y187 Panel PC for Control Panel Enclosures:

1. Supplier shall provide a single panel mounted Operator Interface Unit (OIU) for local monitoring, alarming, and control functions.
2. Touch screen operator interface shall be an industrial graphic workstation with the following features as a minimum:
    a. 15-inch (minimum) Full color LCD touch screen.
    b. Dual Ethernet communication port.
    c. Suitable for outdoor installation.
3. Display:
    a. Display: 38.1 cm/15-inch TFT.
    b. Screen Resolution: 1024 by 768 Pixel(s) (XGA).
    c. Backlighting: LED.
    d. Display Backlight MTB: Greater than 50,000 hours.
    e. Touch Technology: Analog resistive (GFG).
    f. Colors: 262144 colors.
4. Computer data:
    a. Processor: Intel® Atom™ E680T 1.6 GHz.
    b. Cooling: Passive.
    c. Operating Systems: Windows® Embedded Standard 7.
    d. RAM: 2 GB DDR2 800.
    e. Mass Storage: Flash SSD 64 GB.
    f. Network: 2x Ethernet (10/100/1000 Mbps), RJ45.
    g. Network Chipset: Mikrel® KSZ9021RN.
    h. Interfaces: 4 by USB host 2.0.

i. Monitor Output: Without.
j. Optional Interfaces: 1x COM (RS-232), 1x COM (RS-485).
k. Slots: SD card.
l. Optical Drive: Without drive.
m. Realtime Clock: Yes (battery-backed).
n. Service Life of Battery: 5 years (typical).

5. General:
   a. Mounting Type: Front installation.
   b. Weight: 3,400 g.
6. Ambient Conditions:
   a. Degree of Protection:
      1) IP67 (front), IP20 (back).
      2) NEMA 4X.
   b. Ambient Temperature (Operation): Minus 4 degrees F to 140 degrees F (minus 20 degrees C to 60 degrees C).
   c. Ambient Temperature (Storage/Transport): Minus 22 degrees F to 176 degrees F (minus 30 degrees C to 80 degrees C).
   d. Permissible Humidity (Operation): 20 percent to 85 percent (noncondensing).
   e. Permissible Humidity (Storage/Transport): 20 percent to 85 percent (noncondensing).
   f. Vibration (Operation): DIN EN 60068-2-6.
   g. Shock: DIN EN 60068-2-27.
7. Device Supply:
   a. Power Consumption: 31.2 watts.
   b. Power Supply Unit: 24V dc plus or minus 20 percent.
8. Touch screen operator interface, as a minimum, shall be provided with the following:
   a. Overview screen displaying process monitoring and process control.
   b. Alarm summary display.
   c. PLC diagnostics.
   d. Operation of the equipment in of associated process in the “Remote-Manual” mode of operation.
   e. Adjust all setpoints (password protected) for the operation of the control system operation.
   f. All programming software required for programming the OIU.
      1) Operating System: Windows® Embedded Standard 7.
      2) HMI Application Software: Allen-Bradley FactoryTalk® View Machine Edition (latest version).
         a) Furnish a copy of development software licensed to the Owner.
   g. 64 GB Flash SSD WT.

9. Manufacturer and Product:
    a. Allen Bradley:
        1) Panel PC: –PanelView Plus 7.
        2) No substitution allowed.

O. Y187A Panel PC for Small Package System Enclosures:

1. Supplier shall provide a single panel mounted Operator Interface Unit (OIU) for local monitoring, alarming, and control functions.
2. Touch screen operator interface shall be an industrial graphic workstation with the following features as a minimum:
    a. 7-inch (minimum) Full color LCD touch screen.
    b. Dual Ethernet communication port.
    c. Suitable for outdoor installation.
3. Display:
    a. Display: 17.8 cm/7-inch TFT.
    b. Screen Resolution: 800 pixel by 480 pixel (WVGA).
    c. Backlighting: LED.
    d. Display Backlight MTB: Greater than 50,000 hours.
    e. Touch Technology: Analog resistive (GFG).
    f. Colors: 262144 colors.
4. Computer Data:
    a. Processor: Intel® Atom™ E680T 1.6 GHz.
    b. Cooling: Passive.
    c. Operating Systems: Windows® Embedded Standard 7.
    d. RAM: 2 GB DDR2 800.
    e. Mass Storage: Flash SSD 32 GB
    f. Network: 2x Ethernet (10/100/1000 Mbps), RJ45.
    g. Network Chipset: Mikrel® KSZ9021RN.
    h. Interfaces: 4 by USB host 2.0.
    i. Monitor Output: Without.
    j. Optional Interfaces: 1x COM (RS-232), 1x COM (RS-485).
    k. Slots: SD card.
    l. Optical Drive: Without drive.
    m. Realtime Clock: Yes (battery-backed).
    n. Service Life of Battery: 5 years (typical).
5. General:
    a. Mounting Type: Front installation.
    b. Weight: 1,100 g.
6. Ambient Conditions:
    a. Degree of Protection:
        1) IP67 (front), IP20 (back).
        2) NEMA 4X.

b. Ambient Temperature (Operation): Minus 4 degrees F to 140 degrees F (minus 20 degrees C to 60 degrees C).
c. Ambient Temperature (Storage/Transport): Minus 22 degrees F to 176 degrees F (minus 30 degrees C to 80 degrees C).
d. Permissible Humidity (Operation): 20 percent to 85 percent (noncondensing).
e. Permissible Humidity (Storage/Transport): 20 percent to 85 percent (noncondensing).
f. Vibration (Operation): DIN EN 60068-2-6.
g. Shock: DIN EN 60068-2-27.

7. Device Supply:
   a. Power Consumption: 16.8 watts.
   b. Power Supply Unit: 24V dc plus or minus 20 percent.
8. Touch screen operator interface, as a minimum, shall be provided with the following:
   a. Overview screen displaying process monitoring and process control.
   b. Alarm summary display.
   c. PLC diagnostics.
   d. Operation of the equipment in of associated process in the "Remote-Manual" mode of operation.
   e. Adjust all setpoints (password protected) for the operation of the control system operation.
   f. All programming software required for programming the OIU.
      1) Operating System: Windows® Embedded Standard 7.
      2) HMI Application Software: Allen-Bradley FactoryTalk® View Machine Edition (latest version).
         a) Furnish a copy of development software licensed to the Owner.
   g. 32 GB Flash SSD WT.
9. Manufacturer:
   a. Allen Bradley:
      1) Panel PC: –PanelView Plus 7.
      2) No substitution allowed.

END OF SUPPLEMENT

AB Jewell Clarifier No. 02 Instrument List

TAG NO.	CODE	DESCRIPTION	COMPONENT OPTIONS	SURGE SUPPRESSION DETAIL	INSTRUMENT INSTALLATION DETAIL	P&ID	NOTES
(Clarifier 02) EFLL-TRB-10008 (Clarifier 02) EFLL-TRB-10009	A16D	Turbidity Element; Immersion Type	**Process Fluid:** Clarified Water. **Range:** Turbidity - 0 to 4000 NTU. **Span:** 0 - 10 NTU. **Installation:** Immersion Type with HACH Handrail Mounting Kit.	n/a	4091-156AD	(Clarifier 02) P&ID N-002	Suitable for use in potable water. NSF 61 compliance.
(Clarifier 02) EFLL-PHH-10003 (Clarifier 02) EFLL-PHH-10004	A7	pH Element	**Process Fluid:** Clarified Water. **Range:** -2 to 14 pH. **Span:** 2 to 10 pH. **Installation:** Immersion Type with HACH Handrail Mounting Kit.	n/a	4091-156AD	(Clarifier 02) P&ID N-002	Suitable for use in potable water. NSF 61 compliance.
(Clarifier 02) EFLL-CTL-10201 (Clarifier 02) EFLL-CTL-10202	A150	Analytical Indicating Transmitter, Two-Channel	**Enclosure:** NEMA 4X **Dual Digital Channel Analytical Indicating Transmitter** **Digital Communication:** Modbus RTU / RS-485. **Contacts:** 4 SPDT.	4091-420US	4091-403D	(Clarifier 02) P&ID N-002	Analytical Indicating Transmitter mounted on equipment rack on Clarifier No. 4 walkway, mounted in 316 Stainless Steel, NEMA 4X enclosure (powder coated white) mounted under a 316 stainless steel sun shield (powder coated white) with glare shield and type "SS-4" surge suppression. 4–20 mA dc/Digital HART® Protocol.
PE-10301A PE-10301B PE-10302A PE-10302B	P15	Pressure Seal, Annular	**Process Fluid:** Sludge. **Size:** 2 inch. **Type:** Off-line.	n/a	4091-304DG	P&ID N-007	
PI-10301A PI-10301B PI-10302A PI-10302B	P4	Pressure Gauge	**Process Fluid:** Fill Fluid of Annular Seal. **Gauge Size:** 4.5 inch. **Gauge Range:** 0 - 15 psi. **Style:** Solid Front, Liquid Filled (Glycerin). **Process Connection:** 1/4 inch NPT. **Connection Type:** Lower. **Ball Valves:** 316 Stainless Steel, Full-port.	n/a	4091-304DG	P&ID N-007	

AB Jewell Clarifier No. 02 Control Panel Schedule

TAG NO.	DESCRIPTION	COMPONENT OPTIONS	SURGE SUPPRESSION DETAIL	INSTALLATION DETAIL	P&ID	NOTES
ABJ-CLAR-Clar02-Mxr-CPN10201	Clarifier No. 02 Rapid Mixer Control Panel East 1	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Mxr-CPN10202	Clarifier No. 02 Rapid Mixer Control Panel West 2	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10203	Clarifier No. 02 Flocculators Control Panel North 1	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	. With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10204	Clarifier No. 02 Flocculators Control Panel North 2	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10205	Clarifier No. 02 Flocculators Control Panel North 3	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10206	Clarifier No. 02 Flocculators Control Panel North 4	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10207	Clarifier No. 02 Flocculators Control Panel South 1	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10208	Clarifier No. 02 Flocculators Control Panel South 2	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10209	Clarifier No. 02 Flocculators Control Panel South 3	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Floc-CPN10210	Clarifier No. 02 Flocculators Control Panel South 4	**Type:** Rack-Mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-001	With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 43 22 56 Package System Supplier.
ABJ-CLAR-Clar02-Infl-CPN10211	Clarifier No. 02 Control Panel	**Type:** Freestanding. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-139 4091-441X 4091-451D 4091-452D	09-N-001	Allen Bradley ControlLogix PLC (Y375). Furnished by 40 90 01 PICS Contractor.
ABJ-CLAR-SLG-Clar02-CPN10218	Clarifier No. 02 Sludge Collection System Control Panel	**Type:** Freestanding. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield.	4091-406AG	4091-139 4091-441X 4091-451D 4091-452D	09-N-002	Allen Bradley ControlLogix PLC (Y375). Y187 - Panel PC for Control Panel Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 44 42 63 Package System Supplier.
ABJ-CLAR-SLG-Clar02-CPN10212	Clarifier No. 2 Sludge Collection Drive 2-1 Control Panel	**Type:** Rack-mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield with hinged glare shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-005	Allen Bradley Remote I/O (Y50B). With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 44 42 63 Package System Supplier.
ABJ-CLAR-SLG-Clar02-CPN10213	Clarifier No. 2 Sludge Collection Drive 2-2 Control Panel	**Type:** Rack-mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield with hinged glare shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-005	Allen Bradley Remote I/O (Y50B). With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 44 42 63 Package System Supplier.
ABJ-CLAR-SLG-Clar02-CPN10214	Clarifier No. 2 Sludge Collection Drive 2-3 Control Panel	**Type:** Rack-mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield with hinged glare shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-005	Allen Bradley Remote I/O (Y50B). With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 44 42 63 Package System Supplier.
ABJ-CLAR-SLG-Clar02-CPN10215	Clarifier No. 2 Sludge Collection Drive 2-4 Control Panel	**Type:** Rack-mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield with hinged glare shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-005	Allen Bradley Remote I/O (Y50B). With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 44 42 63 Package System Supplier.
ABJ-CLAR-SLG-Clar02-CPN10216	Clarifier No. 2 Sludge Collection Drive 2-5 Control Panel	**Type:** Rack-mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield with hinged glare shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-005	Allen Bradley Remote I/O (Y50B). With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 44 42 63 Package System Supplier.
ABJ-CLAR-SLG-Clar02-CPN10217	Clarifier No. 2 Sludge Collection Drive 2-6 Control Panel	**Type:** Rack-mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield with hinged glare shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-005	Allen Bradley Remote I/O (Y50B). With Small Package System Enclosures. Hinged Access Enclosure (UV protection for Panel PC). Furnished by 44 42 63 Package System Supplier.
Existing - CP-FK-2403	Clarifier No. 4 Sludge Pump Station No. 2 Control Panel	**Type:** Rack-mounted. **Material:** 316 Stainless Steel. **NEMA Rating:** 4X. **Finish:** Powder Coated White. **Options:** 316 Stainless Steel, Powder Coated White Sun Shield with hinged glare shield.	4091-406AG	4091-384 4091-388PD 4091-402D 4091-441X 4091-451D 4091-452D	09-N-007	Additional I/O points

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	AI	ABJ-CLAR-SLG-CLR02	MOT10201-SI	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 SPEED INDICATION	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	AI	ABJ-CLAR-SLG-CLR02	CPN-10212TI	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10201 MEASURED INTERIOR TEMPERATURE	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	AO	ABJ-CLAR-SLG-CLR02	MOT10201-SC	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 SPEED SETPOINT	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	MOT10201-IR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "IN REMOTE" STATUS	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	MOT10201-MN	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "RUNNING" STATUS	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	MOT10201-XF	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "VFD FAULT" STATUS	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	MOT10201-RE	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "RESET DEPRESSED" STATUS	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	MOT10201-HS	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "EMERGENCY STOP DEPRESSED" STATUS	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	MOT10201-ZSH	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "HOME POSITION" STATUS	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	MOT10201-ZSL	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "FULL TRAVEL" STATUS	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	VLV-10209-IR	SLUDGE FLOW VALVE NO VLV-10209 " IN REMOTE " STATUS	N-005	VLV10209
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	VLV-10209-ZF	SLUDGE FLOW VALVE NO VLV-10209 " FAULT " STATUS	N-005	VLV10209
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	VLV-10209-ZH	SLUDGE FLOW VALVE NO VLV-10209 " FULLY OPENED " STATUS	N-005	VLV10209
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	VLV-10209-ZL	SLUDGE FLOW VALVE NO VLV-10209 " FULLY CLOSED " STATUS	N-005	VLV10209
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	VLV-10209-XA	SLUDGE FLOW VALVE NO VLV-10209 "ACTUATOR FAULT" STATUS	N-005	VLV10209
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA01	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "UTILITY POWER OK" STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA02	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "PANEL INTRUSION " STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA03	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "MANAGED ETHERNET SWITCH ESW-10212 " FAULT" STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA04	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "24 VDC POWER SUPPLIES OK" STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA05	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "UPS-10212 "FAULT" STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA06	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "UPS-10212 "BATTERY LOW" STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA07	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "UPS-10212 "UPS ON BYPASS" STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DI	ABJ-CLAR-SLG-CLR02	CPN-10212XA08	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10212 "POWER FAILURE FROM UPS" STATUS	NA	CPN-10212
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DO	ABJ-CLAR-SLG-CLR02	MOT10201-MD	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "RUN FORWARD" COMMAND	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DO	ABJ-CLAR-SLG-CLR02	MOT10201-MR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10201 "RUN IN REVERSE" COMMAND	N-005	MOT10201
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DO	ABJ-CLAR-SLG-CLR02	VLV-10209-ZD	SLUDGE FLOW VALVE NO VLV-10209 " OPEN" COMMAND	N-005	VLV10209
CLR02-SLUDGE COLLECTION	CPN10212	SCD10201	DO	ABJ-CLAR-SLG-CLR02	VLV-10209-ZB	SLUDGE FLOW VALVE NO VLV-10209 " CLOSE" COMMAND	N-005	VLV10209

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	AI	ABJ-CLAR-SLG-CLR02	MOT10202-SI	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 SPEED INDICATION	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	AI	ABJ-CLAR-SLG-CLR02	CPN-10213TI	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 MEASURED INTERIOR TEMPERATURE	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	AO	ABJ-CLAR-SLG-CLR02	MOT10202-SC	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 SPEED SETPOINT	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	MOT10202-IR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "IN REMOTE" STATUS	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	MOT10202-MN	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "RUNNING" STATUS	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	MOT10202-XF	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "VFD FAULT" STATUS	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	MOT10202-RE	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "RESET DEPRESSED" STATUS	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	MOT10202-HS	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "EMERGENCY STOP DEPRESSED" STATUS	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	MOT10202-ZSH	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "HOME POSITION" STATUS	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	MOT10202-ZSL	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "FULL TRAVEL" STATUS	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	VLV-10210-IR	SLUDGE FLOW VALVE NO VLV-10210 " IN REMOTE " STATUS	N-005	VLV10210
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	VLV-10210-ZF	SLUDGE FLOW VALVE NO VLV-10210 " FAULT " STATUS	N-005	VLV10210
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	VLV-10210-ZH	SLUDGE FLOW VALVE NO VLV-10210 " FULLY OPENED " STATUS	N-005	VLV10210
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	VLV-10210-ZL	SLUDGE FLOW VALVE NO VLV-10210 " FULLY CLOSED " STATUS	N-005	VLV10210
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	VLV-10210-XA	SLUDGE FLOW VALVE NO VLV-10210 "ACTUATOR FAULT" STATUS	N-005	VLV10210
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA01	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "UTILITY POWER OK" STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA02	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "PANEL INTRUSION " STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA03	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "MANAGED ETHERNET SWITCH ESW-10202 " FAULT" STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA04	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "24 VDC POWER SUPPLIES OK" STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA05	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "UPS-10202 "FAULT" STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA06	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "UPS-10202 "BATTERY LOW" STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA07	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "UPS-10202 "UPS ON BYPASS" STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DI	ABJ-CLAR-SLG-CLR02	CPN-10213XA08	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10213 "POWER FAILURE FROM UPS" STATUS	NA	CPN-10213
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DO	ABJ-CLAR-SLG-CLR02	MOT10202-MD	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "RUN FORWARD" COMMAND	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DO	ABJ-CLAR-SLG-CLR02	MOT10202-MR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10202 "RUN IN REVERSE" COMMAND	N-005	MOT10202
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DO	ABJ-CLAR-SLG-CLR02	VLV-10210-ZD	SLUDGE FLOW VALVE NO VLV-10210 " OPEN" COMMAND	N-005	VLV10210
CLR02-SLUDGE COLLECTION	CPN10213	SCD10202	DO	ABJ-CLAR-SLG-CLR02	VLV-10210-ZB	SLUDGE FLOW VALVE NO VLV-10210 " CLOSE" COMMAND	N-005	VLV10210

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	AI	ABJ-CLAR-SLG-CLR02	MOT10203-SI	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 SPEED INDICATION	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	AI	ABJ-CLAR-SLG-CLR02	CPN-10214TI	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 MEASURED INTERIOR TEMPERATURE	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	AO	ABJ-CLAR-SLG-CLR02	MOT10203-SC	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 SPEED SETPOINT	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	MOT10203-IR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "IN REMOTE" STATUS	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	MOT10203-MN	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "RUNNING" STATUS	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	MOT10203-XF	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "VFD FAULT" STATUS	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	MOT10203-RE	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "RESET DEPRESSED" STATUS	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	MOT10203-HS	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "EMERGENCY STOP DEPRESSED" STATUS	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	MOT10203-ZSH	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "HOME POSITION" STATUS	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	MOT10203-ZSL	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "FULL TRAVEL" STATUS	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	VLV-10211-IR	SLUDGE FLOW VALVE NO VLV-10211 " IN REMOTE " STATUS	N-005	VLV10211
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	VLV-10211-ZF	SLUDGE FLOW VALVE NO VLV-10211 " FAULT " STATUS	N-005	VLV10211
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	VLV-10211-ZH	SLUDGE FLOW VALVE NO VLV-10211 " FULLY OPENED " STATUS	N-005	VLV10211
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	VLV-10211-ZL	SLUDGE FLOW VALVE NO VLV-10211 " FULLY CLOSED " STATUS	N-005	VLV10211
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	VLV-10211-XA	SLUDGE FLOW VALVE NO VLV-10211 "ACTUATOR FAULT" STATUS	N-005	VLV10211
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA01	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "UTILITY POWER OK" STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA02	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "PANEL INTRUSION " STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA03	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "MANAGED ETHERNET SWITCH ESW-10203 " FAULT" STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA04	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "24 VDC POWER SUPPLIES OK" STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA05	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "UPS-10203 "FAULT" STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA06	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "UPS-10203 "BATTERY LOW" STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA07	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "UPS-10203 "UPS ON BYPASS" STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DI	ABJ-CLAR-SLG-CLR02	CPN-10214XA08	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10214 "POWER FAILURE FROM UPS" STATUS	NA	CPN-10214
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DO	ABJ-CLAR-SLG-CLR02	MOT10203-MD	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "RUN FORWARD" COMMAND	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DO	ABJ-CLAR-SLG-CLR02	MOT10203-MR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10203 "RUN IN REVERSE" COMMAND	N-005	MOT10203
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DO	ABJ-CLAR-SLG-CLR02	VLV-10211-ZD	SLUDGE FLOW VALVE NO 10203 " OPEN" COMMAND	N-005	VLV10211
CLR02-SLUDGE COLLECTION	CPN10214	SCD10203	DO	ABJ-CLAR-SLG-CLR02	VLV-10211-ZB	SLUDGE FLOW VALVE NO 10203 " CLOSE" COMMAND	N-005	VLV10211

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	AI	ABJ-CLAR-SLG-CLR02	MOT10204-SI	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 SPEED INDICATION	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	AI	ABJ-CLAR-SLG-CLR02	CPN-10215TI	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 MEASURED INTERIOR TEMPERATURE	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	AO	ABJ-CLAR-SLG-CLR02	MOT10204-SC	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 SPEED SETPOINT	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	MOT10204-IR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "IN REMOTE" STATUS	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	MOT10204-MN	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "RUNNING" STATUS	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	MOT10204-XF	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "VFD FAULT" STATUS	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	MOT10204-RE	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "RESET DEPRESSED" STATUS	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	MOT10204-HS	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "EMERGENCY STOP DEPRESSED" STATUS	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	MOT10204-ZSH	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "HOME POSITION" STATUS	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	MOT10204-ZSL	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "FULL TRAVEL" STATUS	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	VLV-10212-IR	SLUDGE FLOW VALVE NO VLV-10212 " IN REMOTE " STATUS	N-005	VLV10212
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	VLV-10212-ZF	SLUDGE FLOW VALVE NO VLV-10212 " FAULT " STATUS	N-005	VLV10212
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	VLV-10212-ZH	SLUDGE FLOW VALVE NO VLV-10212 " FULLY OPENED " STATUS	N-005	VLV10212
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	VLV-10212-ZL	SLUDGE FLOW VALVE NO VLV-10212 " FULLY CLOSED " STATUS	N-005	VLV10212
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	VLV-10212-XA	SLUDGE FLOW VALVE NO VLV-10212 "ACTUATOR FAULT" STATUS	N-005	VLV10212
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA01	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "UTILITY POWER OK" STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA02	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "PANEL INTRUSION " STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA03	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "MANAGED ETHERNET SWITCH ESW-10204 " FAULT" STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA04	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "24 VDC POWER SUPPLIES OK" STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA05	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "UPS-10204 "FAULT" STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA06	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "UPS-10204 "BATTERY LOW" STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA07	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "UPS-10204 "UPS ON BYPASS" STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DI	ABJ-CLAR-SLG-CLR02	CPN-10215XA08	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10215 "POWER FAILURE FROM UPS" STATUS	NA	CPN-10215
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DO	ABJ-CLAR-SLG-CLR02	MOT10204-MD	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "RUN FORWARD" COMMAND	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DO	ABJ-CLAR-SLG-CLR02	MOT10204-MR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10204 "RUN IN REVERSE" COMMAND	N-005	MOT10204
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DO	ABJ-CLAR-SLG-CLR02	VLV-10212-ZD	SLUDGE FLOW VALVE NO 10204 " OPEN" COMMAND	N-005	VLV10212
CLR02-SLUDGE COLLECTION	CPN10215	SCD10204	DO	ABJ-CLAR-SLG-CLR02	VLV-10212-ZB	SLUDGE FLOW VALVE NO 10204 " CLOSE" COMMAND	N-005	VLV10212

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	AI	ABJ-CLAR-SLG-CLR02	MOT10205-SI	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 SPEED INDICATION	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	AI	ABJ-CLAR-SLG-CLR02	CPN-10216TI	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 MEASURED INTERIOR TEMPERATURE	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	AO	ABJ-CLAR-SLG-CLR02	MOT10205-SC	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 SPEED SETPOINT	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	MOT10205-IR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "IN REMOTE" STATUS	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	MOT10205-MN	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "RUNNING" STATUS	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	MOT10205-XF	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "VFD FAULT" STATUS	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	MOT10205-RE	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "RESET DEPRESSED" STATUS	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	MOT10205-HS	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "EMERGENCY STOP DEPRESSED" STATUS	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	MOT10205-ZSH	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "HOME POSITION" STATUS	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	MOT10205-ZSL	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "FULL TRAVEL" STATUS	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	VLV-10213-IR	SLUDGE FLOW VALVE NO VLV-10213 " IN REMOTE " STATUS	N-005	VLV10213
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	VLV-10213-ZF	SLUDGE FLOW VALVE NO VLV-10213 " FAULT " STATUS	N-005	VLV10213
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	VLV-10213-ZH	SLUDGE FLOW VALVE NO VLV-10213 " FULLY OPENED " STATUS	N-005	VLV10213
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	VLV-10213-ZL	SLUDGE FLOW VALVE NO VLV-10213 " FULLY CLOSED " STATUS	N-005	VLV10213
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	VLV-10213-XA	SLUDGE FLOW VALVE NO VLV-10213 "ACTUATOR FAULT" STATUS	N-005	VLV10213
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA01	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "UTILITY POWER OK" STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA02	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "PANEL INTRUSION " STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA03	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "MANAGED ETHERNET SWITCH ESW-10205 " FAULT" STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA04	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "24 VDC POWER SUPPLIES OK" STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA05	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "UPS-10205 "FAULT" STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA06	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "UPS-10205 "BATTERY LOW" STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA07	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "UPS-10205 "UPS ON BYPASS" STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DI	ABJ-CLAR-SLG-CLR02	CPN-10216XA08	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10216 "POWER FAILURE FROM UPS" STATUS	NA	CPN-10216
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DO	ABJ-CLAR-SLG-CLR02	MOT10205-MD	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "RUN FORWARD" COMMAND	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DO	ABJ-CLAR-SLG-CLR02	MOT10205-MR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10205 "RUN IN REVERSE" COMMAND	N-005	MOT10205
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DO	ABJ-CLAR-SLG-CLR02	VLV-10213-ZD	SLUDGE FLOW VALVE NO 10205 " OPEN" COMMAND	N-005	VLV10213
CLR02-SLUDGE COLLECTION	CPN10216	SCD10205	DO	ABJ-CLAR-SLG-CLR02	VLV-10213-ZB	SLUDGE FLOW VALVE NO 10205 " CLOSE" COMMAND	N-005	VLV10213

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	AI	ABJ-CLAR-SLG-CLR02	MOT10206-SI	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 SPEED INDICATION	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	AI	ABJ-CLAR-SLG-CLR02	CPN-10217TI	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 MEASURED INTERIOR TEMPERATURE	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	AO	ABJ-CLAR-SLG-CLR02	MOT10206-SC	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 SPEED SETPOINT	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	MOT10206-IR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "IN REMOTE" STATUS	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	MOT10206-MN	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "RUNNING" STATUS	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	MOT10206-XF	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "VFD FAULT" STATUS	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	MOT10206-RE	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "RESET DEPRESSED" STATUS	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	MOT10206-HS	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "EMERGENCY STOP DEPRESSED" STATUS	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	MOT10206-ZSH	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "HOME POSITION" STATUS	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	MOT10206-ZSL	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "FULL TRAVEL" STATUS	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	VLV-10214-IR	SLUDGE FLOW VALVE NO VLV-10214 " IN REMOTE " STATUS	N-005	VLV10214
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	VLV-10214-ZF	SLUDGE FLOW VALVE NO VLV-10214 " FAULT " STATUS	N-005	VLV10214
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	VLV-10214-ZH	SLUDGE FLOW VALVE NO VLV-10214 " FULLY OPENED " STATUS	N-005	VLV10214
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	VLV-10214-ZL	SLUDGE FLOW VALVE NO VLV-10214 " FULLY CLOSED " STATUS	N-005	VLV10214
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	VLV-10214-XA	SLUDGE FLOW VALVE NO VLV-10214 "ACTUATOR FAULT" STATUS	N-005	VLV10214
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA01	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "UTILITY POWER OK" STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA02	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "PANEL INTRUSION " STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA03	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "MANAGED ETHERNET SWITCH ESW-10206 " FAULT" STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA04	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "24 VDC POWER SUPPLIES OK" STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA05	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "UPS-10206 "FAULT" STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA06	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "UPS-10206 "BATTERY LOW" STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA07	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "UPS-10206 "UPS ON BYPASS" STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DI	ABJ-CLAR-SLG-CLR02	CPN-10217XA08	SLUDGE COLLECTION SYSTEM FIELD PANEL CPN10217 "POWER FAILURE FROM UPS" STATUS	NA	CPN-10217
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DO	ABJ-CLAR-SLG-CLR02	MOT10206-MD	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "RUN FORWARD" COMMAND	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DO	ABJ-CLAR-SLG-CLR02	MOT10206-MR	CLARIFIER NO 02 SLUDGE COLLECTOR DRIVE MOT10206 "RUN IN REVERSE" COMMAND	N-005	MOT10206
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DO	ABJ-CLAR-SLG-CLR02	VLV-10214-ZD	SLUDGE FLOW VALVE NO 10206 " OPEN" COMMAND	N-005	VLV10214
CLR02-SLUDGE COLLECTION	CPN10217	SCD10206	DO	ABJ-CLAR-SLG-CLR02	VLV-10214-ZB	SLUDGE FLOW VALVE NO 10206 " CLOSE" COMMAND	N-005	VLV10214

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
CLARIFIER 02	CPN10218	SCD10277	AI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10201A	Clarifier No. 02 North Basin Effluent Measured Turbidity	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	AI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10201B	Clarifier No. 02 North Basin Effluent Measured pH	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	AI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10202A	Clarifier No. 02 South Basin Effluent Measured Turbidity	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	AI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10202B	Clarifier No. 02 South Basin Effluent Measured pH	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	AI	ABJ-CLAR-SLG-CLR02	CPN-10218TI	Sludge Collection System Control Panel CPN-10218 Measured Interior Temperature	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10201HA	Clarifier No. 02 North Basin Effluent Turbidity High Alarm Status	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10201LA	Clarifier No. 02 North Basin Effluent Low pH Alarm Status	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10201XF	Clarifier No. 02 North Basin Effluent Analyzer "Fault" Status	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10202HA	Clarifier No. 02 South Basin Effluent Turbidity High Alarm Status	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10202LA	Clarifier No. 02 South Basin Effluent Low pH Alarm Status	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	EEFLL-CTL10202XF	Clarifier No. 02 South Basin Effluent pH "Fault" Status	N-002	CL02-EEFLL
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	VLV-10208-ZF	Clarifier No. 02 Effluent North Gate (VLV-10208) Actuator "Fault" Status	N-002	CL02-BSNVLV
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	VLV-10208-ZH	Clarifier No. 02 Effluent North Gate (VLV-10208) "Fully Opened" Status	N-002	CL02-BSNVLV
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	VLV-10208-ZL	Clarifier No. 02 Effluent North Gate (VLV-10208) "Fully Closed" Status	N-002	CL02-BSNVLV
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	VLV-10215ZF	Clarifier No. 02 Effluent South Gate (VLV-10215)Actuator "Fault" Status	N-002	CL02-BSNVLV
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	VLV-10215-ZH	Clarifier No. 02 Effluent South Gate (VLV-10215) "Fully Opened" Status	N-002	CL02-BSNVLV
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	VLV-10215-ZL	Clarifier No. 02 Effluent South Gate (VLV-10215) "Fully Closed" Status	N-002	CL02-BSNVLV
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-01XA	Sludge Collection System Control Panel CPN-10218 "Utility Power OK" Status	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-02XA	Sludge Collection System Control Panel CPN-10218 "Panel Intrusion" Status	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-03XA	Sludge Collection System Control Panel CPN-10218 Managed Ethernet Switch "Fault" Status	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-04XA	Sludge Collection System Control Panel CPN-10218 "24VDC Power Supply OK" Status	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-05XA	Sludge Collection System Control Panel CPN-10218 "UPS Fault" Status	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-06XA	Sludge Collection System Control Panel CPN-10218 "UPS Battery Low" Status	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10277	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-07XA	Sludge Collection System Control Panel CPN-10218 "UPS on Bypass" Status	NA	CPN-10218
CLARIFIER 02	CPN10218	SCD10207	DI	ABJ-CLAR-SLG-CLR02	CPN-10218-08XA	Sludge Collection System Control Panel CPN-10218 "Power Failure from UPS" Status	NA	CPN-10218

AREA	PANEL NO.	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID	LOOP
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	VLV-10205-ZI	INFLUENT FLOW CONTROL VLV-10205 VALVE POSITION FEEDBACK	N-001	CL02-10201
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	VLV-10205-ZC	INFLUENT FLOW CONTROL VLV-10205 POSITION SETPOINT	N-001	CL02-10201
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10205-IR	INFLUENT FLOW CONTROL VLV-10205" IN REMOTE" STATUS	N-001	CL02-10201
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10205-ZF	INFLUENT FLOW CONTROL VLV-10205 " FAULT" STATUS	N-001	CL02-10201
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10205-ZH	INFLUENT FLOW CONTROL VLV-10205 " FULLY OPENED" STATUS	N-001	CL02-10201
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10205-ZL	INFLUENT FLOW CONTROL VLV-10205 " FULLY CLOSED" STATUS	N-001	CL02-10201
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLW-10205	CLARIFIER NO 02 MEASURE INFLUENT FLOW FE/FIT-10205	N-001	CL02-10201
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	MXR-10201-SI	CLARIFIER NO 02 RAPID MIXER MXR-10201 SPEED FEEDBACK	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	MXR-10202-SI	CLARIFIER NO 02 RAPID MIXER MXR-10202 SPEED FEEDBACK	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10203-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10203 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10204-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10204 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10205-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10205 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10206-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10206 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10207-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10207 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10208-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10208 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10209-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10209 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	FLOC-10210-SI	CLARIFIER NO 02 FLOCCULATOR FLOC-10210 SPEED FEEDBACK	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AI	ABJ-CLAR-SLG-CLR02	CPN-10211-TI	CLARIFIER NO 02 CONTROL PANEL CPN-10211 MEASURED INTERIOR TEMPERATURE	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	MXR-10201-SC	CLARIFIER NO 02 RAPID MIXER MXR-10201 SPEED SETPOINT	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	MXR-10202-SC	CLARIFIER NO 02 RAPID MIXER MXR-10202 SPEED SETPOINT	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10203-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10203 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10204-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10204 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10205-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10205 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10206-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10206 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10207-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10207 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10208-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10208 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10209-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10209 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	AO	ABJ-CLAR-SLG-CLR02	FLOC-10210-SC	CLARIFIER NO 02 FLOCCULATOR FLOC-10210 SPEED SETPOINT	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10201-IR	CLARIFIER NO 02 RAPID MIXER MXR-10201 " IN REMOTE" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10201-MN	CLARIFIER NO 02 RAPID MIXER MXR-10201 " RUNNING" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10201-XF	CLARIFIER NO 02 RAPID MIXER MXR-10201 VFD "FAULT" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10201-RE	CLARIFIER NO 02 RAPID MIXER MXR-10201 "RESET DEPRESSED" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10202-IR	CLARIFIER NO 02 RAPID MIXER MXR-10202 " IN REMOTE" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10202-MN	CLARIFIER NO 02 RAPID MIXER MXR-10202 " RUNNING" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10202-XF	CLARIFIER NO 02 RAPID MIXER MXR-10202 VFD "FAULT" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	MXR-10202-RE	CLARIFIER NO 02 RAPID MIXER MXR-10202 "RESET DEPRESSED" STATUS	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10206-ZH	SOUTH BASIN INFLUENT GATE VLV-10206 "FULLY OPENED" STATUS	N-001	CL02-BSNVLV
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10206-ZL	SOUTH BASIN INFLUENT GATE VLV-10206 "FULLY CLOSED" STATUS	N-001	CL02-BSNVLV
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10206-ZF	SOUTH BASIN INFLUENT GATE VLV-10206 "ACTUATOR FAULT" STATUS	N-001	CL02-BSNVLV
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10207-ZH	NORTH BASIN INFLUENT GATE VLV-10207 "FULLY OPENED" STATUS	N-001	CL02-BSNVLV
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10207-ZL	NORTH BASIN INFLUENT GATE VLV-10207 "FULLY CLOSED" STATUS	N-001	CL02-BSNVLV
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	VLV-10207-ZF	NORTH BASIN INFLUENT GATE VLV-10207 "ACTUATOR FAULT" STATUS	N-001	CL02-BSNVLV
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10203-IR	CLARIFIER 03 FLOCCULATOR FLOC-10203 " IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10203-MN	CLARIFIER 03 FLOCCULATOR FLOC-10203 " RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10203-XF	CLARIFIER 03 FLOCCULATOR FLOC-10203 " FAULT" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10203-MY	CLARIFIER 03 FLOCCULATOR FLOC-10203 " EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10203-TH	CLARIFIER 03 FLOCCULATOR FLOC-10203 " HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10203-RE	CLARIFIER 03 FLOCCULATOR FLOC-10203 " RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10204-IR	CLARIFIER 03 FLOCCULATOR FLOC-10204" IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10204-MN	CLARIFIER 03 FLOCCULATOR FLOC-10204" RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10204-XF	CLARIFIER 03 FLOCCULATOR FLOC-10204" FAULT" STATUS	N-001	CL02-FLCLTR

AREA	PANEL NO.	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID	LOOP
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10204-MY	CLARIFIER 03 FLOCCULATOR FLOC-10204" EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10204-TH	CLARIFIER 03 FLOCCULATOR FLOC-10204" HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10204-RE	CLARIFIER 03 FLOCCULATOR FLOC-10204" RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10205-IR	CLARIFIER 03 FLOCCULATOR FLOC-10205 " IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10205-MN	CLARIFIER 03 FLOCCULATOR FLOC-10205 " RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10205-XF	CLARIFIER 03 FLOCCULATOR FLOC-10205 " FAULT" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10205-MY	CLARIFIER 03 FLOCCULATOR FLOC-10205 " EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10205-TH	CLARIFIER 03 FLOCCULATOR FLOC-10205 " HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10205-RE	CLARIFIER 03 FLOCCULATOR FLOC-10205 " RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10206-IR	CLARIFIER 03 FLOCCULATOR FLOC-10206" IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10206-MN	CLARIFIER 03 FLOCCULATOR FLOC-10206" RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10206-XF	CLARIFIER 03 FLOCCULATOR FLOC-10206" FAULT" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10206-MY	CLARIFIER 03 FLOCCULATOR FLOC-10206" EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10206-TH	CLARIFIER 03 FLOCCULATOR FLOC-10206" HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10206-RE	CLARIFIER 03 FLOCCULATOR FLOC-10206" RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10207-IR	CLARIFIER 03 FLOCCULATOR FLOC-10207" IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10207-MN	CLARIFIER 03 FLOCCULATOR FLOC-10207" RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10207-XF	CLARIFIER 03 FLOCCULATOR FLOC-10207" FAULT" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10207-MY	CLARIFIER 03 FLOCCULATOR FLOC-10207" EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10207-TH	CLARIFIER 03 FLOCCULATOR FLOC-10207" HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10207-RE	CLARIFIER 03 FLOCCULATOR FLOC-10207" RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10208-IR	CLARIFIER 03 FLOCCULATOR FLOC-10208" IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10208-MN	CLARIFIER 03 FLOCCULATOR FLOC-10208" RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10208-XF	CLARIFIER 03 FLOCCULATOR FLOC-10208" FAULT" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10208-MY	CLARIFIER 03 FLOCCULATOR FLOC-10208" EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10208-TH	CLARIFIER 03 FLOCCULATOR FLOC-10208" HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10208-RE	CLARIFIER 03 FLOCCULATOR FLOC-10208" RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10209-IR	CLARIFIER 03 FLOCCULATOR FLOC-10209" IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10209-MN	CLARIFIER 03 FLOCCULATOR FLOC-10209" RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10209-XF	CLARIFIER 03 FLOCCULATOR FLOC-10209" FAULT" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10209-MY	CLARIFIER 03 FLOCCULATOR FLOC-10209" EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10209-TH	CLARIFIER 03 FLOCCULATOR FLOC-10209" HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10209-RE	CLARIFIER 03 FLOCCULATOR FLOC-10209" RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10210-IR	CLARIFIER 03 FLOCCULATOR FLOC-10210" IN REMOTE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10210-MN	CLARIFIER 03 FLOCCULATOR FLOC-10210" RUNNING" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10210-XF	CLARIFIER 03 FLOCCULATOR FLOC-10210" FAULT" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10210-MY	CLARIFIER 03 FLOCCULATOR FLOC-10210" EMERGENCY STOP DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10210-TH	CLARIFIER 03 FLOCCULATOR FLOC-10210" HIGH WINDING TEMPERATURE" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	FLOC-10210-RE	CLARIFIER 03 FLOCCULATOR FLOC-10210" RESET DEPRESSED" STATUS	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-01XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " PANEL INTRUSTION" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-02XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " PANEL INTRUSTION" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-03XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " UTILITY POWER OK" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-04XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " MANAGED ETHERNET SWITCH ESW-10211 " FAULT" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-05XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " 24 VDC POWER SUPPLY PWS-10211A OK" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-06XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " 24 VDC POWER SUPPLY PWS-10211B OK" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-07XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " UPS-10211" FAULT" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-08XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " UPS-10211" BATTERY LOW" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-09XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " UPS-10211"UPS ON BYPASS" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DI	ABJ-CLAR-SLG-CLR02	CPN-10211-10XA	CLARIFIER NO 02 CONTROL PANEL CPN-10211 " UPS-10211" POWER FAILURE FROM UPS" STATUS	NA	CPN-10211
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	MXR-10201-MD	CLARIFIER NO 02 RAPID MIXER MXR-10201 "RUN" COMMAND	N-001	CL02-RPDMXR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	MXR-10202-MD	CLARIFIER NO 02 RAPID MIXER MXR-10202 "RUN" COMMAND	N-001	CL02-RPDMXR

AREA	PANEL NO.	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID	LOOP
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10203-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10203 "RUN" COMMAND	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10204-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10204 "RUN" COMMAND	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10205-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10205 "RUN" COMMAND	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10206-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10206 "RUN" COMMAND	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10207-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10207 "RUN" COMMAND	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10208-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10208 "RUN" COMMAND	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10209-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10209 "RUN" COMMAND	N-001	CL02-FLCLTR
CLARIFIER 02	CPN10211	SCD10279	DO	ABJ-CLAR-SLG-CLR02	FLOC-10210-MD	CLARIFIER NO 02 FLOCCULATOR FLOC-10210 "RUN" COMMAND	N-001	CL02-FLCLTR

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID No.	LOOP ID
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	AI	ABJ-CLAR-SLG	PMP-10301-SI	SLUDGE WASTER PUMP PMP-10301 VFD SPEED FEEDBACK	N-007	P10301
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	AO	ABJ-CLAR-SLG	PMP-10301-SC	SLUDGE WASTER PUMP PMP-10301 VFD SPEED SETPOINT	N-007	P10301
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10301-IR	SLUDGE WASTER PUMP PMP-10301 VFD " IN REMOTE" STATUS	N-007	P10301
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10301-MN	SLUDGE WASTER PUMP PMP-10301 VFD " RUNNING" STATUS	N-007	P10301
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10301-XF	SLUDGE WASTER PUMP PMP-10301 VFD "FAULT" STATUS	N-007	P10301
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DO	ABJ-CLAR-SLG	PMP-10301-MD	SLUDGE WASTER PUMP PMP-10301 VFD "RUN" COMMAND	N-007	P10301
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10301-RE	SLUDGE WASTER PUMP PMP-10301 VFD "RESET DEPRESSED" STATUS	N-007	P10301
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	AI	ABJ-CLAR-SLG	PMP-10302-SI	SLUDGE WASTER PUMP PMP-10302 VFD SPEED FEEDBACK	N-007	P10302
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	AO	ABJ-CLAR-SLG	PMP-10302-SC	SLUDGE WASTER PUMP PMP-10302 VFD SPEED SETPOINT	N-007	P10302
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10302-IR	SLUDGE WASTER PUMP PMP-10302 VFD " IN REMOTE" STATUS	N-007	P10302
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10302-MN	SLUDGE WASTER PUMP PMP-10302 VFD " RUNNING" STATUS	N-007	P10302
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10302-XF	SLUDGE WASTER PUMP PMP-10302 VFD "FAULT" STATUS	N-007	P10302
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DO	ABJ-CLAR-SLG	PMP-10302-MD	SLUDGE WASTER PUMP PMP-10302 VFD "RUN" COMMAND	N-007	P10302
PUMP STATION-2	SLUDGE PUMP STATION 2 PLC PANEL	SLUDGE PUMP STATION 2 PLC	DI	ABJ-CLAR-SLG	PMP-10302-RE	SLUDGE WASTER PUMP PMP-10302 VFD "RESET DEPRESSED" STATUS	N-007	P10302

Loop Specifications

General SCADA Requirements

1. These descriptions cover Clarifier No. 02 and ancillary systems at the Tulsa, OK A.B. Jewell Water Treatment Plant.

2. Refer to Specification Section 44 42 63, Hose-less Solids Collection System, for additional I/O interfacing and SCADA programming requirements.

3. Refer to Specification Section 44 44 36, Horizontal Paddle Flocculation System, for additional I/O interfacing and SCADA programming requirements.

4. Numbers shown at the end of a device tag number encased in parenthesis indicate multiple instruments and/or devices with the same tag number but the final digit of the tag number shall be sequential, not to exceed the number encased in parenthesis. Example: FIT-0103-(3) would indicate three flow indicating transmitters with the tag designation of FIT-0103-1, FIT-0103-2 and FIT-0103-3.

5. Provide “bumpless” transfer when changing from SCADA Manual to SCADA Automatic control and from SCADA Automatic to SCADA Manual control. Provide “bumpless” transfer when changing from LOCAL to PLC control and from REMOTE to LOCAL control.

6. Provide discrepancy alarms for all discrete control outputs that have corresponding discrete status inputs. Provide an adjustable time delay for each such alarm. Treat discrepancy alarms as priority 400 (minor) alarms (coordinate with the Water Treatment Plant’s alarm standards and requirements).

7. Standard “LOCAL” Control Functions: Motorized equipment at the A.B. Jewell Water Treatment Plant facilities shall have standardized local controls available, here after referred to as “Standard Local Controls.” Unless otherwise noted in the loop descriptions, these controls consist of:

    a. A local LOCAL/OFF/REMOTE hand switch. In the LOCAL switch position, the motorized equipment can be started and stopped using the local STOP/START pushbuttons. In the OFF position, the motorized equipment is shut down. In the REMOTE position, control is from the SCADA system.

    b. Local STOP/START pushbuttons. When the LOCAL/REMOTE hand switch is in the LOCAL position, the motorized equipment can be started and stopped using these pushbuttons. When the LOCAL/REMOTE hand switch is in the REMOTE position, the STOP button shall stop the equipment, but the START button shall not start the equipment.

8. All references to “SCADA HMI” shall also apply to local “Panel Mounted PC”s.

9. Analytical Measuring and Trending Requirements:

    a. The analytical "High," "Low," and "Average" values shall be shown "per day" as indicated below.

    b. The measured analytical values shall be displayed and/or shown in the following manner:

        i. Instantaneous Analytical Values: Indicates the analytical values as currently being measured by the corresponding analytical transmitter.

        ii. Prior Days Analytical Values: Indicates the "High," "Low," and "Average" analytical values from the prior day (the "High" and "Low" values shall be time/date stamped). The analytical values shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

        iii. Current Days Analytical Values: Indicates the "High," "Low," and "Average" analytical values from the current day (the "High" and "Low" values shall be time/date stamped). The analytical values shall be measured from 0000:00 to the time the operator requests to view the current day's analytical values (midnight through user requested analytical data display time).

        iv. Historic Overall Analytical Values: Indicates the overall "High," "Low," and "Average" analytical values (the "High" and "Low" values shall be time/date stamped) from the last time the measured analytical values were reset to the time the operator requests to view the Historic Overall Analytical Values.

        v. Analytical Value Trending: Indicates the trended analytical values.

    c. The measured analytical values (as indicated above) shall be recorded in the SCADA Historical repository. The recorded analytical values and trending shall be displayed on the SCADA HMI upon operator request.

    d. The analytical values shall have a dedicated SCADA HMI graphic which shall display all the measured analytical values as indicated above.

    e. The measured analytical values may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the "Max.," "Min.," "Average" and trended values (Prior Days, Current Days and Historic Overall Analytical) and time date stamp the event of all analytical values which are reset.

10. Flow Totalizing and Trending Requirements (both SCADA HMI and local Panel Mounted PC):

    a. All measured flows shall be totalized in the PLC the signal terminates at.

    b. All flows shall be totalized “per day” and “total flow” as indicated below.

    c. For each flow measured, the flow shall be displayed and/or totalized and/or trended and shown in the following manner:

        i. Instantaneous Flow: Indicates the flow as currently being measured by the corresponding flow meter.

        ii. Prior Days Flow: Indicates the flow as totalized from the prior day. This flow shall be totalized over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

        iii. Current Days Flow: Indicates the flow as totalized from the current day. This flow shall be totalized from 0000:00 to the time the operator requests to view the current days flow (midnight through user requested flow display time).

        iv. Total Flow: Indicates the flow as totalized from the last time the totalized flow was reset to the time the operator requests to view the totalized flow.

        v. Flow Trending: Indicates the trended flow of the as measured by the Flow Indicating Transmitter.

    d. The totalized flows (as indicated above) shall be recorded in the SCADA Historical repository. The recorded flow values and trending shall be displayed on the SCADA HMI upon operator request.

    e. Each Flow Meter shall have a dedicated SCADA HMI graphic which shall display all the flow information as indicated above.

    f. The totalized flows may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the totalized flow values (Prior Days, Current Days and Total Flow), trending and time date stamp the event of all flows which are reset.

11. Level Measuring and Trending Requirements (SCADA HMI and local Panel Mounted PC):

    a. The measured level “High,” “Low,” and “Average” values shall be shown “per day” as indicated below.

b. The measured level shall be displayed and/or shown in the following manner:

i. Instantaneous Level: Indicates the level as currently being measured by the corresponding level transmitter.

ii. Prior Days Level: Indicates the "High," "Low," and "Average" levels from the prior day (the "High" and "Low" values shall be time/date stamped). The average level shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

iii. Current Days Level: Indicates the "High," "Low," and "Average" levels from the current day (the "High" and "Low" values shall be time/date stamped). The level shall be measured from 0000:00 to the time the operator requests to view the current days level (midnight through user requested level display time).

iv. Historic Overall Level: Indicates the overall "High," "Low," and "Average" levels (the "High" and "Low" values shall be time/date stamped) from the last time the measured level was reset to the time the operator requests to view the Historic Overall Level.

v. Measured Level Trending: Indicates the trended measured level.

c. The measured level (as indicated above) shall be recorded in the SCADA Historical repository. The recorded level values and trending shall be displayed on the SCADA HMI upon operator request.

d. The measured level shall have a dedicated SCADA HMI graphic that shall display all the measured levels as indicated above.

e. The measured levels may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the "Max.," "Min.", "Average" and trended values (Prior Days, Current Days and Historic Overall Level) and time date stamp the event of all level values which are reset.

12. PID Trending Requirements:

a. The measured PID values shall be displayed and/or shown in the following manner:

i. Instantaneous PID Values: Indicates the PID values as currently being measured by the corresponding analytical, flow transmitter, valve actuator and calculated values.

ii. Prior Days PID Values: Indicates the trended PID values from the prior day. The PID values shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

iii. Current Days PID Values: Indicates the trended PID values from the current day. The PID values shall be measured from 0000:00 to the time the operator requests to view the current day's PID values (midnight through user requested PID data display time).

iv. Historic PID Values: Indicates the overall trended PID values (the "Alarm State" values shall be time/date stamped) from the last time the measured PID values were reset to the time the operator requests to view the Historic PID Values.

v. Measured PID Value Trending: Indicates the trending of the measured PID values.

b. The measured PID values (as indicated above) shall be recorded in the SCADA Historical repository. The recorded PID values and trending shall be displayed on the SCADA HMI upon operator request.

c. The measured PID values shall have a dedicated SCADA HMI graphic which shall display all the measured PID values as indicated above.

d. The measured PID values may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the "Max.," "Min.," and "Average" and trended values (Prior Days, Current Days and Historic Overall Analytical) and time date stamp the event of all PID values which are reset.

13. Position Measuring and Trending Requirements (SCADA HMI and local Panel Mounted PC):

a. The measured position "High," "Low," and "Average" values shall be shown "per day" as indicated below.

b. The measured position shall be displayed and/or shown in the following manner:

i. Instantaneous Position: Indicates the position as currently being measured by the corresponding position transmitter.

ii. Prior Days Position: Indicates the "High," "Low," and "Average" positions from the prior day (the "High" and "Low" values shall be time/date stamped). The average position shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

iii. Current Days Position: Indicates the "High," "Low," and "Average" positions from the current day (the "High" and "Low" values shall be time/date stamped). The position shall be measured from 0000:00 to the

time the operator requests to view the current days position (midnight through user requested position display time).

iv. Historic Overall Position: Indicates the overall "High," "Low," and "Average" positions (the "High" and "Low" values shall be time/date stamped) from the last time the measured position was reset to the time the operator requests to view the Historic Overall Position.

v. Measured Position Trending: Indicates the trended measured position.

c. The measured position (as indicated above) shall be recorded in the SCADA Historical repository. The recorded position values and trending shall be displayed on the SCADA HMI upon operator request.

d. The measured position shall have a dedicated SCADA HMI graphic that shall display all the measured positions as indicated above.

e. The measured positions may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the "Max.," "Min.," "Average" and trended values (Prior Days, Current Days and Historic Overall Position) and time date stamp the event of all position values which are reset.

14. Pressure Measuring and Trending Requirements (SCADA HMI and local Panel Mounted PC):

a. The measured pressure "High," "Low," and "Average" values shall be shown "per day" as indicated below.

b. The measured pressure shall be displayed and/or shown in the following manner:

i. Instantaneous Pressure: Indicates the pressure as currently being measured by the corresponding pressure transmitter.

ii. Prior Days Pressure: Indicates the "High," "Low," and "Average" pressures from the prior day (the "High" and "Low" values shall be time/date stamped). This pressure shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

iii. Current Days Pressure: Indicates the "High," "Low," and "Average" pressures from the current day (the "High" and "Low" values shall be time/date stamped). The pressure shall be measured from 0000:00 to the time the operator requests to view the current day's pressure (midnight through user requested pressure display time).

iv. Historic Overall Pressure: Indicates the overall "High," "Low," and "Average" pressures (the "High" and "Low" values shall be time/date stamped) from the last time the measured pressure was reset to the time the operator requests to view the Historic Overall Pressure.

v. Measured Pressure Trending: Indicates the trending of the measured pressure values.

c. The measured pressure (as indicated above) shall be recorded in the SCADA HMI and local Panel Mounted PC Historical repository. The recorded pressure values and trending shall be displayed on the SCADA HMI and local Panel Mounted PC upon operator request. Trended data shall be stored on the removable memory card.

d. The measured pressure shall have a dedicated SCADA HMI and local Panel Mounted PC graphic which shall display all the measured pressure as indicated above.

e. The measured pressure may be reset by an operator with the proper authorization (password protected). The SCADA HMI and local Panel Mounted PC shall log the user ID, the "Max.," "Min.," "Average," and trended values (Prior Days, Current Days and Historic Overall Pressure) and time date stamp the event of all pressure values which are reset.

15. Temperature Measuring and Trending Requirements (both SCADA HMI and local Panel Mounted PC):

a. The measured temperature "High," "Low," and "Average" values shall be shown "per day" as indicated below.

b. The measured temperature shall be displayed and/or shown in the following manner:

i. Instantaneous Temperature: Indicates the temperature as currently being measured by the corresponding temperature transmitter.

ii. Prior Days Temperature: Indicates the "High," "Low," and "Average" temperatures from the prior day (the "High" and "Low" values shall be time/date stamped). This temperature shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

iii. Current Days Temperature: Indicates the "High," "Low," and "Average" temperatures from the current day (the "High" and "Low" values shall be time/date stamped). The temperature shall be measured from 0000:00 to the time the operator requests to view the current day's temperature (midnight through user requested temperature display time).

iv. Historic Overall Temperature: Indicates the overall “High,” “Low,” and “Average” temperatures (the “High” and “Low” values shall be time/date stamped) from the last time the measured temperature was reset to the time the operator requests to view the Historic Overall Temperature.

v. Measured Temperature Trending: Indicates the trending of the measured temperature.

c. The measured temperature (as indicated above) shall be recorded in the SCADA Historical repository. The recorded temperature values and trending shall be displayed on the SCADA HMI upon operator request.

d. Each temperature measured shall have a dedicated SCADA HMI graphic which shall display all the measured temperatures as indicated above.

e. The measured temperatures may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the “Max.,” “Min.,” “Average,” and trended values (Prior Days, Current Days and Historic Overall Temperature) and time date stamp the event of all temperature values which are reset.

16. All discrete status change of states shall be time-date stamped and logged in the SCADA Historical Repository. This recorded data shall be displayed on the SCADA HMI upon operator request.

17. Permissive Indication (both SCADA HMI and local Panel Mounted PC):

a. If an operator attempts to operate a device in the REMOTE – MANUAL operation via the SCADA HMI and/or the local Panel Mounted PC and all the permissives to allow that device to operate in this mode of operation are not met, the HMI shall display which permissives need to be met in order to allow the device to operate in the REMOTE–MANUAL mode of operation.

b. Gray out the HMI controls if the equipment is not in REMOTE or all permissives are not met to operate the equipment.

18. PLC Diagnostics (indicated on local Panel Mounted PC only):

a. The Panel Mounted PC shall have a series of screens for PLC diagnostics. These screens shall be accessible by the operator by depressing the “Diagnostics” pushbutton icon located on the main screen.

b. An overall screen of the PLC, communication module and all I/O cards shall be shown. The operator shall have the ability to select which card they want displayed by depressing the appropriate pushbutton icon.

c. Discrete I/O shall list the PLC points, the tag number of the points, a word description of what that point represents an indication if the point is on or off.

d. Analog I/O shall list all analog signals, the tag number of the analog signal, a word description of what the analog signal represents an indication of the value of signal in Engineering Units.

19. Local Alarm Screen (indicated on local Panel Mounted PC only – independent of the SCADA historian server and Head-End SCADA alarm screen):

a. The local Panel Mounted PC shall be programmed to have an "Alarm Screen," which shall indicate all alarms present at the control system the control panel is monitoring with a time/date stamp on when the alarm occurred.

b. The "Alarm Screen" shall have the following pushbutton icons:

i. Scroll Up: This shall scroll up the alarms listed on the screen.

ii. Scroll Down: This shall scroll down the alarms listed on the screen.

iii. Alarm Acknowledge: This shall silence the alarm horn if activated.

iv. Alarm Reset: This shall reset any alarm which has locked out any equipment from operation when all alarm conditions have been cleared.

v. Alarm Historical Screen: This shall take the operator to the "Alarm Historical Screen."

vi. Back: This shall take the operator back to the previous screen.

c. The local Panel Mounted PC shall be programmed to have an "Alarm Historical Screen" which shall indicate all cleared alarms which occurred over the past 2 weeks at the control system the control panel is monitoring with a time/date stamp on when the alarm occurred.

d. The "Alarm Historical Screen" shall have the following pushbutton icons:

i. Scroll Up: This shall scroll up the alarms listed on the screen.

ii. Scroll Down: This shall scroll down the alarms listed on the screen.

iii. Alarm Acknowledge: This shall silence the alarm horn if activated.

iv. Alarm Reset: This shall reset any alarm which has locked out any equipment from operation when all alarm conditions have been cleared.

v. Alarm Screen: This shall take the operator to the "Alarm Screen."

vi. Back: This shall take the operator back to the previous screen.

e. Once an alarm condition has been cleared and the "Alarm Reset" pushbutton icon has been depressed, the alarm shall be removed the "Alarm Screen" and placed in the "Alarm Historical Screen."

f. If the Panel Mounted PC is in a different screen other than the "Alarm Screen" and an alarm occurs at the control system the control panel is monitoring, a flashing banner indicating the alarm shall be displayed on the bottom of the screen.

g. If the operator touches the banner, the operator shall be taken to the "Alarm Screen."

20. Setpoints:

a. All setpoints shall be set during the commissioning process.

b. Each setpoint shall be password protected/operator adjustable.

c. Each setpoint shall have a password protected pushbutton graphic which shall reset the setpoint to its default state (the setpoint as determined during the commissioning process).

d. The setpoints may also be reset globally by a password protected pushbutton graphic which shall reset all setpoints to their default state.

e. The SCADA Historian shall maintain a history of the ten prior setpoints (to include which user made the setpoint change).

21. Alarm Resets:

a. Alarms generated at the motor control center (MCC); such as motor overloads, seal water failure, hard-wired process interlocks shall be manually reset at the MCC or pump operator interface panel.

b. Alarms generated at the local control panels, such as pump safety lock-out alarms, package blower alarms, shall be manually reset at the local control panel or Local Control Station.

c. Alarms generated in the SCADA system such as discrepancy alarms (FAIL TO START, etc.) and SCADA process interlocks shall be manually reset at the SCADA HMI.

22. Power Supply Monitoring Requirements:

    a. The “Power Supply OK” contacts of all power supplies and power supply redundancy modules shall be wired in series to an interposing relay. A contact of the interposing relay shall be wired to the PLC housed within the panel to monitor for a power supply fault within the control panel.

23. Additional Programming Requirements:

    a. Cycle Count: This shall be an operator resettable (password protected) indication of how many times a piece of equipment has been turned on and off or how often a valve/gate has been opened and closed.

    b. The following shall be required “Warnings” on all analog PID loops (Note: Warnings do not shut off equipment nor does it shut down a process, it is only for informational purposed only and to be logged by the SCADA Historian):

        i. “Setpoint Deviation”: This warning shall be initiated by the PLC if a process is called to maintain a setpoint and does not reach that setpoint (password protected operator settable deadband) within an allotted amount of time (password protected operator adjustable – time delay to be process dependent).

    c. In the event multiple level transmitters are used (in a wetwell or tank) to monitor and control pump operation, the following control options shall be incorporated on the pump station SCADA graphic:

        i. The operator may manually select which level transmitter to use for control of the pumps via a pushbutton icon located on the corresponding SCADA graphic for the pump station.

        ii. The operator may select an averaging mode where the average of all measured levels from the level transmitters is used as the measured level in the wetwell/tank.

        iii. Alarms: When the measured levels of the level transmitters vary by five percent (operator adjustable) or greater, an “Alarm” shall be generated by the PLC which shall indicate a measured level deviation. The operator shall then manually select which measured level is to be used for control of the pumps at the pump station.

    d. PLC control programming of AFD pumps to maintain a level in the wetwell/tank shall use a PI loop to modulate the pumps.

24. Function Definitions:

    a. Open Fail: If a valve has been commanded to OPEN by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and is not proven "FULLY OPENED" within 30 seconds (password protected operator adjustable), the valve shall be considered failed by the PLC. Unless otherwise noted, a valve is confirmed "FULLY OPENED" by receiving an Open contact closure from the valve limit switch.

    b. Close Fail: If a valve has been commanded to CLOSE by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and is not proven "FULLY CLOSED" within 30 seconds (password protected operator adjustable), the valve shall be considered failed by the PLC. Unless otherwise noted, a valve is confirmed "FULLY CLOSED" by receiving a Closed contact closure from the valve limit switch.

    c. Failure to Start/Run: If a pump or piece of mechanical equipment is commanded to RUN by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and has not been proven to be running within 15 seconds or greater (password protected operator adjustable), the pump or piece of mechanical equipment shall be considered failed by the PLC. Unless otherwise noted, a pump or piece of mechanical equipment is confirmed running by receiving the "Pump Running" or "Running" contact closure, by a current switch (monitoring the motor leads) changing states, differential pressure across the pump, AFD speed feedback or any combination of the above.

    d. Failure to Stop: If a pump or piece of mechanical equipment is commanded to STOP by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and has not been proven to be stopped within 15 seconds or greater (password protected operator adjustable), the pump or piece of mechanical equipment shall be considered failed by the PLC. Unless otherwise noted, a pump or piece of mechanical equipment is confirmed stopped by receiving the "Pump Running" or "Running" contact being restored to its normal state, by a current switch (monitoring the motor leads) is restored to its normal state, differential pressure across the pump is restored to its normal state, AFD speed feedback reads a speed of zero (4mADC) or any combination of the above.

    e. Analog Setpoint/Speed Deviation Warning: A warning shall be displayed on the SCADA HMI when an analog device (Example: AFD pump) is commanded to a setpoint by the PLC and the device does not achieve that setpoint (within the allowable deadband) within 20 seconds (password protected operator adjustable). This shall only alert the operator and not shut down the associated process.

    f. Totalize Flow: Integrate flow rate with respect to time. Unless otherwise noted, operator shall be able to reset totalized value to zero.

g. Cycle Count: Count the number of cycles a piece of equipment undergoes. One cycle is defined as the transition from OFF to ON. For valves, one cycle is defined from one Closed status event to the next.

h. Ramp: Adjust the position of a controlled device; e.g., modulating valve, adjustable speed drive at slow controlled rate.

i. Modulating in Sequence: This describes when multiple adjustable frequency drive (AFD) motors are operating in parallel modulating at the same speed to maintain the process setpoint.

25. Programming Requirements:

a. The "Head-End" SCADA HMI shall have new SCADA graphics programmed to accommodate all work as described on Drawings and within these Specifications. The existing "Head-End" SCADA software shall be Wonderware. Coordinate with Owner on software version.

i. New HMI screens shall be programmed to monitor and accept operator inputs and log any changes of state; all functions as described within these Contract Documents.

ii. The PLC shall be programmed to control the process as described within these Contract Documents.

b. The Data/Alarm Historian shall be reprogrammed to capture all data and alarms as described within these Contract Documents.

c. All programming of existing and new PLCs shall be ladder logic or function blocks.

d. All Package System screens shall be duplicated on the new Plant SCADA system. Screens shall monitor the new package systems and all data shall be added to the new SCADA Historian. Coordinate with the package system control vendors for additional information.

Clarifier No. 2

Overview: The major equipment in Clarifier No. 2 Improvements includes new Rapid Mixing System, new Flocculator Drives, a new Clarifier No. 2 Control Panel with new PLC, new Sludge Collection System, new Sludge Pump Station Pumps, new Sludge Pump Station Control Panel with new PLC and monitoring ancillary mechanical equipment and instrumentation.

Flocculator System

(P&ID N-001)

Loop CL02-10201: Raw Water Flow Indicating Transmitter (FIT-10002)

One existing differential pressure transmitter across a venture flow tube shall be wired to the new PLC Control Panel. The Water Flow measurement signal shall be integrated to the new Plant SCADA system utilizing the new Control Panel PLC (SCD10279) located in the new Control Panel (CPN10211) and the flow measurement shall be displayed on the new programmed graphic on the Plant SCADA HMI.

Local Functions:

The flow shall be locally indicated (FIT-10002).

PLC Function:

Receive System FLOW Analog Input (AI) signal from the Flow Meter, convert to engineering units, and transmit to the SCADA system.

SCADA Function:

Receive the flow signal from the PLC and display on the appropriate graphic display. Record the flow values in the SCADA Historical repository. Display the recorded flow values upon operator request. See “Flow Totalizing and Trending Requirements” at the beginning of this section.

Loop CL02-10201: Raw Water Influent Flow Control Valve (VLV-10205)

A new modulating valve with motorized actuator shall be installed on the influent raw water line to Clarifier No. 2. The Valve Actuator I/O, interlocks and operator interface devices shall be integrated to the new plant SCADA system utilizing the new Clarifier No. 2 Control Panel PLC (SCD10279) located in the new Control Panel (CPN10211). The valve status, signals and control interface shall be displayed on the new programmed graphic on the Plant SCADA HMI.

Local Functions:

Integral in the valve actuator:

- "LOCAL-OFF-REMOTE" selector switch.
- Valve "Fully-Opened" pilot light.
- Valve "Fully-Closed" pilot light.
- Valve three-position "OPEN-STOP-CLOSE" spring return to center selector switch.

PLC Function:

Receive the following Discrete Input (DI) signals from the Valve Actuator and transmit to the Plant SCADA system:

- "LOCAL-OFF-REMOTE" switch in the "REMOTE" position.
- Valve Actuator "Fault" status.
- Valve "Fully Opened" status.
- Valve "Fully Closed" status.

Receive the following Analog Input (AI) signal from the Valve Actuator and transmit to the Plant SCADA system:

- Valve Position Feedback.

Transmit the following Analog Output (AO) signal from the PLC and send to the Valve Actuator:

- Valve Position Command.

LOCAL-MANUAL Operation:

The operator may operate the flow control valve by placing the valves "LOCAL-OFF-REMOTE" selector switch in the "LOCAL" position.

The operator may open the valve by placing the "OPEN-STOP-CLOSE" selector switch in the "OPEN" position. This shall command the valve to open while the switch is held in the "OPEN" position.

The operator may stop the valve travel by releasing the "OPEN-STOP-CLOSE" selector switch, which will release to the "STOP" position.

The operator may close the valve by placing the "OPEN-STOP-CLOSE" selector switch in the "CLOSE" position. This shall command the valve to close while the switch is held in the "CLOSE" position

The operator may stop the valve travel by releasing the "OPEN-STOP-CLOSE" selector switch, which will release to the "STOP" position.

The valve shall remain in this state indefinitely until the "LOCAL-OFF-REMOTE" selector switch is restored to the "REMOTE" position.

Remote Operation:

The valve's corresponding "LOCAL-OFF-REMOTE" selector must be placed in the "REMOTE" position.

"REMOTE-MANUAL Mode of Operation – Position Adjust":

Remotely, the operator may adjust the valve's position adjust icon (located on the valve actuator's corresponding SCADA graphic). Position adjust range shall be 0 percent to 100 percent range of travel.

INTERLOCKS:

None.

ALARMS:

Note: The alarms shall both be alarmed and displayed at the Plant SCADA HMI graphic. The valve alarms are reset at the "Valve Reset" Plant SCADA HMI graphic pushbutton icon.

- **"Valve VLV-01205 – Valve Position Mismatch Fault":** This shall occur when the valve is commanded to a position by the PLC and is not proven to be within a preset percent deadband (operator adjustable) of that position, within 1 minute or greater (operator adjustable). The valve shall be considered failed by the PLC and locked out for operation. Once the fault has cleared, the operator may reset the actuator by depressing the "Actuator Reset" pushbutton icon located on the new valve SCADA graphic - this shall allow the valve actuator to resume control through the PLC.

- **"Valve VLV-01205 - Actuator Fault":** This shall occur when the Valve Actuator "Fault" contact changes state. The PLC shall cease commanding the actuator to continue its travel and lock the actuator out for operation. Once the fault has cleared and the actuator reset locally, the operator may reset the actuator by depressing the "Actuator Reset" pushbutton icon located on the new valve SCADA graphic, this shall allow the actuator to resume control through the PLC.

SCADA Function:

Receive "Valve in "Remote" status" "Valve Actuator Fault" status, "Valve "Fully Opened" status," "Valve "Fully Closed" status," "Valve Position Mismatch Fault" status and "Valve Position Feedback" value from the PLC and display on the appropriate graphic display.

Receive all discrete change of states from the PLC and display on the appropriate graphic display. Record the discrete change of states in the SCADA Historical repository. Display the time-date stamped discrete change of states upon operator request.

Loop CL02-RPDMXR: Rapid Mixer System

Two (2) new adjustable speed rapid mixers shall be added. The rapid mixers shall be driven by new AFDs. Local control shall be maintained at the AFDs. The new rapid mixer system shall be integrated to this existing system utilizing the new Plant SCADA PLC (SCD10279) located in the new Control Panel (CPN10211) and shall be monitored and controlled via the existing Plant SCADA system.

Typical for two Rapid Mixer AFDs:

Local Functions:

Included in the new AFDs:

- "RUN-OFF-REMOTE" selector switch.
- "Rapid Mixer Running" status.
- "Manual Speed" setpoint.
- "AFD Fault" alarm status.
- "Rapid Mixer Reset" pushbutton.

PLC Functions:

Receive the following Discrete Input (DI) signals from the Rapid Mixer AFDs and transmit to the SCADA system:

- "RUN-OFF-REMOTE" switch in the "REMOTE" position.
- "Rapid Mixer Running" status.
- "AFD Fault" alarm.
- "Reset Depressed" status.

Transmit the Rapid Mixer "RUN" command Discrete Output (DO) to the Rapid Mixer Drive AFD when Plant SCADA System is requiring Rapid Mixer Drive to run.

Transmit the Rapid Mixer "Drive Speed" setpoint Analog Output (AO) to the Rapid Mixer Drive AFD when Plant SCADA System is requiring Rapid Mixer Drive to run.

Receive the "Rapid Mixer Drive Speed" Analog Input (AI) signal from the Rapid Mixer Drive AFD, convert to engineering units, and transmit to the SCADA system.

"REMOTE-MANUAL" Mode of Operation: To start the Rapid Mixer drive, the "Rapid Mixer Drive Speed" setpoint and the "Rapid Mixer Drive Start" command shall be entered at the HMI by the operator. To stop the Rapid Mixer drive, the "Rapid Mixer Drive Stop" command shall be entered at the HMI by the operator.

SCADA Functions:

Receive "REMOTE Mode" status, "Rapid Mixer Running" status, "Reset Depressed" and "AFD Fault" alarm from PLC and display on the appropriate graphic display.

Provide a graphic for the operator to enter a desired "Rapid Mixer Speed" setpoint and remote "Rapid Mixer Run" command. Transmit the "Rapid Mixer Run" and "Rapid Mixer Speed" setpoint commands to the PLC when commanded to do so by the SCADA/Manual graphic display.

Receive the "Rapid Mixer Speed" status feedback from the PLC and display on the appropriate graphic display. Record the speed values and motor runtimes in the SCADA Historical repository. Display the recorded speed and motor runtime values upon operator request.

Loop CL02-BSNVLV: Clarifier No. 2 Influent Gate Monitoring

Two new gates with motorized actuators shall be installed with the I/O interfaced through the new Clarifier No. 2 control panel (CPN10211). The Gate Actuator I/O and operator interface devices shall be integrated to the existing Plant SCADA system via the new Plant SCADA PLC (SCD10279) located in the new Control Panel (CPN10211) and the Gate status, signals and control interface shall be displayed on the new programmed graphic on the Plant SCADA HMI.

Local Functions:

Typical for each Influent Gate Actuator:

- "Influent Gate Fully-Opened" pilot light for each gate.
- "Influent Gate Fully Closed" pilot light for each gate.
- Influent Gate "Open" momentary-contact pushbutton for each gate.
- Influent Gate "Stop" momentary-contact pushbutton for each gate.

- Influent Gate “Close” momentary-contact pushbutton for each gate.

PLC Function:

Receive the following Discrete Input (DI) signals from each gate actuator and operator interface devices and transmit to the SCADA system (typical for each Influent Gate):

- Influent Gate “Fully Opened” status.
- Influent Gate “Fully Closed” status.
- Influent Gate Actuator “Fault” status.

Manual Operation:

The operator may open the gate by depressing the gate’s corresponding “Open” momentary-contact pushbutton. The gate shall open until the gate has been proven “Fully Opened”.

The operator may close the gate by depressing the gate’s corresponding “Close” momentary-contact pushbutton. The gate shall close until the gate has been proven “Fully Closed”.

The operator may stop the gate travel by depressing the gate’s corresponding “Stop” momentary-contact pushbutton during the actuator operation.

Remote Operation:

“REMOTE-MANUAL Mode of Operation”:

None.

“AUTOMATIC Mode of Operation”:

None.

ALARMS:

Note: The alarms shall both be alarmed and displayed at the SCADA HMI graphic. The gate actuator alarms are reset at the “Actuator Reset” SCADA HMI graphic pushbutton icon.

- **“Influent Gate VLV-1020X (where “X” = 6 or 7) - Actuator Fault”:** This shall occur when the Gate Actuator “Fault” contact changes state. Once the fault has cleared and the contact resumes its normal state, the “Fault” shall be cleared by the SCADA system.

SCADA Function:

Receive "Influent Gate "Fully Opened"", "Influent Gate "Fully Closed"" and "Influent Gate Actuator Fault" status from the PLC and display on the appropriate graphic display.

Receive all discrete change of states from the PLC and display on the appropriate graphic display. Record the discrete change of states in the SCADA Historical repository. Display the time-date stamped discrete change of states upon operator request.

Loop CL02-FLCLTR: Flocculator System

Eight (8) new Flocculator Drives shall be added. The Flocculators shall be driven by new AFDs. Local control shall be maintained at the AFDs. The new automated Flocculator system shall be integrated to this existing system utilizing the new Plant SCADA PLC (SCD10279) located in the new Control Panel (CPN10211) and shall be monitored and controlled via the Plant SCADA system.

Typical for Eight Flocculator AFDs:

Local Functions:

Included in the new AFDs:

- "RUN-OFF-REMOTE" selector switch.
- "Flocculator Running" status.
- "Flocculator Stopped" status.
- "Manual Speed" setpoint.
- "Emergency Stop" pushbutton.
- "Emergency Stop" pushbutton depressed status.
- "AFD Fault" alarm.
- "High Winding Temperature" status.
- "Flocculator Reset" pushbutton.

PLC Functions:

Receive the following Discrete Input (DI) signals from the Flocculator AFDs and transmit to the SCADA system:

- "RUN-OFF-REMOTE" switch in the "REMOTE" position.
- "Flocculator Running" status.
- "Emergency Stop Depressed" status.
- "AFD Fault" alarm.
- "High Winding Temperature" status.
- "Flocculator Reset Depressed" status.

Transmit the Flocculator "Drive Run" command Discrete Output (DO) to the Flocculator Drive AFD when Plant SCADA System is requiring Flocculator Drive to run.

Transmit the Flocculator "Drive Speed" setpoint Analog Output (AO) to the Flocculator Drive AFD when Plant SCADA System is requiring Flocculator Drive to run.

Receive the "Flocculator Drive Speed" Analog Input (AI) signal from the Flocculator Drive AFD, convert to engineering units, and transmit to the SCADA system.

"REMOTE-MANUAL" Mode of Operation: To start the Flocculator drive, the "Flocculator Drive Speed" setpoint and the "Flocculator Drive Start" command shall be entered at the HMI by the operator. To stop the Flocculator drive, the "Flocculator Drive Stop" command shall be entered at the HMI by the operator.

"REMOTE-AUTO" Mode of Operation: There is no remote "AUTO" Mode of Operation.

SCADA Functions:

Receive "REMOTE Mode" status, "Flocculator Running" status, "Emergency Stop Depressed" status, "AFD Fault" alarm, "High Winding Temperature" status and "Flocculator Reset Depressed" status from PLC and display on the appropriate graphic display.

Provide a graphic for the operator to enter a desired "Flocculator Speed" setpoint and remote "Flocculator Run" command. Transmit the "Flocculator Run" and "Flocculator Speed" setpoint commands to the PLC when commanded to do so by the SCADA/Manual graphic display.

Receive the "Flocculator Speed" status feedback from the PLC and display on the appropriate graphic display. Record the speed values and motor runtimes in the SCADA Historical repository. Display the recorded speed and motor runtime values upon operator request.

Sludge Collection System

(P&ID N-002)

General Note: PICS Contractor shall duplicate all Sludge Collection System local graphics and integrate them into the SCADA system.

Loop CL02-BSNVLV: Clarifier No. 2 Effluent Gate Monitoring

Two (2) new gates with motorized actuators shall be installed with the I/O interfaced through the new Clarifier No. 2 Sludge Collection System Package Control Panel (CPN-10218). The Gate Actuator I/O, interlocks and operator interface devices shall be integrated to the existing Plant SCADA system via the new Plant SCADA PLC (SCD10277) located in the new Control Panel (CPN10218) and the gate status, signals and control interface shall be displayed on the new programmed graphic on the Plant SCADA HMI.

Local Functions:

- "Effluent Gate Fully-Opened" pilot light.
- "Effluent Gate Fully Closed" pilot light.
- Effluent Gate "Open" momentary-contact pushbutton for each gate.
- Effluent Gate "Stop" momentary-contact pushbutton for each gate.
- Effluent Gate "Close" momentary-contact pushbutton for each gate.

PLC Function:

Receive the following Discrete Input (DI) signals from each gate actuator and operator interface devices and transmit to the SCADA system (typical for each Effluent Gate):

- Effluent Gate "Fully Opened" status.
- Effluent Gate "Fully Closed" status.
- Effluent Gate Actuator "Fault" status.

Manual Operation:

The operator may open the gate by depressing the gate's corresponding "Open" momentary-contact pushbutton. The gate shall open until the gate has been proven "Fully Opened".

The operator may close the gate by depressing the gate's corresponding "Close" momentary-contact pushbutton. The gate shall close until the gate has been proven "Fully Closed".

The operator may stop the gate travel by depressing the gate's corresponding "Stop" momentary-contact pushbutton during the actuator operation.

Remote Operation:

"REMOTE-MANUAL Mode of Operation":

None.

"AUTOMATIC Mode of Operation":

None.

ALARMS:

Note: The alarms shall both be alarmed and displayed at the SCADA HMI graphic.

- **"Effluent Gate VLV-102XX (where "X" = 08 or 15) - Actuator Fault":** This shall occur when the Gate Actuator "Fault" contact changes state. Once the fault has cleared and the contact resumes its normal state, the "Fault" shall be cleared by the SCADA system.

SCADA Function:

Receive "Effluent Gate "Fully Opened"", "Effluent Gate "Fully Closed"" and "Effluent Gate Actuator Fault" status from the PLC and display on the appropriate graphic display.

Receive all discrete change of states from the PLC and display on the appropriate graphic display. Record the discrete change of states in the SCADA Historical repository. Display the time-date stamped discrete change of states upon operator request.

Loop CL02-EEFLL: Clarifier No. 2 Effluent pH and Turbidity Monitoring

Two new Analytical Indicating Controllers (monitoring for Turbidity and pH) [EEFLL-CTL10201 & EEFLL-CTL10202] (monitoring Clarifier No. 2 North and South Basins) shall be interfaced to the new Clarifier No. 2 Sludge Collection System Package Control Panel (CPN-10218). The new Analytical Indicating Controller status signals and analog signals shall be integrated to this system utilizing the new Clarifier No. 2 Sludge Collection System Package Control Panel PLC (SCN-10277) located in the new Control Panel (CPN-10218) and the analytical instrument status and measurement information shall be displayed on new programmed graphic on the Plant SCADA HMI.

Local Functions:

n/a

External Interfaces: See Drawings.

PLC Function:

Monitor the following for each Analytical Indicating Controller:

Discrete Inputs:

- "Turbidity High" status.
- "Low pH" status.
- "EEFLL-CTL1020X (where "X" = 1 or 2) Fault" status.

Receive the following Analog Input (AI) signals from the Analytical Indicating Transmitters, convert to engineering units, and transmit to the SCADA system:

- Measured (North/South) Basin Turbidity.
- Measured (North/South) Basin pH.

SCADA Function:

Receive the above listed status signals from the PLC and display on the appropriate graphic display. Record the above listed status signals in the SCADA Historical repository. Display the recorded above listed status signals upon operator request.

Sludge Collection System

(P&ID N-005)

Loop MOT102XX: Sludge Collection System

The existing Sludge Collection system shall be replaced with a new "Hose-Less" Solids Collection system. The new system includes six (6) Sludge Rake drives. Each new Rake drive shall be furnished with its own Field Panel (CPN-102XX where "X" = 12 - 17) and shall include an AFD and various local control and safety devices. The new automated Sludge Collection also include a vendor furnished PLC control panel (CPN10218) system and shall be integrated to this Plant SCADA system utilizing the existing Fiber Optic based SCADA network.

Typical for Six Sludge Collection Rake AFDs:

Local Functions:

Reference Mechanical Specification Section 44 42 63, Hose-Less Solids Collection System for requirements.

PLC Functions:

Reference Mechanical Specification Section 44 42 63, Hose-Less Solids Collection System for requirements.

SCADA Functions:

The HMI graphic screens(s) shall mimic the graphic displays and control functions being provided by the vendor at the local Operator Interface Unit (Panel Mounted PC). The following are minimum requirements:

Receive "REMOTE Mode" status, "Drive Running Forward" status, "Drive Running Reverse" status and "AFD Fault" alarm from PLC and display on the appropriate graphic display.

Receive the "Drive Speed" status feedback from the PLC and display on the appropriate graphic display. Record the speed values and motor runtimes in the SCADA Historical repository. Display the recorded speed and motor runtime values upon operator request.

Provide a graphic for the operator to select REMOTE-MANUAL or REMOTE-AUTO mode of operation.

"REMOTE-MANUAL" Mode of Operation:

A graphic shall be furnished which shall allow the operator to enter the following:

1. The speed at which the selected Sludge Collector is to operate (Minimum Sludge Collector Operating Speed – 100 percent).

2. The percentage of the Sludge Collector is to travel in the basin (0 – 100 percent).

3. Sludge Collector "Run" and "Stop" HMI pushbutton icons for the selected Sludge Collector.

Transmit the "Drive Run" command and "Drive Speed" setpoint to the PLC when commanded to do so by the SCADA/Manual graphic display.

"REMOTE–AUTO" Mode of Operation:

A graphic shall be furnished which shall allow the operator to enter the following:

1. The speed at which the selected Sludge Collector is to operate (Minimum Sludge Collector Operating Speed – 100 percent).

2. The percentage of the Sludge Collector is to travel in the basin (0 – 100 percent).

3. Enter a time to initiate a "Total System Cycle Interval" (example: Initiate a Clarifier No. 2 Sludge Collection Cycle every 24 Hours - Repeat Cycle Timer – Operator adjustable).

4. Initiate a "Sludge Collection System Start" by depressing an HMI pushbutton icon.

5. Initiate a "Sludge Collection System Stop" by depressing an HMI pushbutton icon.

Other Alarms/Statuses to be displayed on appropriate Sludge Collection HMI screens (including but not limited to):

1. Line Voltage Failure (Typical for seven panels).

2. UPS Trouble (Typical for seven panels).

3. Unit in "HOME Position" (Typical for six Sludge Collection systems).

4. Unit at "FULL TRAVEL Position" (Typical for six Sludge Collection systems).

5. Emergency Stop Activated (Typical for six Sludge Collection systems).

Loop VLV102XX: Sludge Valves

Six (6) new valves with Electric Actuators shall be furnished. The new Sludge Gate Actuators shall also include local OPEN/STOP/CLOSE control hand switches and a LOCAL/REMOTE Selector hand switch. All LOCAL and REMOTE control for these valves shall be integrated to this existing system utilizing the vendor furnished Sludge Collection PLC (SCD1020X where "x" = 1 - 6) to be located in the new control panel (CPN-1021X where "x" = 2 - 7) and shall be monitored and controlled via the existing Plant SCADA system.

Typical for six Sludge Valves:

Local Functions:

Reference Valve Specification Section 40 27 02, Process Valves and Operators.

PLC Functions:

Reference Mechanical Specification Section 44 42 63, Hose-Less Solids Collection System for requirements.

SCADA Functions:

Receive "REMOTE Mode" status, "Valve Fully Open" status, "Valve Fully Closed" status, "Valve Fail to Open/Close" alarm and "Actuator Fault" status from PLC and display on the appropriate graphic display.

Sludge Pump Station No. 2

Overview: The major equipment in the Sludge Pump Station No. 2 are new AFD drives for the new Sludge Waste Pumps (PMP10301 &PMP-10302) wired to the existing Control Panel with an existing PLC (PLC-XXX), new pressure gauges with annular seal pressure element and a new Grinder (GR-10302) on "Sludge Pump Waste No. 2 (PMP-10302).

In addition, an AFD drive for the new Sludge Waste Pump (PMP-1303) will be added to the existing Pumps (P-0422-01 & P-0422-02) and wired to the existing Control Panel with an existing PLC (PLC-FK-2403).

(P&ID N-007)

Loop XXX: Sludge Pumping System

Two new adjustable frequency drives (AFDs) shall be furnished to drive the new Sludge Pumps. Local control shall be maintained at the AFDs. The new automated Sludge Pumping system shall be integrated to this existing system utilizing the new Plant SCADA PLC (PLC-XXX to be located in the new control panel CP-XXX) and shall be monitored and controlled via the Plant SCADA system.

Pump Sequencing:

A SCADA graphic shall be provided to allow the operator to select the following modes of operation:

Fixed Pumping Sequence: "Sludge Pump P-0422-01 "Lead" / Sludge Pump P-0422-02 "Standby". This shall keep the pumps in a fixed operation sequence where at the end of each pumping cycle, Sludge Pump P-0422-01 shall always remain the "Lead" pump. Sludge Pump P-0422-02 (Standby) shall only assume the role of the "Lead" pump if Sludge Pump P-0422-01 has been considered "Failed" and locked out for operation by the PLC.

Fixed Pumping Sequence: "Sludge Pump P-0422-02 "Lead" / Sludge Pump P-0422-01 "Standby". This shall keep the pumps in a fixed operation sequence where at the end of each pumping cycle, Sludge Pump P-0422-02 shall always remain the "Lead" pump. Sludge Pump P-0422-01 (Standby) shall only assume the role of the "Lead" pump if Sludge Pump P-0422-02 has been considered "Failed" and locked out for operation by the PLC.

Automatic Pumping Sequence: This shall alternate the pumps in a "Lead" / "Standby" configuration upon the completion of each pumping cycle. A pumping cycle is defined when a pump is called to run by the PLC and the cycle is completed once the PLC commands the pump to stop.

Lead Pump Operation:

Local Functions:

Included in existing Local Control Panel (part of existing packaged system):

- "RUN-OFF-REMOTE" selector switch.
- "Running" status.
- "Stopped" status.
- "Manual Speed" setpoint.
- "AFD Fault" alarm.
- "Pump Reset" pushbutton.

PLC Function:

Receive the following Discrete Input (DI) signals from System Control Panel and transmit to the SCADA system:

- "RUN-OFF-REMOTE" switch in the "REMOTE" position.
- "Running" status.
- "AFD Fault" alarm.
- "Pump Reset Depressed" status.

Transmit the Sludge Pump "Pump Start" command Discrete Output (DO) to the Sludge Pump Drive AFD when Plant SCADA System is requiring the Sludge Pump to run.

Transmit the Sludge Pump "Pump Speed" setpoint Analog Output (AO) to the Sludge Pump Drive AFD when Plant SCADA System is requiring the Sludge Pump to run.

Receive the "Sludge Pump Speed" Analog Input (AI) signal from the Sludge Pump Drive AFD, convert to engineering units, and transmit to the SCADA system.

"REMOTE-MANUAL" Mode of Operation: Receive the "Lead Sludge Pump Speed" setpoint and the "Lead Sludge Pump Start" command via the Plant SCADA system and transmit to the pump AFD via a 4-20mADC analog signal and a discrete output "Dry" contact closure upon operator request.

"REMOTE-AUTO" Mode of Operation: Receive the "Sludge Flow" rate setpoint, Sludge Collector in "AUTO" mode of operation, Sludge Collector "Running", Sludge Collector "Not Failed" and Sludge Valve in the "Fully Opened" position (typical for each Sludge Collector for Clarifier No. 2) I/O from the Plant SCADA system. The PLC shall command the "Lead" pump to start if a Clarifier No. 2 sludge collector is in the "AUTOMATIC" mode of operation and is confirmed "Running", "Not Failed" and its corresponding Sludge Valve is in the "Fully Opened" position. The Sludge Pump speed shall modulate to

maintain the “Sludge Flow” setpoint (as entered by the operator via the Plant SCADA HMI).

The PLC shall consider the “Lead” Sludge Pump Failed if the PLC commands the “Lead” Sludge Pump to run and any of the following conditions are not met:

- The “Lead” Sludge Pump “Running” contact does not change states within 15 seconds (operator adjustable setpoint).
- The “Lead” Sludge Pump “Speed” feedback is not received within fifteen seconds (operator adjustable setpoint).
- The “Lead” Sludge Pump “AFD Fault” contact changes states.
- No Sludge Flow is detected via the Sludge Flow Transmitter (FIT-0422) within fifteen seconds (operator adjustable setpoint).

If the PLC fails the “Lead” Sludge Pump, the “Lead” Sludge Pump shall be locked out for operation by the PLC and the “Standby” Sludge Pump shall assume the role of the “Lead” Sludge Pump.

The failed pump shall be reset via the “Sludge Pump” reset command sent via the Plant SCADA system.

The PLC shall calculate and maintain each pump run time. This data shall be transmitted to the Plant SCADA system.

SCADA Function:

Receive the Sludge Collection System I/O (as indicated above) and transmit to the PLC for Sludge Pump operation logic purposes. Receive the Sludge Pump “REMOTE Mode” status, “Pump Running” status, “AFD Fault” alarm and “Pump Reset Depressed” status from PLC and display on the appropriate graphic display.

Provide a graphic that allows the operator to select “PUMP SEQUENCING” mode of operation (see above) and “REMOTE-MANUAL” or “REMOTE-AUTO” mode of operation. If the “REMOTE-MANUAL” mode is selected, provide a graphic for the operator to enter a desired Sludge Pump Speed Setpoint and Sludge Pump Run command. If the “REMOTE-AUTO” mode is selected, provide a graphic for the operator to enter in the Sludge Flow Setpoint. Transmit the Sludge Pump Run and Sludge Flow Setpoint commands to the PLC when commanded to do so by the SCADA/Manual graphic display. If the “Lead” Sludge Pump has failed, provide a graphic that allows the operator to manually reset the pump via the Plant SCADA HMI and transmit the command to the PLC.

Receive Sludge Pump speed feedback from PLC and display on the appropriate graphic display. Record the Sludge Pump Speed and run time values in the SCADA Historical repository. Display the recorded Sludge Pump Speed and run time values upon operator request.

END OF SUPPLEMENT

Surge Suppressor Products Table

SS Type	Application	Enclosure/ Mounting	Manufacturer/ Model	Principle of Operation/ Performance Criteria	Comments/ Performance Criteria
1	Protect 120V ac, single-phase power in control panels	NEMA Rating: None Locate inside panel	Emerson EDCO, HSP-121; or approved equal	**Principle of Operation:** Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device **Performance Criteria:** 1) ARC: Handles 60 kA on 10 by 350 waveform 2) MOV: Handles 40 kA on 8 by 20	Nominal Amp Capacity: 15A Provide parallel units if needed
1	Protect 120V ac, single-phase power in control panels	NEMA Rating: None Locate inside panel	Mains-Plugtrab; Phoenix Contact, PLT-SEC-T3-120-P	**Principle of Operation:** Varistor based device protection. Nominal discharge surge current when subject to 8/20 waveform testing: 3 kA	Nominal Amp Capacity: 20A; provide parallel units if needed
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	Emerson EDCO, PC-642 or SRA-64; or approved equal	**Principle of Operation:** Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	Tested and rated for 50 occurrences of 2,000-amp peak test waveform. Provide as needed
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	Phoenix Contact; TT-2-PE-24DC	**Principle of Operation:** Three Stage 1) Gas-filled arrestors for coarse protection 2) Medium protection varistors 3) Final stage suppressor diodes	Nominal discharge surge current when subject to 8/20 wave form testing: 5kA per path

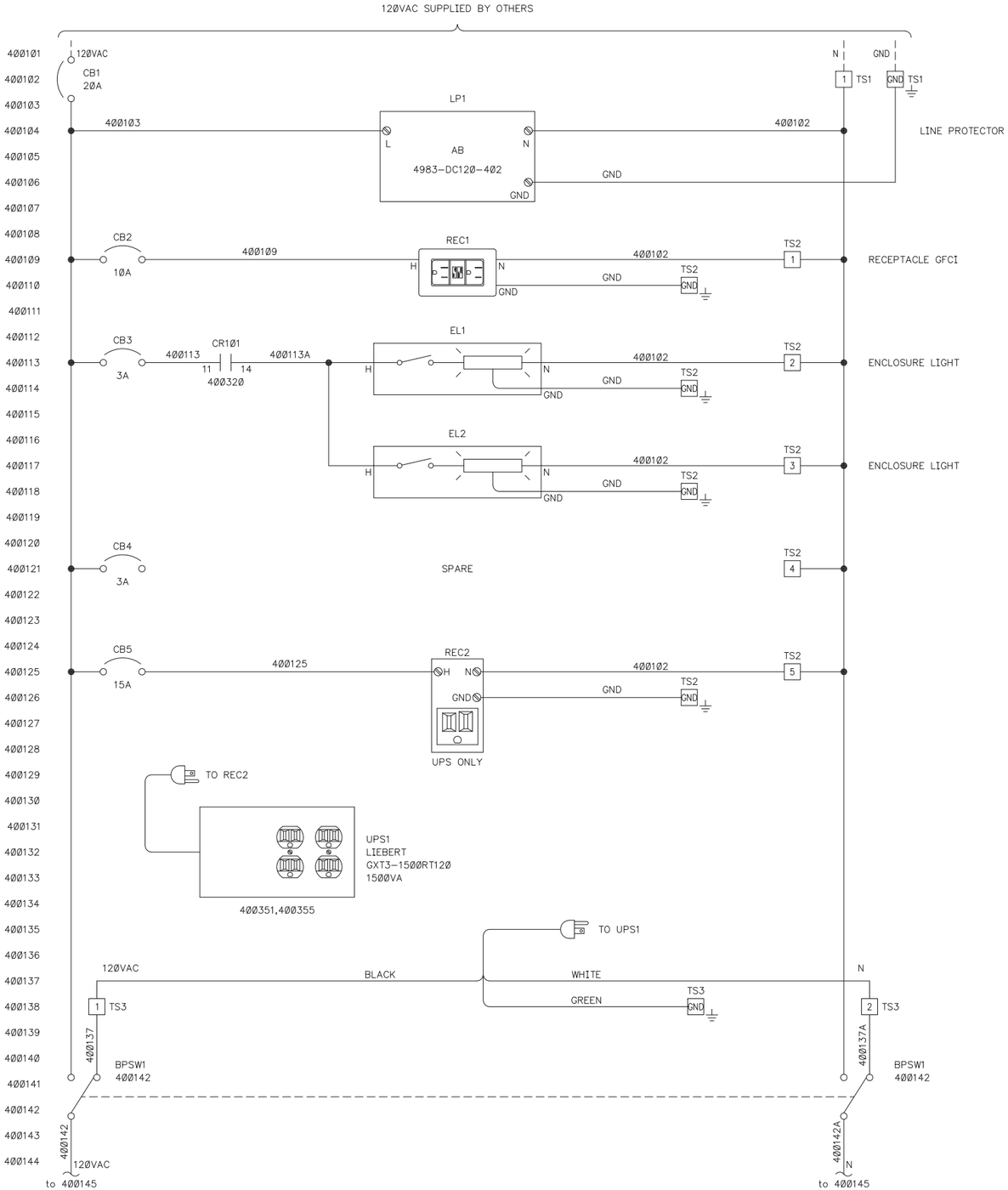
Surge Suppressor Products Table

SS Type	Application	Enclosure/ Mounting	Manufacturer/ Model	Principle of Operation/ Performance Criteria	Comments/ Performance Criteria
3	Analog signal of 2-wire transmitters	Field installed in stainless steel pipe nipple adjacent to 2-wire transmitter	Emerson EDCO, SS64 Series; or approved equal	**Principle of Operation:** Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	
3	Analog signal of 2-wire transmitters	Field installed in stainless steel pipe nipple adjacent to 2-wire transmitter	Phoenix Contact, S-PT1-2PE-24DC	**Principle of Operation:** Two-Stage 1) Gas-filled electrode 2) Suppressor Diode	Nominal discharge current when subject to 8/20 waveform: 10kA
4	Both analog signal and 120V ac power of 4-wire transmitter	NEMA Rating: 316 Stainless Steel, NEMA 4X Field installed; adjacent to 4-wire transmitter	Emerson EDCO, SLAC-12036; or approved equal	**Principle of Operation:** Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device **Performance Criteria:** 1) With 120V AC outlet and AC circuit breaker in a weatherproof enclosure	Tested and rated for 50 occurrences of 2,000-amp peak test waveform. Provide as needed
4	Both analog signal and 120V ac power of 4-wire transmitter	NEMA Rating: 316 Stainless Steel, NEMA 4X Field installed; adjacent to 4-wire transmitter	Phoenix Contact, Type 1 plus PT 1X2-24VDC-ST	Nominal discharge current of PT unit when subject to 8/20 wave form: 10kA testing	

Surge Suppressor Products Table

SS Type	Application	Enclosure/ Mounting	Manufacturer/ Model	Principle of Operation/ Performance Criteria	Comments/ Performance Criteria
5	Protect Category 5 Power over Ethernet or Category 6 Ethernet communication cables in control panels	NEMA Rating: None Locate inside panel	EDCO, CAT6-5 POE Series	Peak Surge Current: 60A (10x1000µs) Frequency Range: 0-250 MHz Insertion Loss: <0.1 dB at 20MHz SPD Technology: Silicon Avalanche Diode Connection Type: RJ-45 Jacks	
5	Protect Category 6 Power over Ethernet communication cables in control panels	NEMA Rating: None Locate inside panel	Phoenix Contact, DT-LAN-CAT.6+ (2881007)	Nominal discharge current when subject to 8/20 wave form: (Core-Core): 100 A (Core-Earth): 2kA (per signal pair)	
6	Protect MODBUS Master/Slave multi-drop signals in panels	316 Stainless Steel, NEMA 4X IP20 for installation in panels in non-hazardous locations.	Phoenix Contact PT 3-HF-12DC-ST module and PT 1X2+F-BE base.	**Principle of Operation:** Three Stage 1) Gas-filled tube between signal lines for coarse protection followed by series impedance separating the two stages 2) Silicon avalanche diodes second stage between signal lines 3) Gas-filled tube between common line and facility ground connection to maintain signal/ground isolation except when surge is present.	12 VDC operating voltage 8/20 µs Ln-Ln & Ln-Gnd 10 kA 10/1000 µs Ln-Ln 67 A 10/350 µs Impls Disch 2.5 kA 1 kV/µs Ln-Ln Spike 55 V 1 kV/µs Ln-Gnd Spike 700 V Resp Time Ln-Ln 500 ns Resp Time Ln-Gnd 500 ns
7	Protect HART multi-drop signals in panels	316 Stainless Steel, NEMA 4X IP20 for installation in panels in non-hazardous locations.	Phoenix Contact PT 1X2-24AC-ST module and PT 1X2+F-BE base.	**Principle of Operation:** Three Stage 1) Gas-filled tube between signal lines for coarse protection followed by series impedance separating the two stages 2) Silicon avalanche diodes second stage between signal lines 3) Gas-filled tube between common line and facility ground connection to maintain signal/ground isolation except when surge is present.	24 VAC 40 VDC operating voltage 8/20 µs Ln-Ln & Ln-Gnd 10 kA 10/1000 µs Ln-Ln 23 A 10/250 µs Impls Disch 2.5 kA 1 kV/µs Ln-Ln Spike 55 V 1 kV/µs Ln-Gnd Spike 450 V Resp Time Ln-Ln 1ns Resp Time Ln-Gnd 100 ns

SECTION 40 90 01
SUPPLEMENT – WIRING DIAGRAM EXAMPLES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400113
400114
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400132
400133
400134
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400137
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400140
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400143
400144
120VAC
CB1
20A
400103
LP1
L
AB
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N
GND
400102
GND
N
GND
1
TS1
GND
TS1
LINE PROTECTOR
CB2
10A
400109
REC1
H
N
GND
400102
GND
TS2
GND
TS2
1
RECEPTACLE GFCI
CB3
3A
400113
CR101
11
14
400320
400113A
EL1
H
N
GND
400102
GND
TS2
GND
TS2
2
ENCLOSURE LIGHT
EL2
H
N
GND
400102
GND
TS2
GND
TS2
3
ENCLOSURE LIGHT
CB4
3A
SPARE
TS2
4
CB5
15A
400125
REC2
H
N
GND
400102
GND
TS2
GND
TS2
5
UPS ONLY
TO REC2
UPS1
LIEBERT
GXT3-1500RT120
1500VA
400351,400355
TO UPS1
120VAC
BLACK
WHITE
GREEN
N
1
TS3
2
TS3
TS3
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BPSW1
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BPSW1
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400142
400142A
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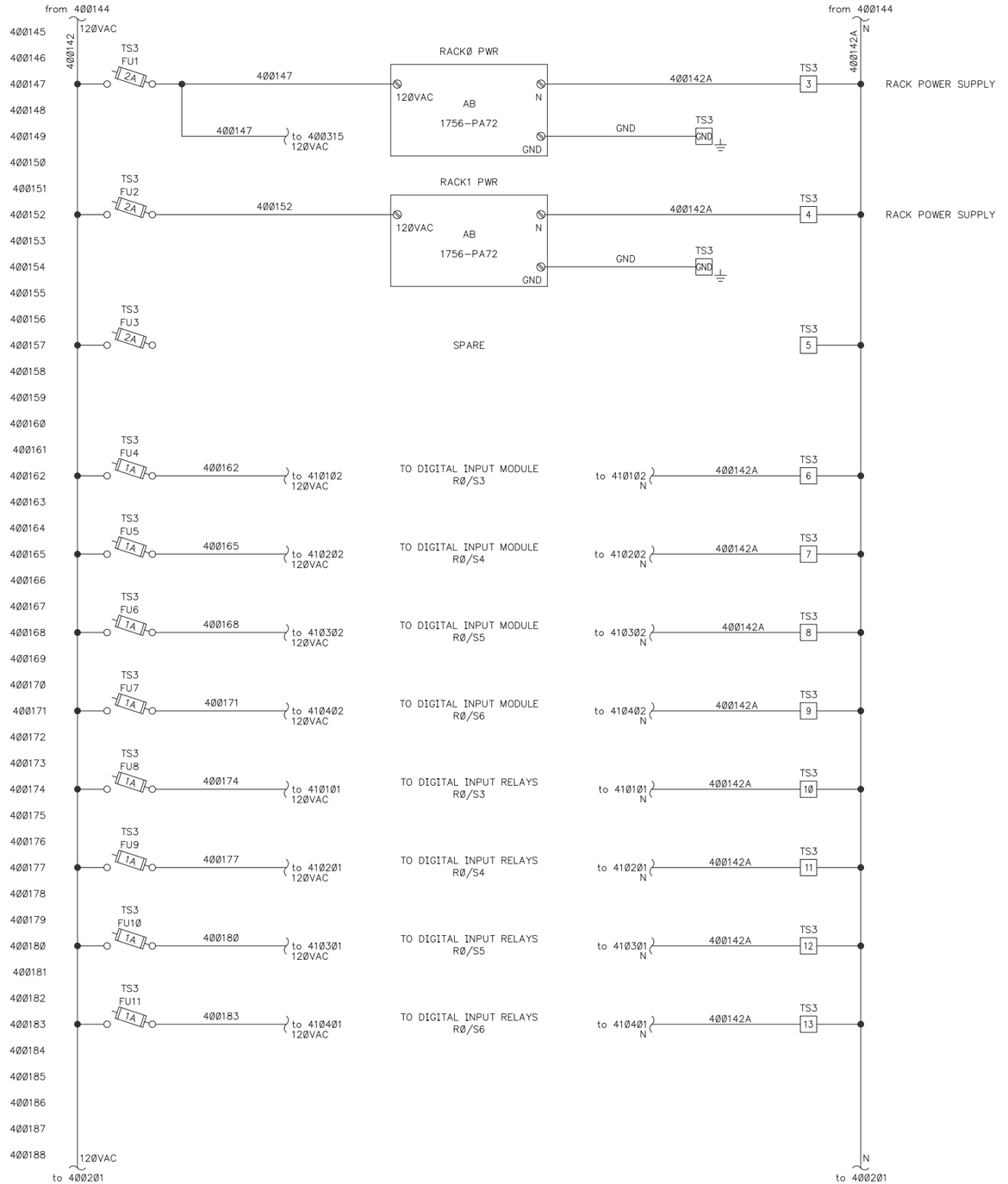
N
to 400145
to 400145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400145
400146
400147
400148
400149
400150
400151
400152
400153
400154
400155
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400158
400159
400160
400161
400162
400163
400164
400165
400166
400167
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400173
400174
400175
400176
400177
400178
400179
400180
400181
400182
400183
400184
400185
400186
400187
400188
TS3
FU1
2A
400147
RACK0 PWR
120VAC
AB
1756-PA72
N
GND
400142A
TS3
3
RACK POWER SUPPLY
400147
to 400315
120VAC
GND
TS3
GND
TS3
FU2
2A
400152
RACK1 PWR
120VAC
AB
1756-PA72
N
GND
400142A
TS3
4
RACK POWER SUPPLY
GND
TS3
GND
TS3
FU3
2A
SPARE
TS3
5
TS3
FU4
1A
400162
to 410102
120VAC
TO DIGITAL INPUT MODULE
R0/S3
to 410102
N
400142A
TS3
6
TS3
FU5
1A
400165
to 410202
120VAC
TO DIGITAL INPUT MODULE
R0/S4
to 410202
N
400142A
TS3
7
TS3
FU6
1A
400168
to 410302
120VAC
TO DIGITAL INPUT MODULE
R0/S5
to 410302
N
400142A
TS3
8
TS3
FU7
1A
400171
to 410402
120VAC
TO DIGITAL INPUT MODULE
R0/S6
to 410402
N
400142A
TS3
9
TS3
FU8
1A
400174
to 410101
120VAC
TO DIGITAL INPUT RELAYS
R0/S3
to 410101
N
400142A
TS3
10
TS3
FU9
1A
400177
to 410201
120VAC
TO DIGITAL INPUT RELAYS
R0/S4
to 410201
N
400142A
TS3
11
TS3
FU10
1A
400180
to 410301
120VAC
TO DIGITAL INPUT RELAYS
R0/S5
to 410301
N
400142A
TS3
12
TS3
FU11
1A
400183
to 410401
120VAC
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R0/S6
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13
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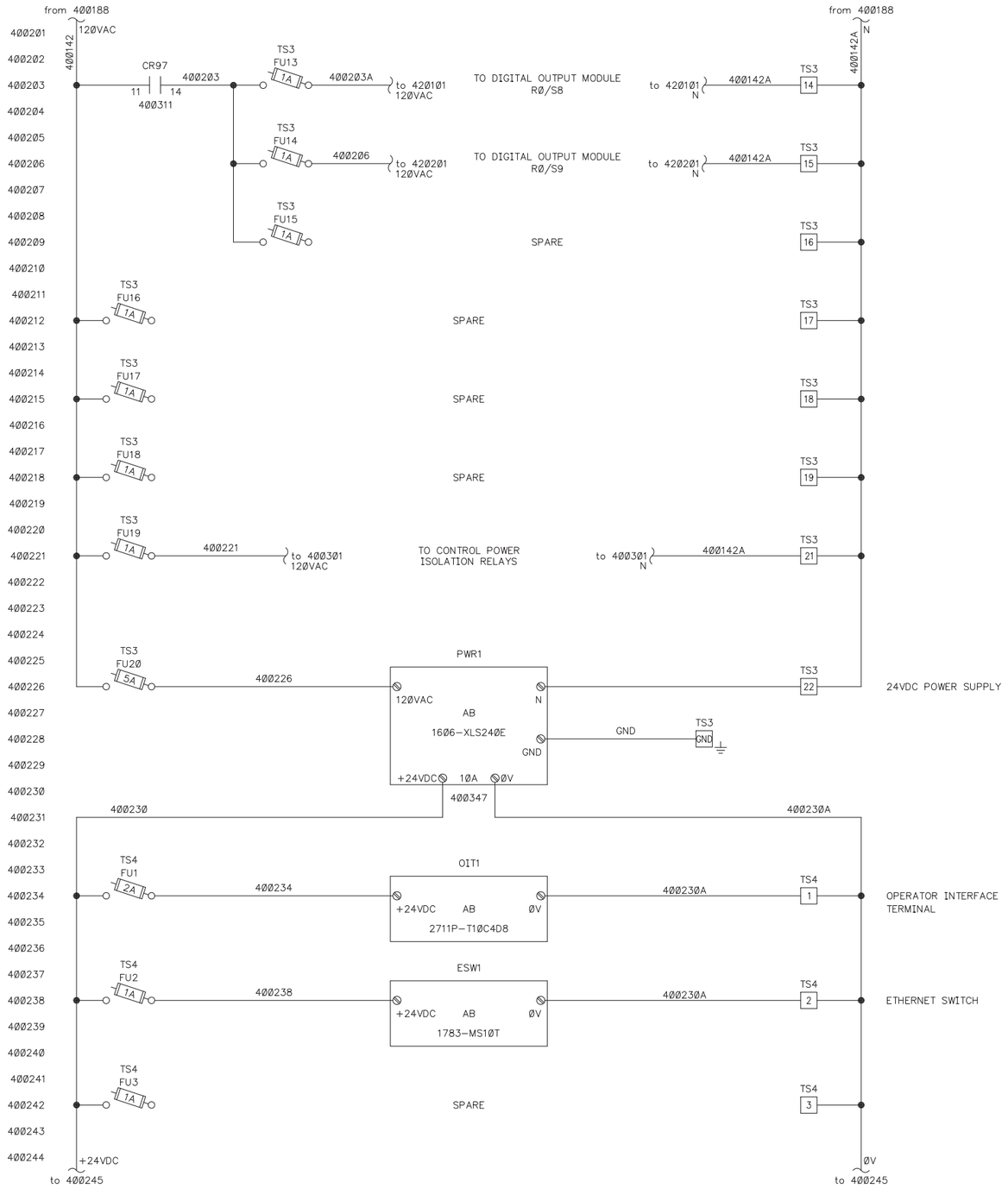
to 400201
N
to 400201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11
14
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to 420101
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TO DIGITAL OUTPUT MODULE
RØ/S8
to 420101
N
400142A
TS3
14
from 400188
N
400142A
TS3
FU14
1A
400206
to 420201
120VAC
TO DIGITAL OUTPUT MODULE
RØ/S9
to 420201
N
400142A
TS3
15
TS3
FU15
1A
SPARE
TS3
16
TS3
FU16
1A
SPARE
TS3
17
TS3
FU17
1A
SPARE
TS3
18
TS3
FU18
1A
SPARE
TS3
19
TS3
FU19
1A
400221
to 400301
120VAC
TO CONTROL POWER
ISOLATION RELAYS
to 400301
N
400142A
TS3
21
TS3
FU20
5A
400226
PWR1
120VAC
AB
1606-XLS240E
N
GND
GND
TS3
GND
+24VDC
10A
ØV
TS3
22
24VDC POWER SUPPLY
400230
400347
400230A
TS4
FU1
2A
400234
OIT1
+24VDC
AB
ØV
2711P-T10C4D8
400230A
TS4
1
OPERATOR INTERFACE
TERMINAL
TS4
FU2
1A
400238
ESW1
+24VDC
AB
ØV
1783-MS10T
400230A
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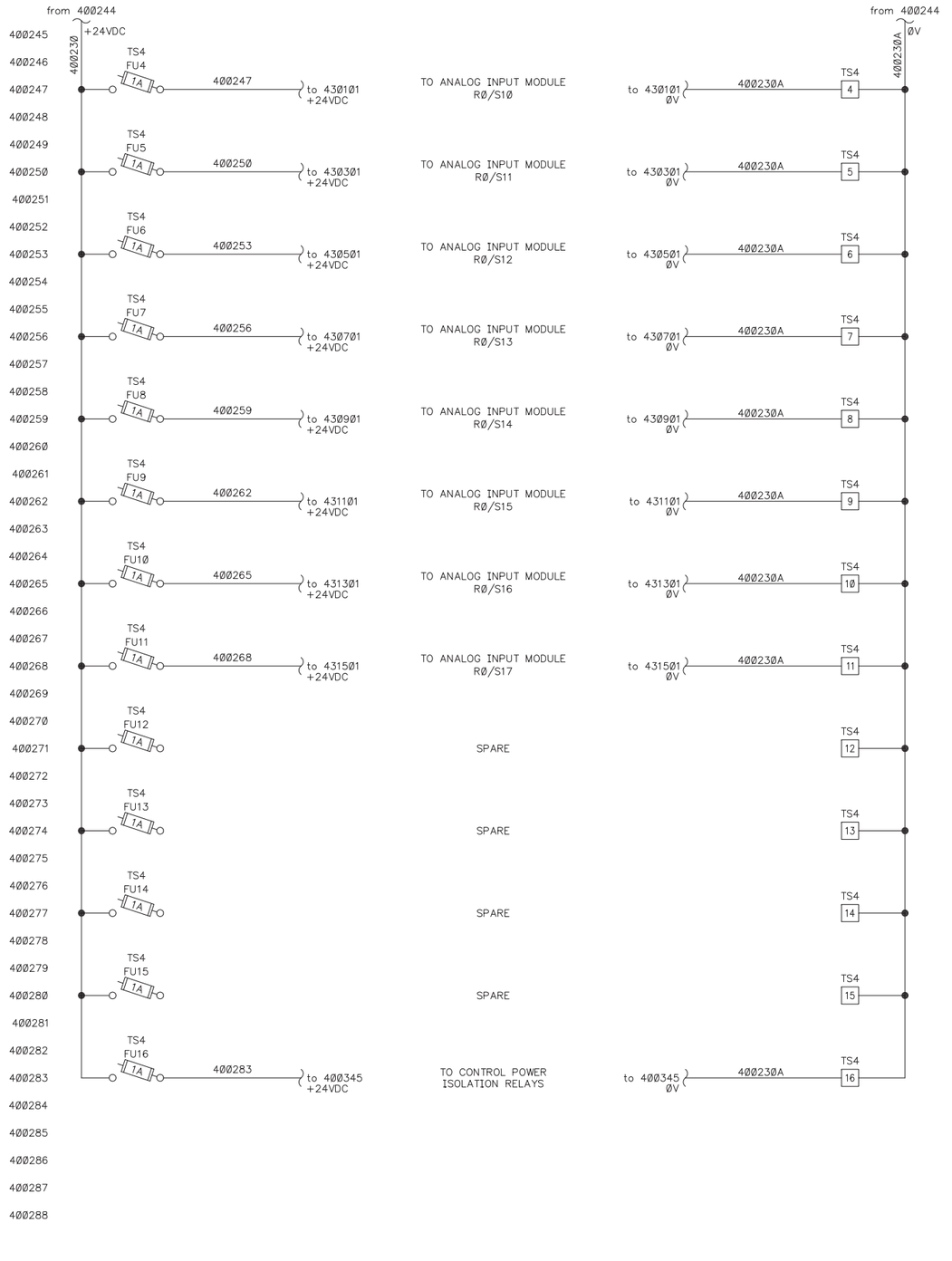
FU3
1A
SPARE
TS4
3
+24VDC
to 400245
ØV
to 400245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400230
TS4
FU4
1A
400247
to 430101
+24VDC
TO ANALOG INPUT MODULE
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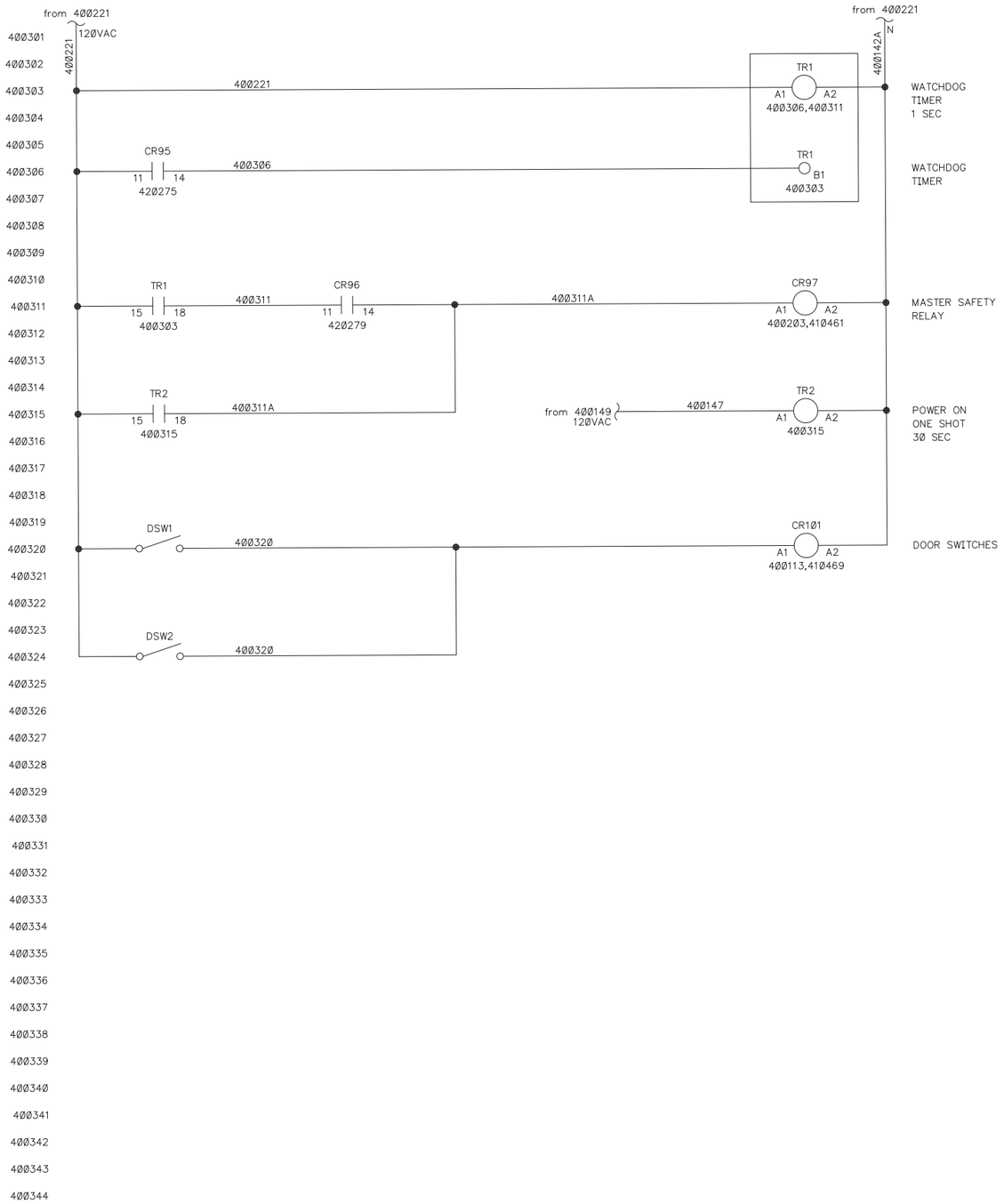
from 400244
ØV
400230A
to 430101
ØV
400230A
TS4
4
TS4
FU5
1A
400250
to 430301
+24VDC
TO ANALOG INPUT MODULE
RØ/S11
to 430301
ØV
400230A
TS4
5
TS4
FU6
1A
400253
to 430501
+24VDC
TO ANALOG INPUT MODULE
RØ/S12
to 430501
ØV
400230A
TS4
6
TS4
FU7
1A
400256
to 430701
+24VDC
TO ANALOG INPUT MODULE
RØ/S13
to 430701
ØV
400230A
TS4
7
TS4
FU8
1A
400259
to 430901
+24VDC
TO ANALOG INPUT MODULE
RØ/S14
to 430901
ØV
400230A
TS4
8
TS4
FU9
1A
400262
to 431101
+24VDC
TO ANALOG INPUT MODULE
RØ/S15
to 431101
ØV
400230A
TS4
9
TS4
FU10
1A
400265
to 431301
+24VDC
TO ANALOG INPUT MODULE
RØ/S16
to 431301
ØV
400230A
TS4
10
TS4
FU11
1A
400268
to 431501
+24VDC
TO ANALOG INPUT MODULE
RØ/S17
to 431501
ØV
400230A
TS4
11
TS4
FU12
1A
SPARE
TS4
12
TS4
FU13
1A
SPARE
TS4
13
TS4
FU14
1A
SPARE
TS4
14
TS4
FU15
1A
SPARE
TS4
15
TS4
FU16
1A
400283
to 400345
+24VDC
TO CONTROL POWER
ISOLATION RELAYS
to 400345
ØV
400230A
TS4
16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120VAC
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from 400221
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CR97
A1
A2
400203,410461
MASTER SAFETY
RELAY
TR2
15
18
400315
400311A
from 400149
120VAC
400147
TR2
A1
A2
400315
POWER ON
ONE SHOT
30 SEC
DSW1
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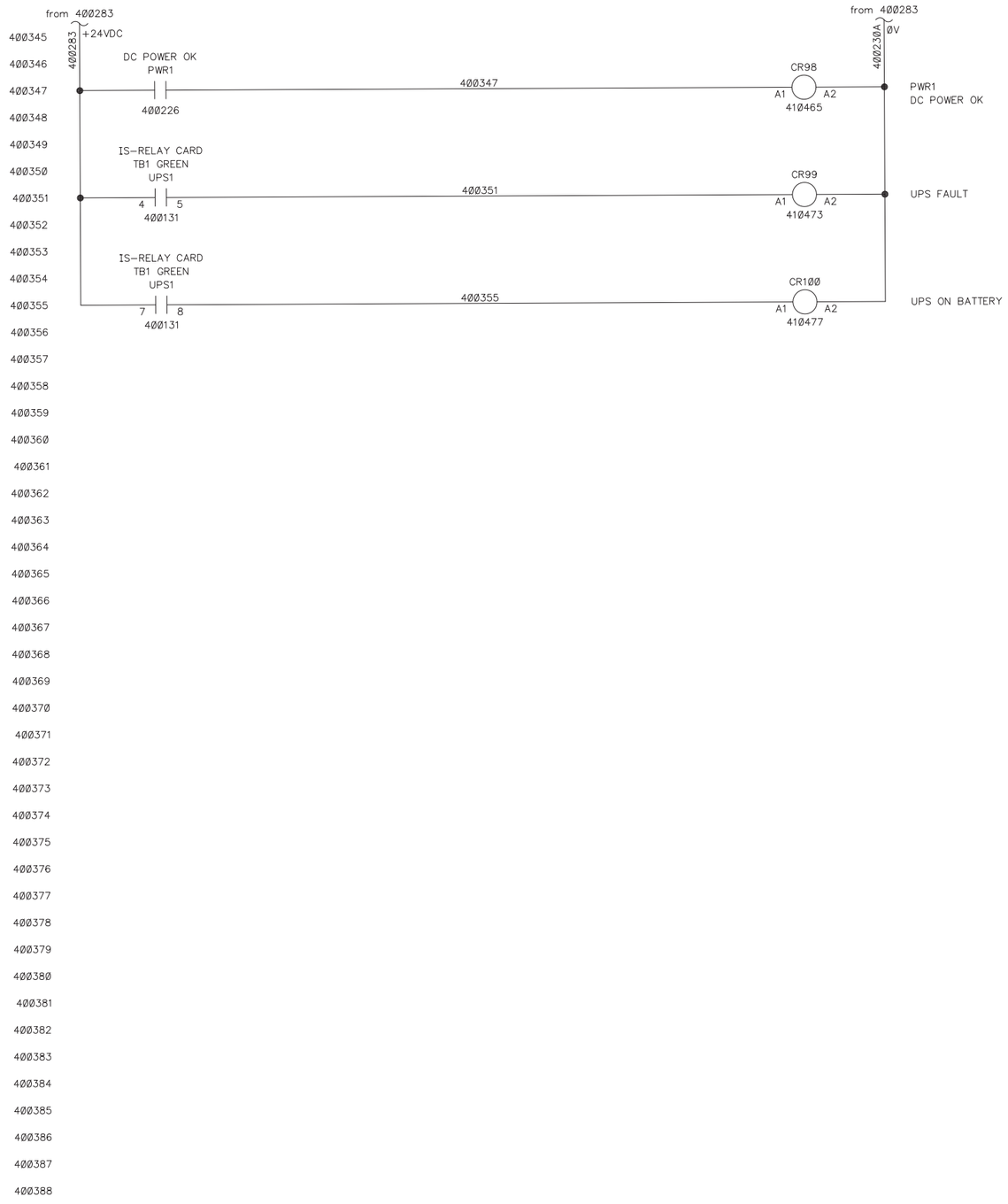
CR101
A1
A2
400113,410469
DOOR SWITCHES
DSW2
400320


from 400283
+24VDC
400283
from 400283
0V
400230A
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400353
400354
400355
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400357
400358
400359
400360
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400380
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400383
400384
400385
400386
400387
400388
DC POWER OK
PWR1
400226
400347
CR98
A1
A2
410465
PWR1
DC POWER OK
IS-RELAY CARD
TB1 GREEN
UPS1
4
5
400131
400351
CR99
A1
A2
410473
UPS FAULT
IS-RELAY CARD
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UPS1
7
8
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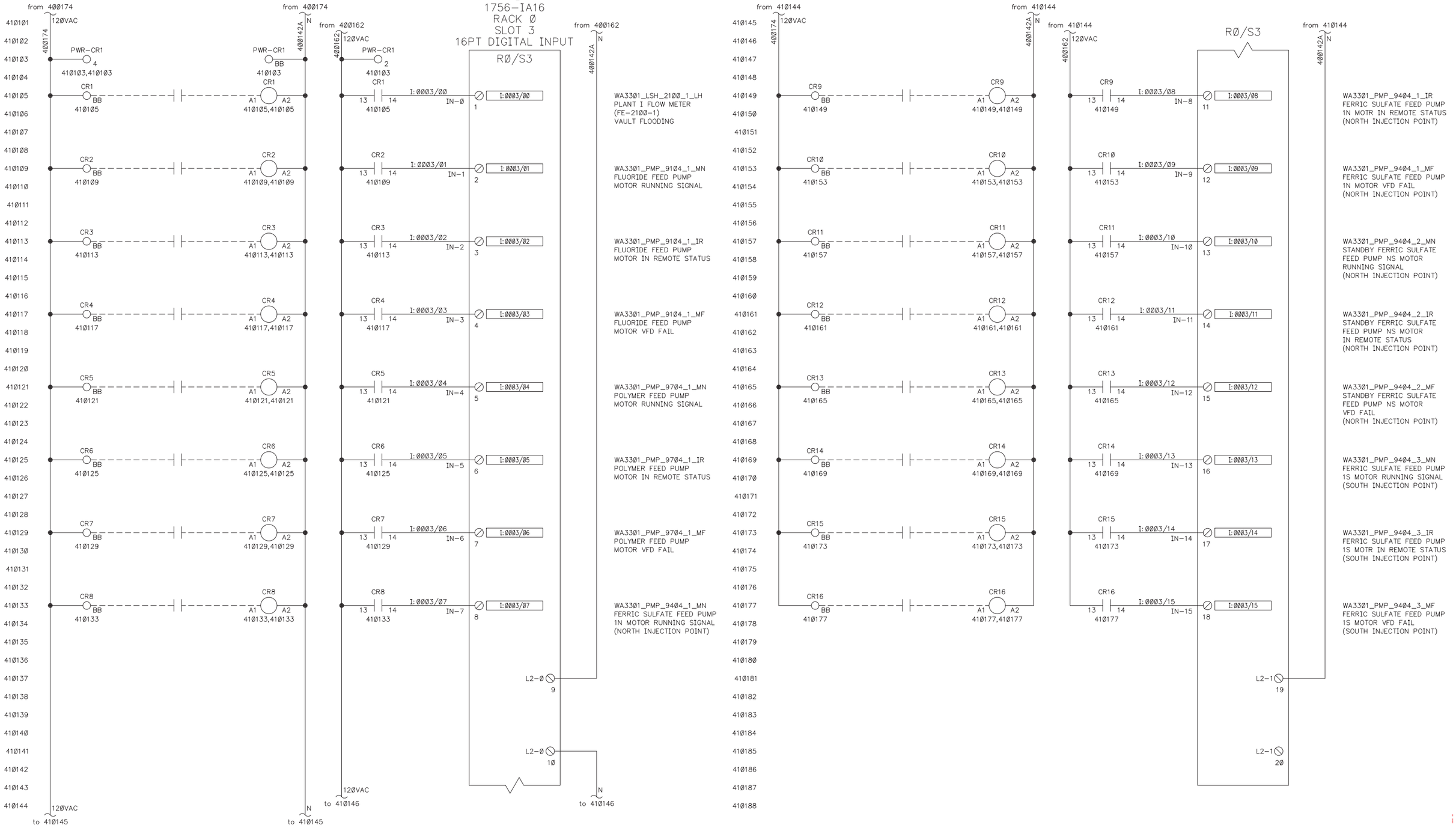
400355
CR100
A1
A2
410477
UPS ON BATTERY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CR7
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CR2
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CR3
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CR4
410117
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IN-3
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CR5
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IN-4
5
CR6
410125
I:0003/05
IN-5
6
CR7
410129
I:0003/06
IN-6
7
CR8
410133
I:0003/07
IN-7
8
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to 410146
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RACK Ø
SLOT 3
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I:0003/01
I:0003/02
I:0003/03
I:0003/04
I:0003/05
I:0003/06
I:0003/07
L2-Ø
9
L2-Ø
1Ø
from 400162
400142A
N
to 410146
WA3301_LSH_2100_1_LH
PLANT I FLOW METER
(FE-2100-1)
VAULT FLOODING
WA3301_PMP_9104_1_MN
FLUORIDE FEED PUMP
MOTOR RUNNING SIGNAL
WA3301_PMP_9104_1_IR
FLUORIDE FEED PUMP
MOTOR IN REMOTE STATUS
WA3301_PMP_9104_1_MF
FLUORIDE FEED PUMP
MOTOR VFD FAIL
WA3301_PMP_9704_1_MN
POLYMER FEED PUMP
MOTOR RUNNING SIGNAL
WA3301_PMP_9704_1_IR
POLYMER FEED PUMP
MOTOR IN REMOTE STATUS
WA3301_PMP_9704_1_MF
POLYMER FEED PUMP
MOTOR VFD FAIL
WA3301_PMP_9404_1_MN
FERRIC SULFATE FEED PUMP
1N MOTOR RUNNING SIGNAL
(NORTH INJECTION POINT)
from 410144
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400174
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410146
410147
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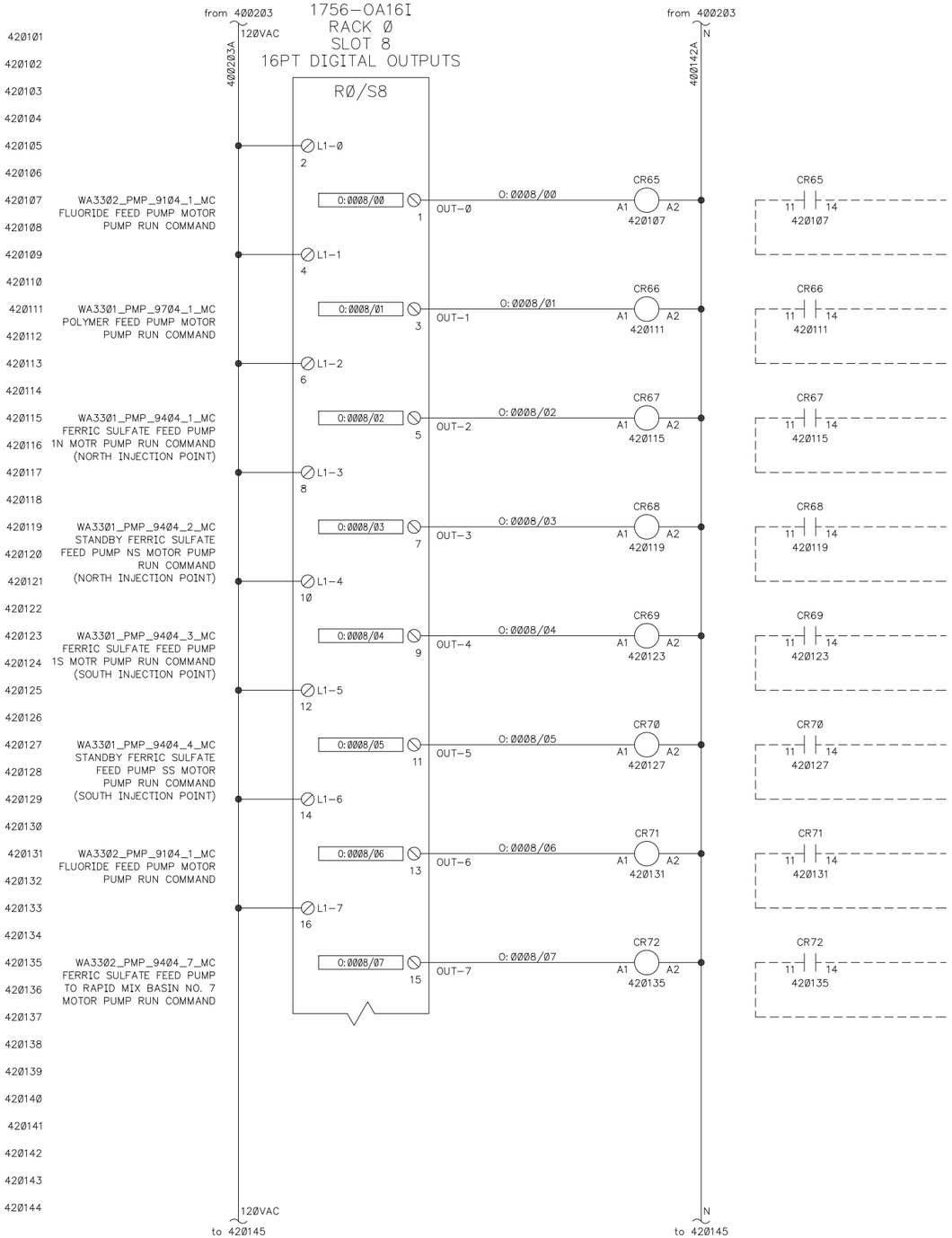
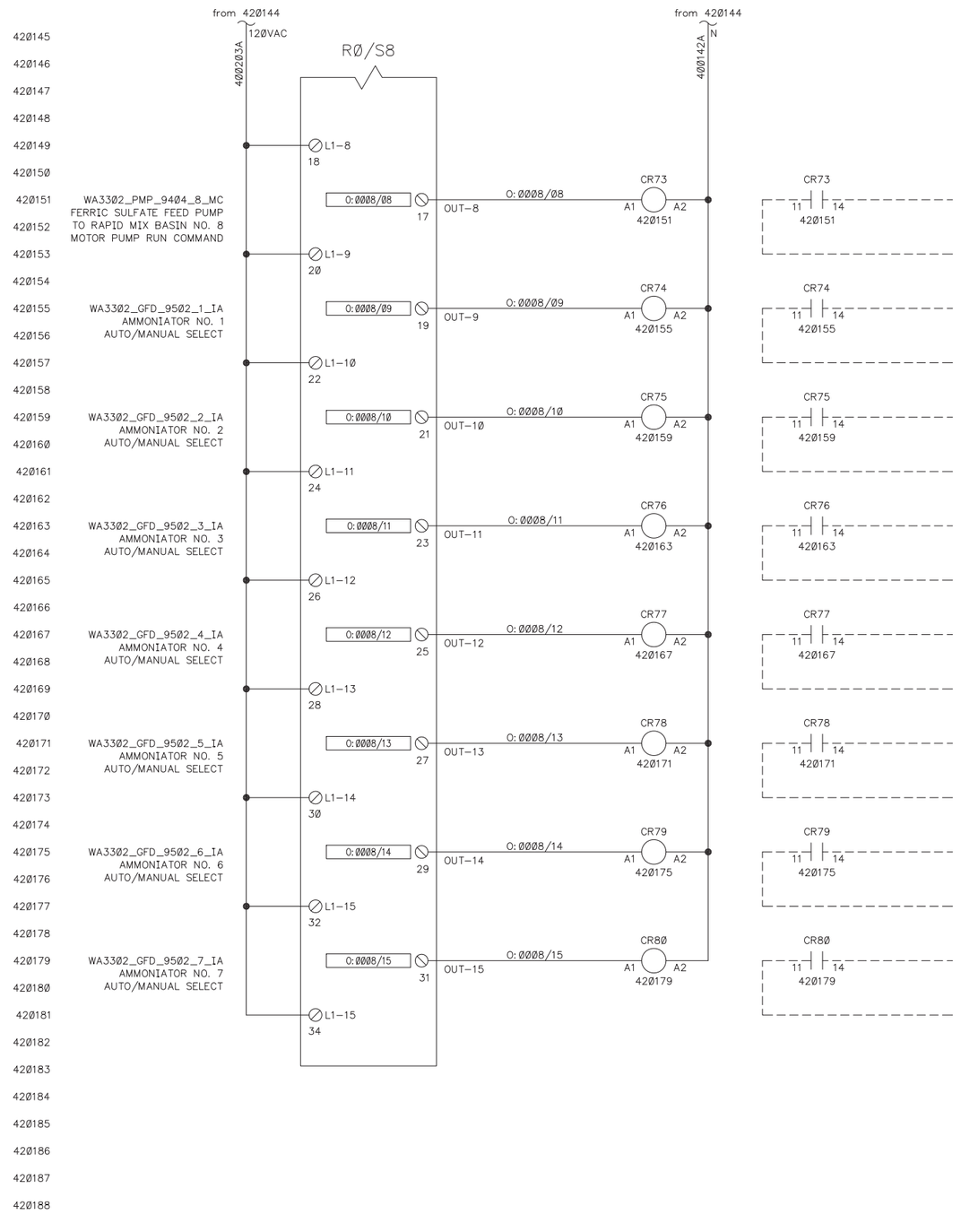
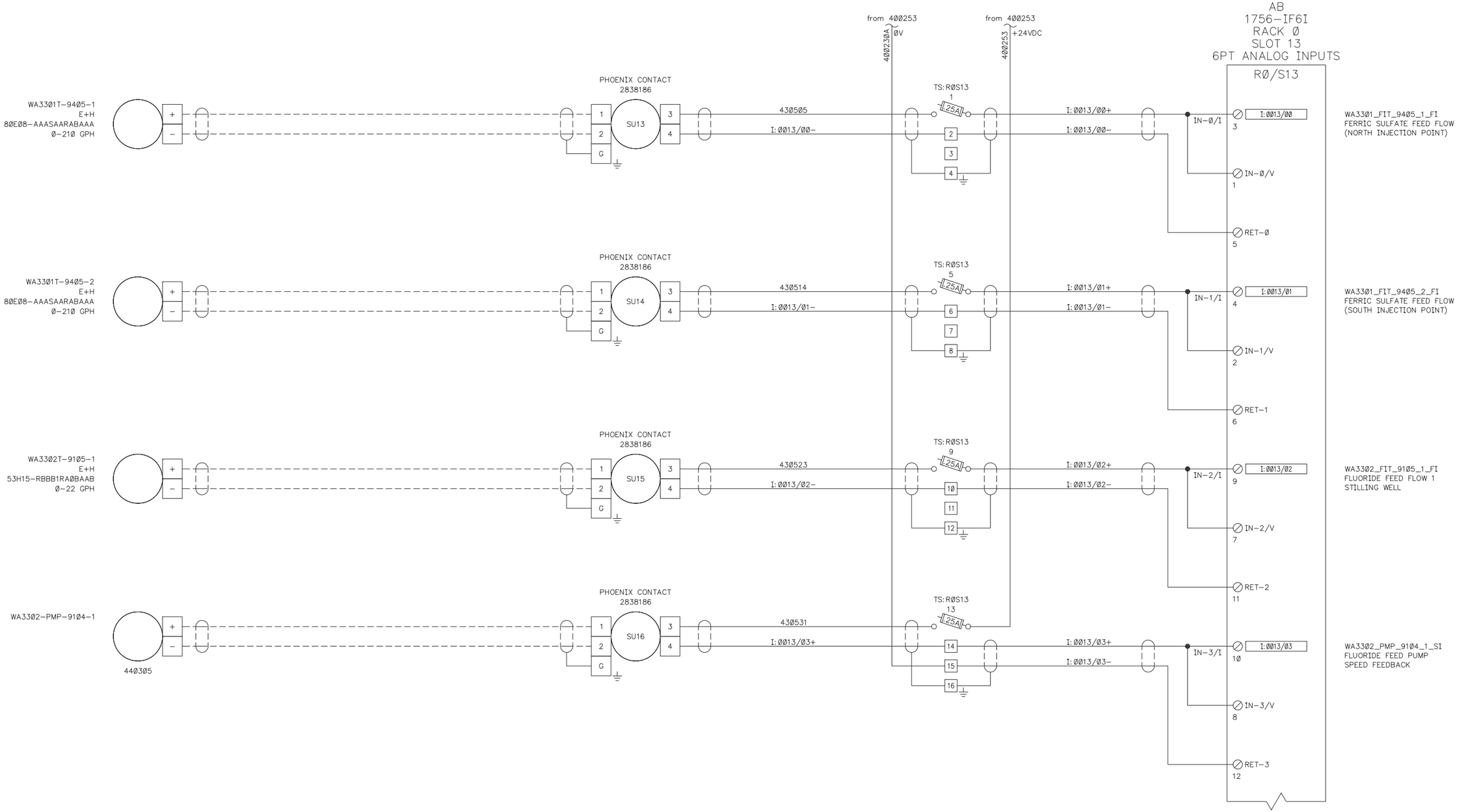
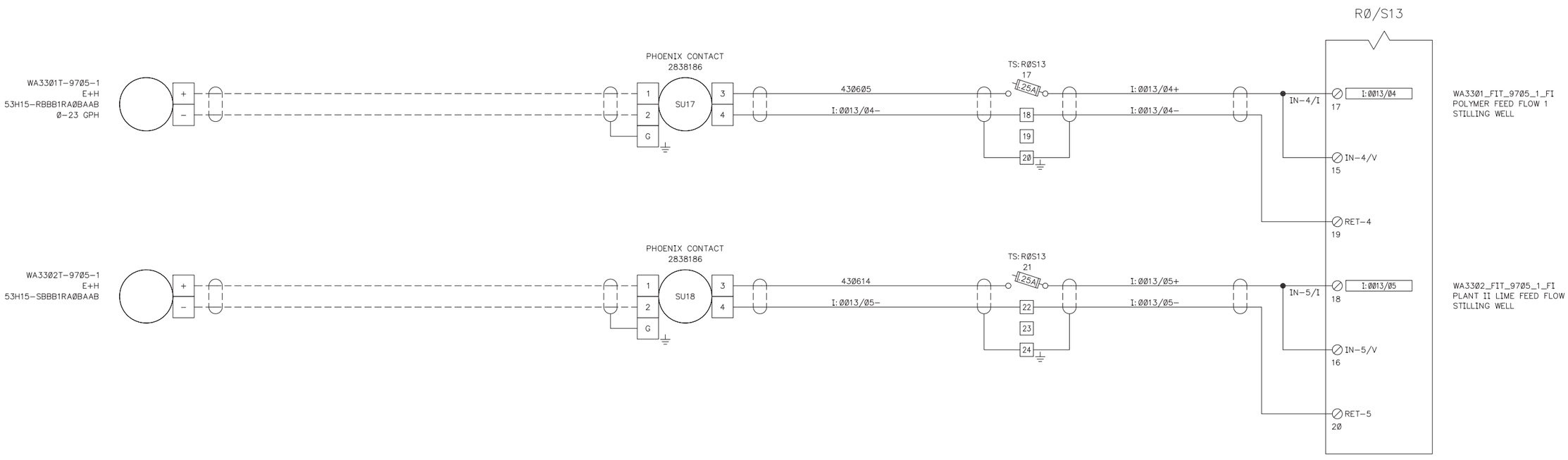
11
CR10
410153
I:0003/09
IN-9
12
CR11
410157
I:0003/10
IN-10
13
CR12
410161
I:0003/11
IN-11
14
CR13
410165
I:0003/12
IN-12
15
CR14
410169
I:0003/13
IN-13
16
CR15
410173
I:0003/14
IN-14
17
CR16
410177
I:0003/15
IN-15
18
L2-1
19
L2-1
2Ø
from 410144
400142A
N
WA3301_PMP_9404_1_IR
FERRIC SULFATE FEED PUMP
1N MOTR IN REMOTE STATUS
(NORTH INJECTION POINT)
WA3301_PMP_9404_1_MF
FERRIC SULFATE FEED PUMP
1N MOTOR VFD FAIL
(NORTH INJECTION POINT)
WA3301_PMP_9404_2_MN
STANDBY FERRIC SULFATE
FEED PUMP NS MOTOR
RUNNING SIGNAL
(NORTH INJECTION POINT)
WA3301_PMP_9404_2_IR
STANDBY FERRIC SULFATE
FEED PUMP NS MOTOR
IN REMOTE STATUS
(NORTH INJECTION POINT)
WA3301_PMP_9404_2_MF
STANDBY FERRIC SULFATE
FEED PUMP NS MOTOR
VFD FAIL
(NORTH INJECTION POINT)
WA3301_PMP_9404_3_MN
FERRIC SULFATE FEED PUMP
1S MOTOR RUNNING SIGNAL
(SOUTH INJECTION POINT)
WA3301_PMP_9404_3_IR
FERRIC SULFATE FEED PUMP
1S MOTR IN REMOTE STATUS
(SOUTH INJECTION POINT)
WA3301_PMP_9404_3_MF
FERRIC SULFATE FEED PUMP
1S MOTOR VFD FAIL
(SOUTH INJECTION POINT)


AB
1756-OA16I
RACK Ø
SLOT 8
16PT DIGITAL OUTPUTS
RØ/S8
from 400203
120VAC
400203A
from 400203
N
400142A
420101
420102
420103
420104
420105
420106
420107
420108
420109
420110
420111
420112
420113
420114
420115
420116
420117
420118
420119
420120
420121
420122
420123
420124
420125
420126
420127
420128
420129
420130
420131
420132
420133
420134
420135
420136
420137
420138
420139
420140
420141
420142
420143
420144
WA3302_PMP_9104_1_MC
FLUORIDE FEED PUMP MOTOR
PUMP RUN COMMAND
WA3301_PMP_9704_1_MC
POLYMER FEED PUMP MOTOR
PUMP RUN COMMAND
WA3301_PMP_9404_1_MC
FERRIC SULFATE FEED PUMP
1N MOTR PUMP RUN COMMAND
(NORTH INJECTION POINT)
WA3301_PMP_9404_2_MC
STANDBY FERRIC SULFATE
FEED PUMP NS MOTOR PUMP
RUN COMMAND
(NORTH INJECTION POINT)
WA3301_PMP_9404_3_MC
FERRIC SULFATE FEED PUMP
1S MOTR PUMP RUN COMMAND
(SOUTH INJECTION POINT)
WA3301_PMP_9404_4_MC
STANDBY FERRIC SULFATE
FEED PUMP SS MOTOR
PUMP RUN COMMAND
(SOUTH INJECTION POINT)
WA3302_PMP_9104_1_MC
FLUORIDE FEED PUMP MOTOR
PUMP RUN COMMAND
WA3302_PMP_9404_7_MC
FERRIC SULFATE FEED PUMP
TO RAPID MIX BASIN NO. 7
MOTOR PUMP RUN COMMAND
L1-Ø
2
L1-1
4
L1-2
6
L1-3
8
L1-4
1Ø
L1-5
12
L1-6
14
L1-7
16
O:0008/00
O:0008/01
O:0008/02
O:0008/03
O:0008/04
O:0008/05
O:0008/06
O:0008/07
1
3
5
7
9
11
13
15
OUT-Ø
OUT-1
OUT-2
OUT-3
OUT-4
OUT-5
OUT-6
OUT-7
O:0008/00
O:0008/01
O:0008/02
O:0008/03
O:0008/04
O:0008/05
O:0008/06
O:0008/07
CR65
A1
A2
420107
CR66
420111
CR67
420115
CR68
420119
CR69
420123
CR70
420127
CR71
420131
CR72
420135
CR65
11
14
420107
CR66
420111
CR67
420115
CR68
420119
CR69
420123
CR70
420127
CR71
420131
CR72
420135
120VAC
to 420145
N
to 420145


from 420144
120VAC
400203A
RØ/S8
from 420144
N
400142A
420145
420146
420147
420148
420149
420150
420151
420152
420153
420154
420155
420156
420157
420158
420159
420160
420161
420162
420163
420164
420165
420166
420167
420168
420169
420170
420171
420172
420173
420174
420175
420176
420177
420178
420179
420180
420181
420182
420183
420184
420185
420186
420187
420188
WA3302_PMP_9404_8_MC
FERRIC SULFATE FEED PUMP
TO RAPID MIX BASIN NO. 8
MOTOR PUMP RUN COMMAND
WA3302_GFD_9502_1_IA
AMMONIATOR NO. 1
AUTO/MANUAL SELECT
WA3302_GFD_9502_2_IA
AMMONIATOR NO. 2
AUTO/MANUAL SELECT
WA3302_GFD_9502_3_IA
AMMONIATOR NO. 3
AUTO/MANUAL SELECT
WA3302_GFD_9502_4_IA
AMMONIATOR NO. 4
AUTO/MANUAL SELECT
WA3302_GFD_9502_5_IA
AMMONIATOR NO. 5
AUTO/MANUAL SELECT
WA3302_GFD_9502_6_IA
AMMONIATOR NO. 6
AUTO/MANUAL SELECT
WA3302_GFD_9502_7_IA
AMMONIATOR NO. 7
AUTO/MANUAL SELECT
L1-8
18
L1-9
2Ø
L1-1Ø
22
L1-11
24
L1-12
26
L1-13
28
L1-14
3Ø
L1-15
32
L1-15
34
O:0008/08
O:0008/09
O:0008/10
O:0008/11
O:0008/12
O:0008/13
O:0008/14
O:0008/15
17
19
21
23
25
27
29
31
OUT-8
OUT-9
OUT-1Ø
OUT-11
OUT-12
OUT-13
OUT-14
OUT-15
O:0008/08
O:0008/09
O:0008/10
O:0008/11
O:0008/12
O:0008/13
O:0008/14
O:0008/15
CR73
A1
A2
420151
CR74
420155
CR75
420159
CR76
420163
CR77
420167
CR78
420171
CR79
420175
CR8Ø
420179
CR73
11
14
420151
CR74
420155
CR75
420159
CR76
420163
CR77
420167
CR78
420171
CR79
420175
CR8Ø
420179


430501
430502
430503
430504
430505
430506
430507
430508
430509
430510
430511
430512
430513
430514
430515
430516
430517
430518
430519
430520
430521
430522
430523
430524
430525
430526
430527
430528
430529
430530
430531
430532
430533
430534
430535
430536
430537
430538
430539
430540
430541
430542
430543
430544
from 400253
400230A
ØV
from 400253
400253
+24VDC
AB
1756-IF6I
RACK Ø
SLOT 13
6PT ANALOG INPUTS
RØ/S13
PHOENIX CONTACT
2838186
WA3301T-9405-1
E+H
80E08-AAASAARABAAA
Ø-210 GPH
SU13
430505
I:0013/00-
TS:RØS13
1
25A
2
3
4
I:0013/00+
I:0013/00-
IN-Ø/1
3
I:0013/00
WA3301_FIT_9405_1_FI
FERRIC SULFATE FEED FLOW
(NORTH INJECTION POINT)
IN-Ø/V
1
RET-Ø
5
PHOENIX CONTACT
2838186
WA3301T-9405-2
E+H
80E08-AAASAARABAAA
Ø-210 GPH
SU14
430514
I:0013/01-
TS:RØS13
5
25A
6
7
8
I:0013/01+
I:0013/01-
IN-1/I
4
I:0013/01
WA3301_FIT_9405_2_FI
FERRIC SULFATE FEED FLOW
(SOUTH INJECTION POINT)
IN-1/V
2
RET-1
6
PHOENIX CONTACT
2838186
WA3302T-9105-1
E+H
53H15-RBBB1RAØBAAB
Ø-22 GPH
SU15
430523
I:0013/02-
TS:RØS13
9
25A
10
11
12
I:0013/02+
I:0013/02-
IN-2/I
9
I:0013/02
WA3302_FIT_9105_1_FI
FLUORIDE FEED FLOW 1
STILLING WELL
IN-2/V
7
RET-2
11
PHOENIX CONTACT
2838186
WA3302-PMP-9104-1
440305
SU16
430531
I:0013/03+
TS:RØS13
13
25A
14
15
16
I:0013/03+
I:0013/03-
IN-3/I
10
I:0013/03
WA3302_PMP_9104_1_SI
FLUORIDE FEED PUMP
SPEED FEEDBACK
IN-3/V
8
RET-3
12


RØ/S13
WA3301T-9705-1
E+H
53H15-RBBB1RAØBAAB
Ø-23 GPH
+
–
PHOENIX CONTACT
2838186
1
2
G
SU17
3
4
430605
I:Ø013/Ø4–
TS:RØS13
17
25A
18
19
20
I:Ø013/Ø4+
I:Ø013/Ø4–
IN-4/I
I:Ø013/Ø4
17
IN-4/V
15
RET-4
19
WA3301_FIT_9705_1_FI
POLYMER FEED FLOW 1
STILLING WELL
WA3302T-9705-1
E+H
53H15-SBBB1RAØBAAB
PHOENIX CONTACT
2838186
SU18
430614
I:Ø013/Ø5–
TS:RØS13
21
22
23
24
I:Ø013/Ø5+
I:Ø013/Ø5–
IN-5/I
I:Ø013/Ø5
18
IN-5/V
16
RET-5
20
WA3302_FIT_9705_1_FI
PLANT II LIME FEED FLOW
STILLING WELL

AB
1756-OF6CI
RACK 1
SLOT 4
6PT ANALOG OUTPUT
R1/S4

WA3301_PMP_9104_1_SC
FLUORIDE FEED PUMP NO. 1
SPEED CONTROL

O:0104/00
OUT-0 1
ALT-0 3
RTN-0 5

O:0104/00+
O:0104/00-

TS:R1S4
1
.25A
2
3

440105

PHOENIX CONTACT
2838186
3
4
SU49
1
2
G

+
-

WA3301-PMP-9104-1
0-100%

WA3301_PMP_9704_1_SC
POLYMER FEED PUMP
SPEED CONTROL

O:0104/01
OUT-1 2
ALT-1 4
RTN-1 6

O:0104/01+
O:0104/01-

TS:R1S4
4
.25A
5
6

440115

PHOENIX CONTACT
2838186
3
4
SU50
1
2
G

+
-

WA3301-PMP-9704-1

WA3301_PMP_9404_1_SC
FERRIC SULFATE FEED PUMP
1N SPEED CONTROL
(NORTH INJECTION POINT)

O:0104/02
OUT-2 7
ALT-2 9
RTN-2 11

O:0104/02+
O:0104/02-

TS:R1S4
7
.25A
8
9

440125

PHOENIX CONTACT
2838186
3
4
SU51
1
2
G

+
-

WA3301-PMP-9404-1

WA3301_PMP_9404_2_SC
STANDBY FERRIC SULFATE
FEED PUMP NS
SPEED CONTROL
(NORTH INJECTION POINT)

O:0104/03
OUT-3 8
ALT-3 10
RTN-3 12

O:0104/03+
O:0104/03-

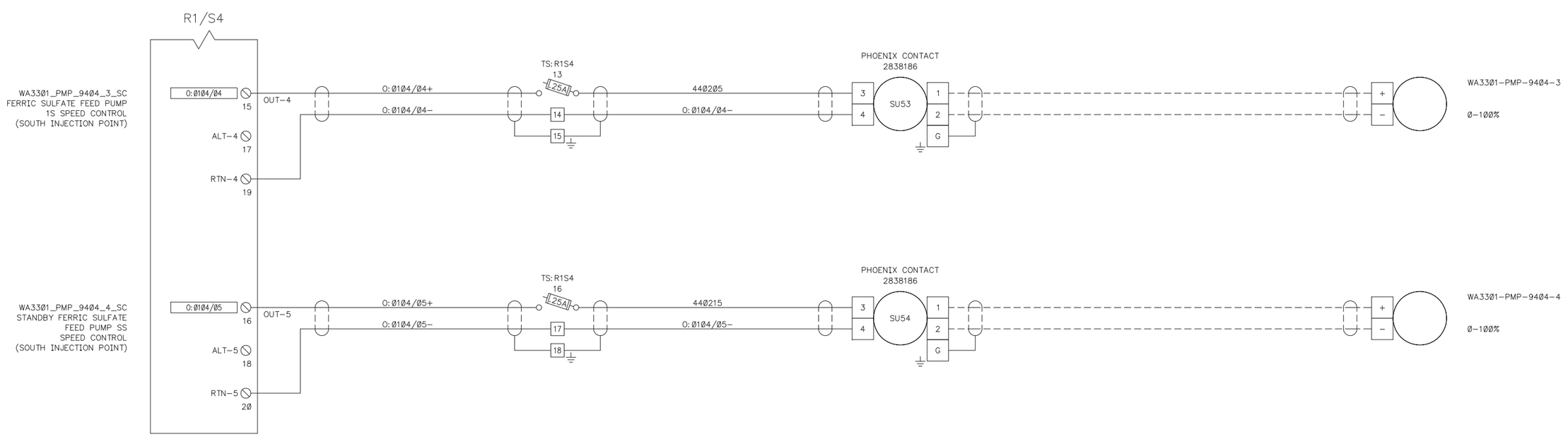
TS:R1S4
10
.25A
11
12

440135

PHOENIX CONTACT
2838186
3
4
SU52
1
2
G

+
-

WA3301-PMP-9404-2


R1/S4
WA3301_PMP_9404_3_SC
FERRIC SULFATE FEED PUMP
1S SPEED CONTROL
(SOUTH INJECTION POINT)
O:0104/04
15
OUT-4
ALT-4
17
RTN-4
19
O:0104/04+
O:0104/04-
TS:R1S4
13
25A
14
15
440205
O:0104/04-
PHOENIX CONTACT
2838186
3
4
SU53
1
2
G
+
-
WA3301-PMP-9404-3
0-100%
WA3301_PMP_9404_4_SC
STANDBY FERRIC SULFATE
FEED PUMP SS
SPEED CONTROL
(SOUTH INJECTION POINT)
O:0104/05
16
OUT-5
ALT-5
18
RTN-5
20
O:0104/05+
O:0104/05-
TS:R1S4
16
25A
17
18
440215
O:0104/05-
PHOENIX CONTACT
2838186
3
4
SU54
1
2
G
+
-
WA3301-PMP-9404-4
0-100%

END OF SECTION

JACOBS **INSTRUMENT CALIBRATION SHEET** Rev.06.05.92

COMPONENT	MANUFACTURER	PROJECT
Code:	Name:	Number:
Name:	Model:	Name:
	Serial #:	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N
Indicate? Y / N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
Record? Y / N	Scale:				SWITCH? Y / N Unit Range: Differential: fixed/adjustable Reset? automatic / manual
Transmit/ Convert? Y / N	Input:				
	Output:				

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
Input	Indicated	Output	Increasing Input		Decreasing Input	
			Indicated	Output	Indicated	Output
CONTROL MODE SETTINGS:			P:	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			AS CALIBRATED		**Note No.**
Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
	(note rising or falling)		(note rising or falling)		
1.					
2.					
3.					
4.					
5.					
6.					
7.					

#	**NOTES:**

Component Calibrated and Ready for Startup

By:

Date:

Tag No.:

JACOBS

INSTRUMENT CALIBRATION SHEET

EXAMPLE - ANALYZER/TRANSMITTER

Rev.06.05.92

COMPONENT	MANUFACTURER	PROJECT
Code: *A7*	Name: *Leeds & Northrup*	Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Name: *UOSA AWT PHASE 3*
	Serial #: *11553322*	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
Convert? Y	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
Input	Indicated	Output	Increasing Input		Decreasing Input	
			Indicated	Output	Indicated	Output
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			AS CALIBRATED		Note
Number	Trip Point (note rising or falling)	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.	**No**
1.	*N.A.*		*N.A.*		
2.					*1.*
3.					
4.					
5.					
6.					
7.					

#	**NOTES:**
	1. Need to recheck low pH calibration solutions.

Component Calibrated and Ready for Startup

By: *J.D. Sewell*

Date: *Jun-6-92*

Tag No.: AIT-12-6[pH]

JACOBS **I&C SLUDGE GATE ADJUSTMENT SHEET** Rev.06.05.92

PARTS	Project Name:	Project Number:
Body	Type:	Mfr:
	Size:	Model:
	Line Connection:	Serial #:
Operator	Type:	Mfr:
	Action:	Model:
	Travel:	Serial #:
Positioner	Input Signal:	Mfr:
	Action:	Model:
	Cam:	Serial #:
Pilot	Action:	Mfr:
Solenoid	Rating:	Model:
		Serial #:
I/P	Input:	Mfr:
Converter	Output:	Model:
	Action:	Serial #:
Position	Settings:	Mfr:
Switch	Contacts:	Model:
		Serial #:
Power	Type:	Air Set Mfr:
Supply	Potential:	Model:
		Serial #:

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set			Gate Action		
Positioner			Installation		
Position Switches			Wire Connection		
I/P Converter			Tube Connection		
Actual Speed					

REMARKS:	**Valve Ready for Startup**
	By:
	Date:
	Tag No.:

JACOBS **I&C VALVE ADJUSTMENT SHEET** Rev.06.05.92

EXAMPLE

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear - Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot Solenoid	Action:	Mfr:
	Rating: *None*	Model:
		Serial #:
I/P Converter	Input: *4-20 mA dc*	Mfr: *Taylor*
	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position Switch	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power Supply	Type: *Pneumatic*	Air Set Mfr: *Air Products*
	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Startup**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** ***Rev.06.05.92***

Project Name:	Project No.:
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.	

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Acceptance Test	By	Date	
Performed			
Witnessed			Loop No.:

JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** **Rev.06.05.92**

EXAMPLE

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

Demonstration Test(s): For each functional requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. *Jun-20-92 BDG*

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*

Vary H and observe that following.

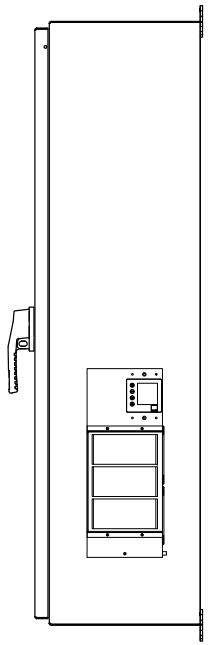
2.a Reading of FIT indicator. *Jun-6-92 BDG*

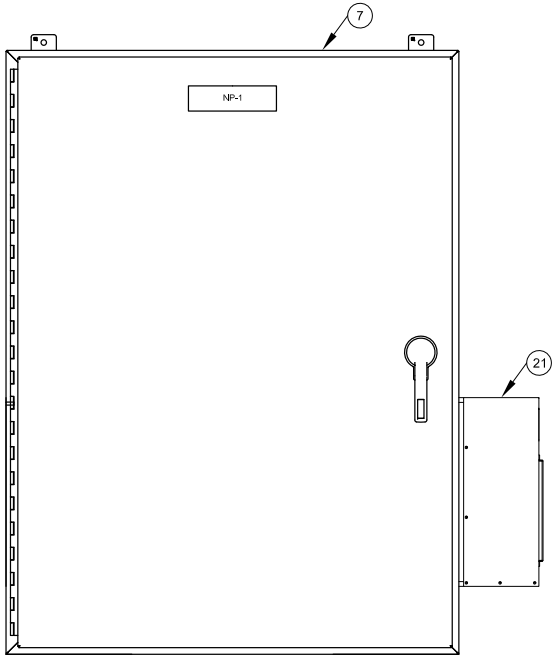
2.b Reading is transmitted to FI on LP-521-1. *Jun-6-92 BDG*

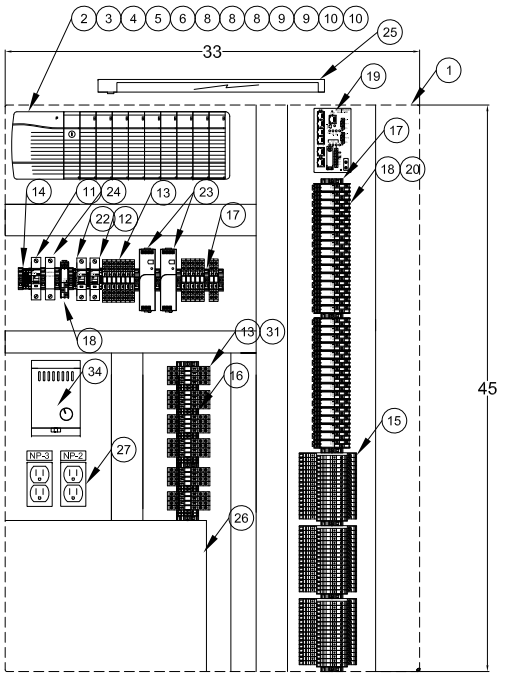
2.c Reading is transmitted and displayed to CCS. *Jun-6-92 BDG*

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Acceptance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B.deGlanville*	*Jun-6-92*	Loop No.: *30-12*







ADD 1 IN R=5 INSULATING SHEATHING TO INSIDE TOP, LEFT SIDE AND RIGHT SIDE. ADD 1/2 IN R=3 SHEATHING TO BACK.. NO SHEATHING WILL BE ADDED TO THE DOOR OR BOTTOM. ALUMINUM TAPE ADDED TO THE SEAMS.

SLUDGE PUMP STATION 2 PANEL	4			DRAWING:	24381-SLUDGE STA 2 PANEL
	3			PROJECT #: 24381	DATE SAVED: 6/28/18
	2	AS BUILT	6/28/18	PROJECT:	A.B. JEWELL - SYSTEM UPGRADE
	1	REVISED	12/1/17		CITY OF TULSA, OK.
	NO.	REVISION	DATE		

SHEET	DRWN:	CHKD:	APPR:	SCALE:
172/221	EL	SM	KH	NONE

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BILL OF MATERIALS (BOM)				
ITEM	QUANITY	MANUFACTURER	PART #	DESCRIPTION
1	1	HOFFMAN	A48H36DLP3PT	48X36 ENCLOSURE, SS
2	1	HOFFMAN	A48P36	48X36 SUBPANEL
3	1	ALLEN BRADLEY	1756-A10	10 SLOT CHASSIS
4	1	ALLEN BRADLEY	1756-PA75	AC POWER SUPPLY, 10AMP
5	1	ALLEN BRADLEY	1756-L73	PROCESSOR
6	1	ALLEN BRADLEY	1756-EN2TR	COMMUNICATION MODULE
7	1	ALLEN BRADLEY	1756-IF16	16 CHANNEL SINGLE END ANALOG INPUT CARD
8	3	ALLEN BRADLEY	1756-IA16	16 CHANNEL DIGITAL INPUT 120VAC CARD
9	2	ALLEN BRADLEY	1756-OA16	16 CHANNEL DIGITAL OUTPUT 120VAC CARD
10	1	ALLEN BRADLEY	1756-N2	BLANK
11	1	ABB	S201U-K20	CIRCUIT BREAKER, 20A
12	1	ABB	S201U-K5	CIRCUIT BREAKER, 5A
13	A/R	ABB ENTRELEC	0115.604.21	DOUBLE STACK FUSED TERMINAL BLOCK
14	A/R	ABB ENTRELEC	0115.116.17	SCREWDOWN TERMINAL BLOCK
15	A/R	ABB ENTRELEC	0115.490.13	DOUBLE STACK TERMINAL BLOCK
16	A/R	ABB ENTRELEC	0115.113.16	GROUNDING TERMINAL BLOCK
17	A/R	ABB ENTRELEC	0399.903.02	END BLOCK
18	33	ALLEN BRADLEY	700-HLT12U1	120VAC RELAY, DPDT
19	1	ALLEN BRADLEY	1783-BMS06SGL	ETHERNET SWITCH, MANAGED
20	33	ALLEN BRADLEY	700-TBR2110	120VAC RELAY, DPDT
21	1	ICEQUBE	IQ1000MML-SS	120VAC 1000 BTU WITH STAINLESS STEEL HOUSING
22	1	ABB	S201U-K15	CIRCUIT BREAKER, 15A
23	2	ALLEN BRADLEY	1606-XLE	24VDC POWER SUPPLY
24	1	MERSEN	ST1201PG	120VAC SURGE SUPPRESSION, TVSS
25	1	STEGO	02540.1-00 / 244631	LED LIGHT WITH MANUAL SWITCH / LIGHT POWER CABLE
26	1	EATON	5S1500LCD	UPS, 1500VA
27	2	LEVITON	M24-5320-WMP	ELECTRICAL CONVENIENCE OUTLET
28	A/R	PANDUIT	F2X3WH6 / C2WH6	2" X 3" WIRE DUCT, WHITE / WIRE DUCT COVER
29	A/R	PANDUIT	F3X3WH6 / C3WH6	3" X 3" WIRE DUCT, WHITE / WIRE DUCT COVER
30				NOT USED
31	A/R	LITTELFUSE	0235.500HXP	500m AMP FAST BLOW FUSE
32	A/R	LITTELFUSE	0235001HXP	1 AMP FAST BLOW FUSE
33	A/R	LITTELFUSE	0235003HXP	3 AMP FAST BLOW FUSE
34	1	HOFFMAN	DAH1001A	100W / 120V HEATER WITH THERMOSTAT

NAMEPLATE SCHEDULE		
NAMEPLATE	SIZE	DESCRIPTION
NP-1	1" X 6"	SLUDGE PUMP STATION 2 PLC
NP-2	.75" X 2"	MAX 5A
NP-3	.75" X 2"	UPS ONLY

WIRE COLOR SCHEDULE		
16 AWG (MIN.) STRANDED, TYPE MTW		
WIRE COLOR	DESCRIPTION	WIRE SIZE
BLACK	120VAC POWER	#16 AWG (MIN.) STRANDED, TYPE MTW
RED	120VAC CONTROL	#16 AWG (MIN.) STRANDED, TYPE MTW
GREEN	GROUND	#16 AWG (MIN.) STRANDED, TYPE MTW
WHITE	120VAC NEUTRAL	#16 AWG (MIN.) STRANDED, TYPE MTW
BLUE	24VDC+	#16 AWG (MIN.) STRANDED, TYPE MTW
BLUE / WHT STRIPE	24VDC-	#16 AWG (MIN.) STRANDED, TYPE MTW
WHT +, BLK -	ANALOG SIGNAL	#18 AWG (MIN.) TWISTED, SHIELDED PAIR
RED +, BLK -	ANALOG SIGNAL	#18 AWG (MIN.) TWISTED, SHIELDED PAIR

Use New I/O Cards [Analog output and digital input cards] in slots

ALLEN BRADLEY RIO LAYOUT - 10 SLOT CHASSIS PART# 1756-A10											
SLOT		0	1	2	3	4	5	6	7	8	9
PART NO.	1756-PA75	1756-L73	1756-EN2TR	1756-IF16	1756-IA16	1756-IA16	1756-IA16	1756-OA16	1756-OA16	1756-N2	1756-N2
TYPE	PS	PROCESSOR	COMM	16 CH AI	16 CH DI	16 CH DI	16 CH DI	16 CH DO	16 CH DO	BLANK	BLANK

Use spare Slots for additional I/Os

SLUDGE PUMP STATION 2 BOM	4			DRAWING:	24381-SLUDGE STA 2 BOM
	3			PROJECT #: 24381	DATE SAVED: 6/28/18
	2	AS BUILT	6/28/18	PROJECT:	A.B. JEWELL - SYSTEM UPGRADE CITY OF TULSA, OK.
	1	REVISED	12/1/17		
	NO.	REVISION	DATE		
SHEET 173/221 | DRWN: EL | CHKD: SM | APPR: KH | SCALE: NONE					

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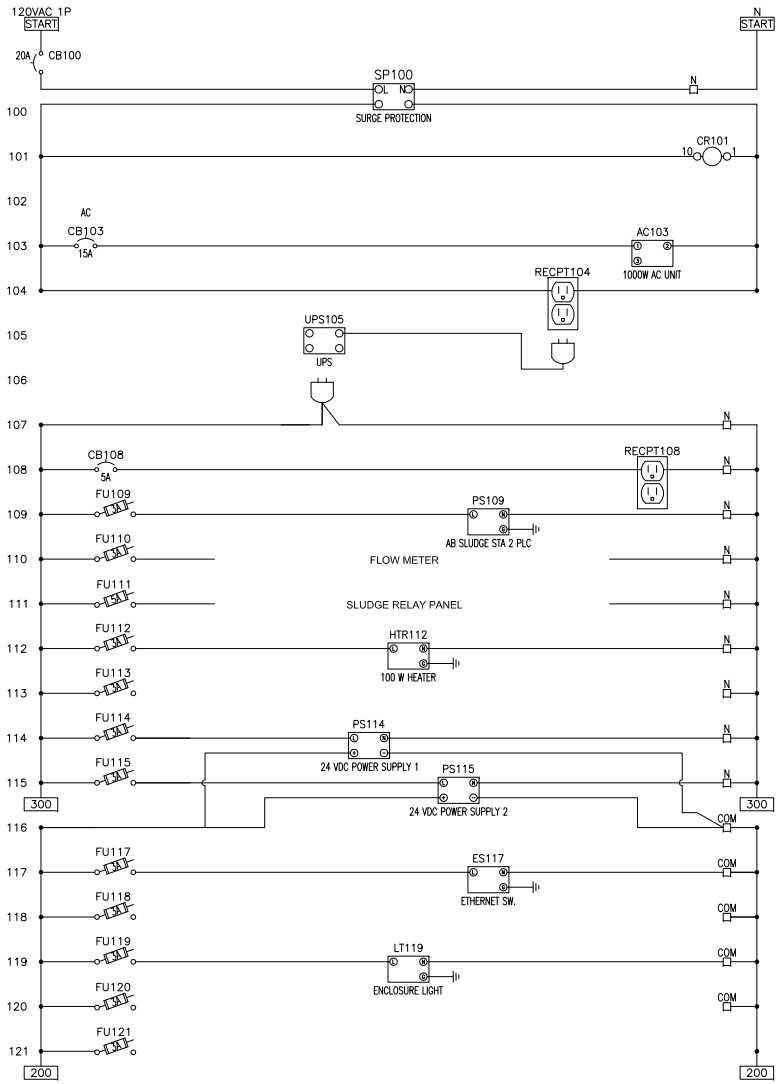

SLUDGE PUMP STATION 2 POWER				4			DRAWING: 24381-SLUDGE STA 2 POWER
				3			PROJECT #: 24381 DATE SAVED: 6/28/18
SHEET	DRWN:	CHKD:	APPR:	SCALE:	2	AS BUILT	6/28/18
174/221	EL	SM	KH	NONE	1	REVISED	12/1/17
					NO.	REVISION	DATE

PROJECT: A.B. JEWELL - SYSTEM UPGRADE
CITY OF TULSA, OK.

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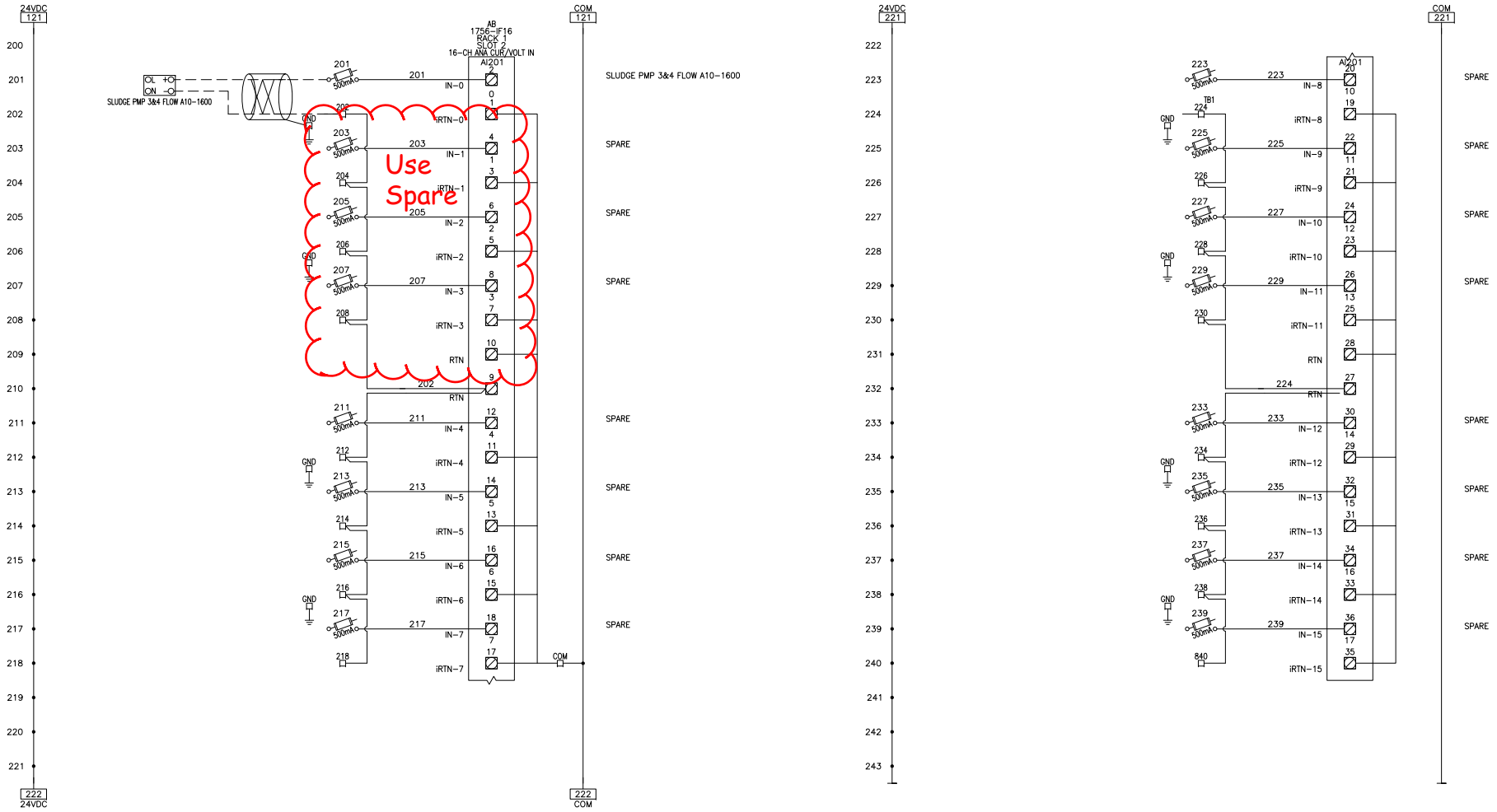
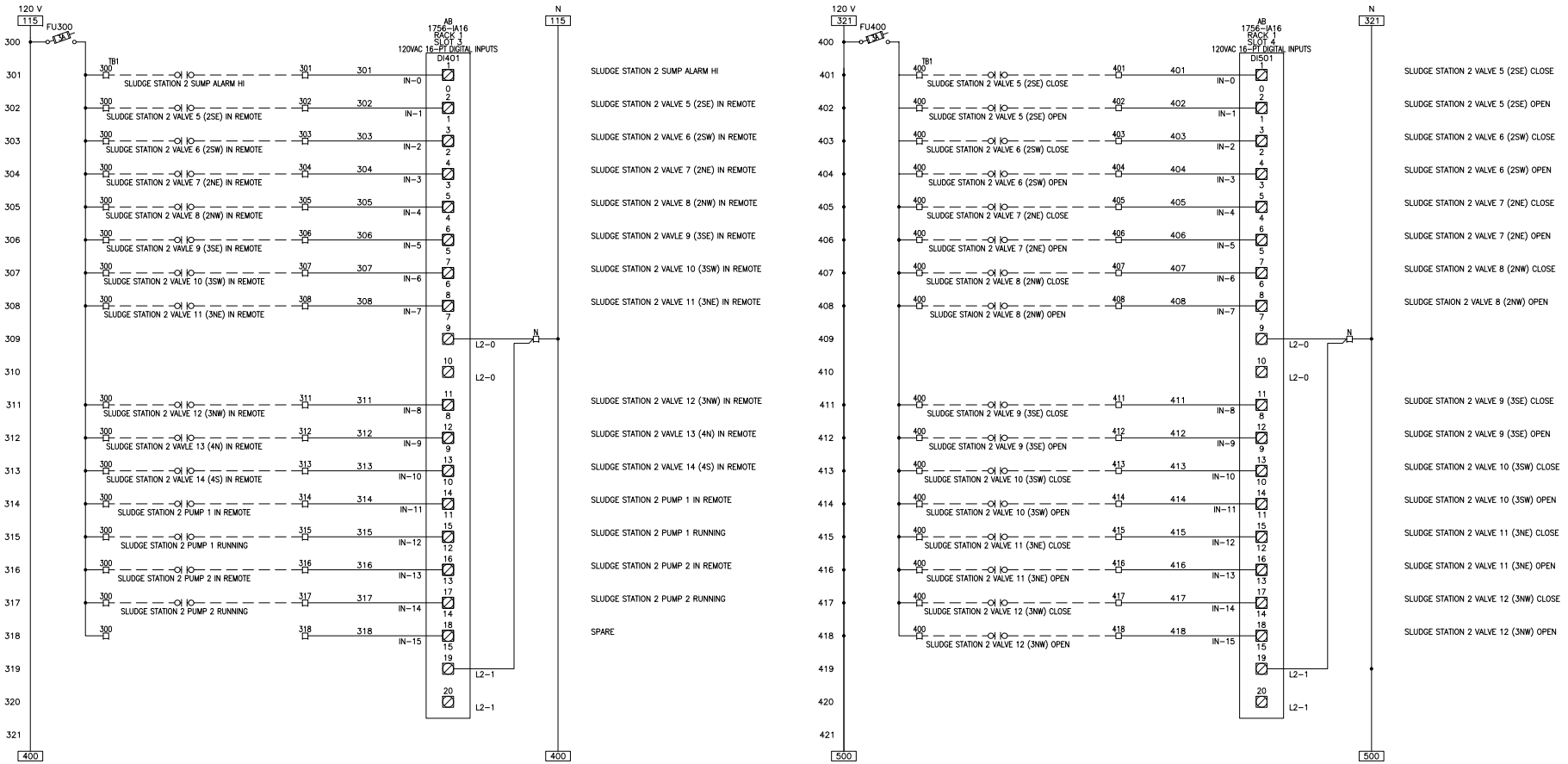


SLUDGE PUMP STATION 2 ANALOG INPUT R0 S2	4			DRAWING: 24381-SLUDGE STA 2 AI 0 02	A. W. SCHULTZ INC. 6861 MARTINDALE, SHAWNEE, KS 66218 PHONE (913)307-0399 FAX (913)307-0452	AWS
SHEET 175/221 | DRWN: EL | CHKD: SM | APPR: KH | SCALE: NONE	3			PROJECT #: 24381 DATE SAVED: 6/28/18		
	2	AS BUILT	6/28/18	PROJECT: A.B. JEWELL - SYSTEM UPGRADE CITY OF TULSA, OK.		
	1	REVISED	12/1/17			
	NO.	REVISION	DATE			



SLUDGE PUIMP STATION 2 DISCRETE INPUT R0 S3 & S4					4		
					3		
					2	AS BUILT	6/28/18
					1	REVISED	12/1/17
					NO.	REVISION	DATE
SHEET: 176/221	DRWN: EL	CHKD: SM	APPR: KH	SCALE: NONE			

DRAWING: 24381-SLUDGE STA 2 DI 0 0304
PROJECT #: 24381 DATE SAVED: 6/28/18
PROJECT: A.B. JEWELL - SYSTEM UPGRADE
CITY OF TULSA, OK.

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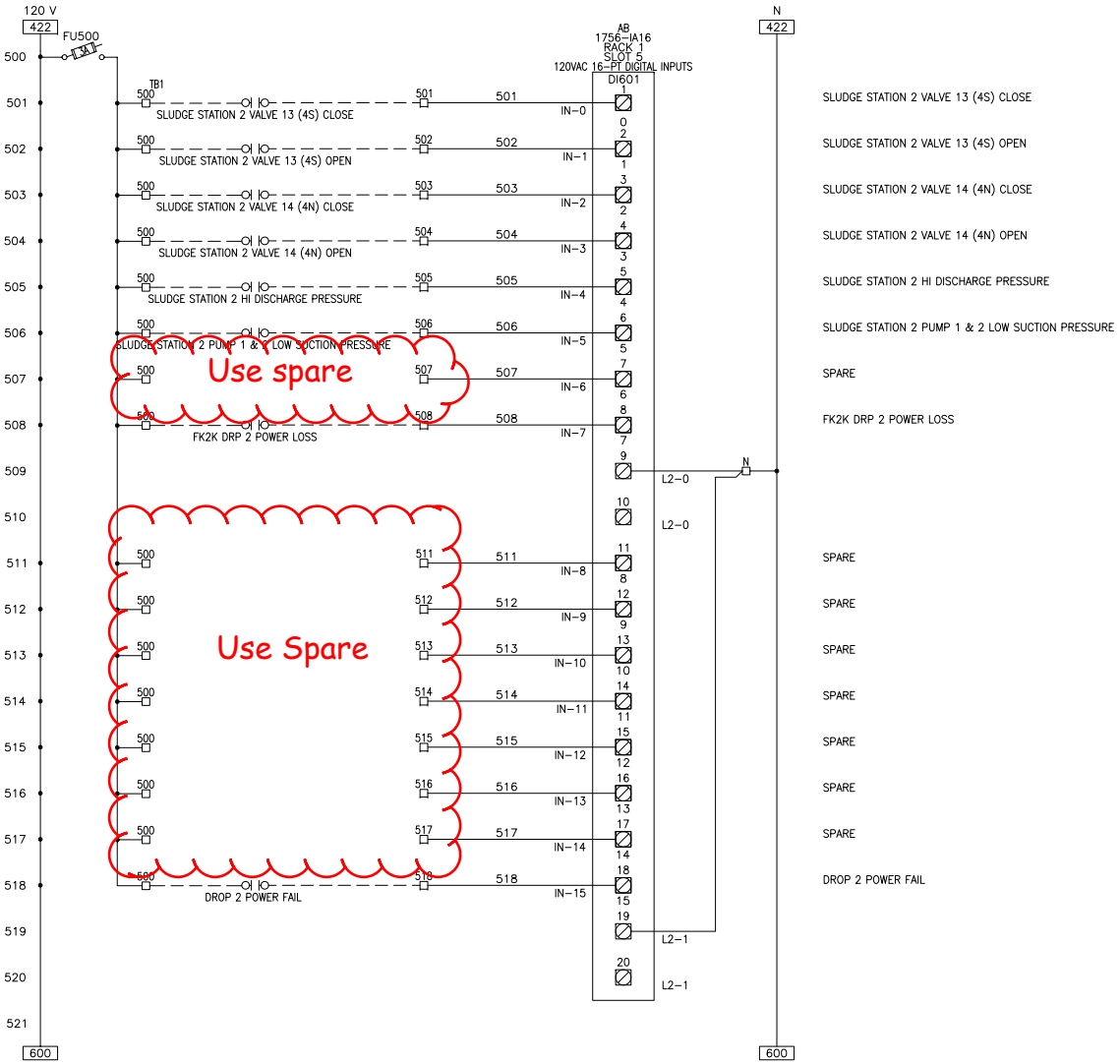
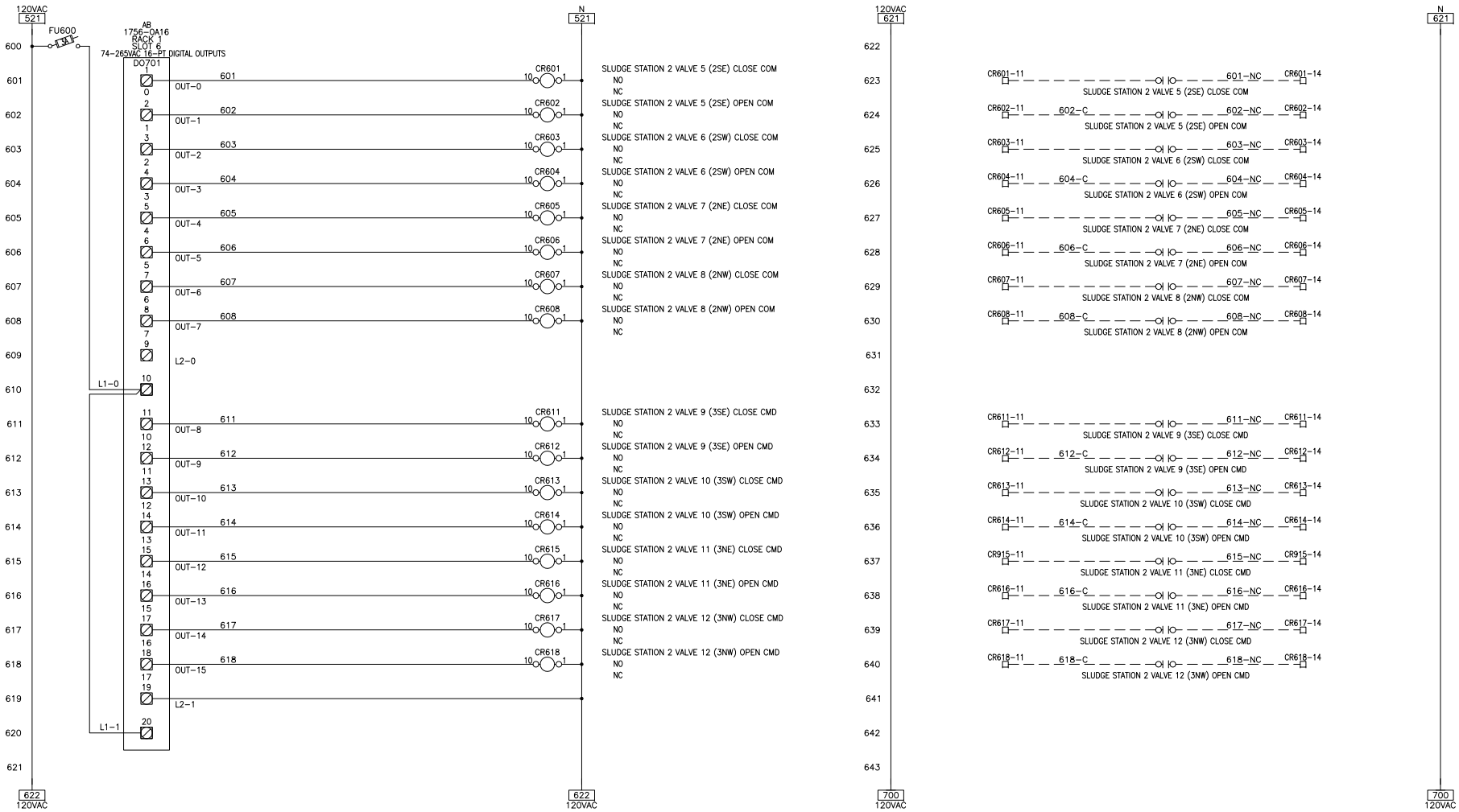


SLUDGE PUMP STATION 2 DISCETE INPUT R0 S5	4			DRAWING: 24381-SLUDGE STA 2 DI 0 05	A. W. SCHULTZ INC. 6861 MARTINDALE, SHAWNEE, KS 66218 PHONE (913)307-0399 FAX (913)307-0452
	3			PROJECT #: 24381 DATE SAVED: 6/28/18	
	2	AS BUILT	6/28/18	PROJECT: A.B. JEWELL - SYSTEM UPGRADE CITY OF TULSA, OK.	
	1	REVISED	12/1/17		
SHEET 177/221 DRWN: EL CHKD: SM APPR: KH SCALE: NONE	NO.	REVISION	DATE		



SLUDGE PUMP STATION 2	4			DRAWING:	24381-SLUDGE STA 2 DO 0 06
DISCRETE OUTPUT R0 S6	3			PROJECT #: 24381	DATE SAVED: 6/28/18
SHEET 178/221 | DRWN: EL | CHKD: SM | APPR: KH | SCALE: NONE	2	AS BUILT	6/28/18	PROJECT: A.B. JEWELL - SYSTEM UPGRADE CITY OF TULSA, OK.	
	1	REVISED	12/1/17		
	NO.	REVISION	DATE		

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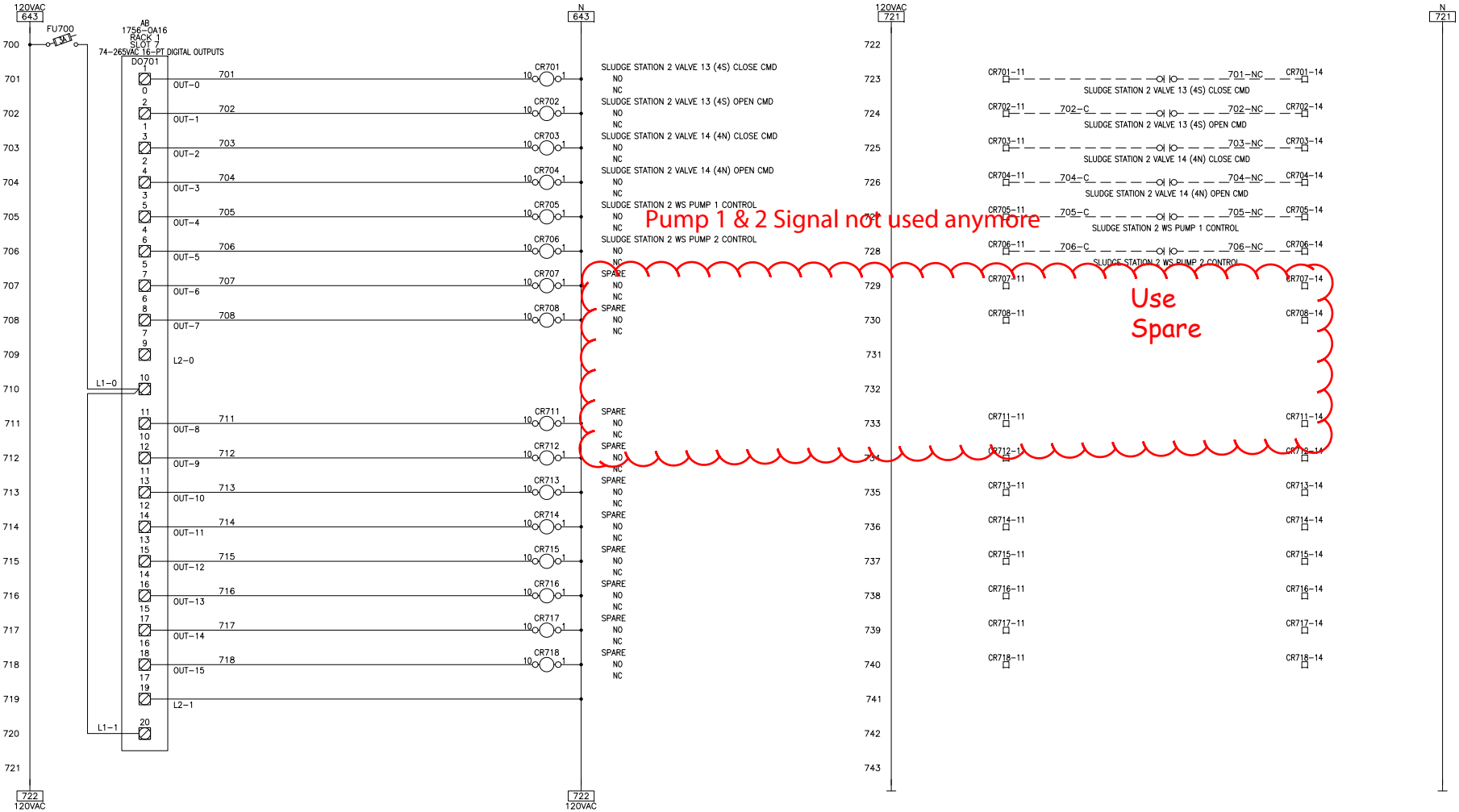

SLUDGE PUMP STATION 2 DISCRETE OUTPUT R0 S7					4			DRAWING: 24381-SLUDGE STA 2 DO 0 07
					3			PROJECT #: 24381 DATE SAVED: 6/28/18
SHEET	DRWN:	CHKD:	APPR:	SCALE:	2	AS BUILT	6/28/18	PROJECT: A.B. JEWELL - SYSTEM UPGRADE CITY OF TULSA, OK.
179/221	EL	SM	KH	NONE	1	REVISED	12/1/17	
					NO.	REVISION	DATE	

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SECTION 41 22 23.19
MONORAIL HOISTS

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI): MH27.1, Underhung Cranes and Monorail Systems.
2. American Society of Mechanical Engineers (ASME):
   a. B30.10, Hooks.
   b. B30.11, Monorails and Underhung Cranes.
   c. HST 1M, Performance Standard for Electric Chain Hoists.
   d. HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.
   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).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Occupational Safety and Health Act (OSHA).
6. UL: 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN REQUIREMENTS

A. Monorail System: Specifications for Underhung Cranes and Monorail Systems, ANSI MH27.1 and ASME B30.11.

B. Hoist: ASME B30.11, Hoist Manufacturers' Institute.

C. Trolley: ANSI MH27.1.

D. Wire Rope Hoist Service Class: ASME HST 4M.

E. Hook: ASME 30.10.

F. Stress and Safety Factors: ANSI MH27.1 and ASME B30.11. Properly select materials of construction for stresses to which subjected.

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. Power and control wiring diagrams, including terminals and numbers.
   d. Motor nameplate data in accordance with NEMA MG 1, and include any motor modifications.
   e. Factory standard two part epoxy system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer’s Certification of Compliance that factory finish system is identical to requirements specified herein.
3. Factory Functional Test Report.
4. 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.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
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.

1.04 WARRANTY

A. Provide as specified in Section 01 61 00, Common Product Requirements.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Maximum 104 degrees F; minimum 40 degrees F.

B. Humidity: 30 percent to 90 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 are required, hoist and trolley manufacturers to furnish a coordinated operating system.

2.02 SUPPLEMENTS

A. See supplements to this section for additional requirements.

2.03 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 trolley drive shaft, driven by an electric motor through a gear reduction unit.

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. 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.

F. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.11.

2.04 HOIST

A. 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 double reeved hoist as specified on Supplements at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.

B. 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.

C. 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.

D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.

2.05 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. Furnish motors compatible with adjustable frequency, variable speed, drive system, 6 to 1 speed range, suitable for trolley applications. Controls with 120V ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 4 enclosure, and supplied with 200 percent overcurrent protection.

1. Manufacturers:
   a. ACE Industries.
   b. Wright.
   c. “Or-equal.”

D. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.

E. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.06 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 4X enclosure.

C. Trolley Drives: 460/230V ac series device, installed between drive motor and motor starter with torque and acceleration rate adjustable, suitable for trolley drive service, and work in conjunction with pendant system.

D. Pendant Pushbutton Control Stations: Heavy-duty, oiltight, suspended from trolley, 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. Furnish control station buttons for control of hoist and trolley ON/OFF main line contactor power switch which removes all power from control station.

E. Control motions indicate direction of resultant monorail motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway monorail situations.

2.07 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.

2.08 FACTORY FINISHING

A. Prepare and prime coat in accordance with manufacturer's standard.

2.09 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 on all equipment 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 trolley system.
2. Load tests in compliance with OSHA, ASME B30.11, and ANSI MH27.1.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 1 person-day for installation assistance and inspection.
   b. 1/2 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1/2 person-day for facility startup.

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

3.04 SUPPLEMENTS

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

1. Hoist/Monorail Data Sheet M-0102.
2. Hoist/Monorail Dimension Sheet M-0102.
3. Induction Motor Data Sheet M-0102.

END OF SECTION

HOIST/MONORAIL DATA SHEET

Project: A.B. Jewell WTP Clarifier 2 and 3 Improvements
Manufacturer.: Ace Gaffey
Owner: Tulsa Metropolitan Utility Authority
Model No.:
Service: Sludge Pump Replacement and Maintenance
Number of Units: 2
Equip. Tag Number(s): M-0102
Rev/Date/By: /_____/_____/_____

GENERAL REQUIREMENTS

Equipment Capacity: 1 tons
Method of Control: Pendant
Location of Control: Hanging from trolley
Equipment Location:
☒Indoors ☐Outdoors

Factory Testing:
☒Required ☐Not Required
Field Testing: ☐Not required
☒Required, functional and performance

Power Supply:
Voltage 460
Phase 3
Frequency 60 Hz

HOIST

Type:
☒Electric, Wire Rope ☐Hand Operated, Chain

Service Class (ANSI):
☒H1 (standby) ☐H2 (light) ☐H3 (standard)
☐H4 (heavy) ☐H5 (severe)

Speed (fpm): 5 to 20
☐Constant Speed ☒Two Speed ☐Variable Speed

Motor hp: 5 (max)

Hook: See Hoist/Monorail Dimension Sheet

Hook Manufacturer: Manufacturer Recommended

Reeving:

TROLLEY

Type:
☐Top Running ☒Underhung

Service Class (ANSI):
☒A1 (standby) ☐A2 (infrequent) ☐B (light)
☐C (moderate) ☐D (heavy)

Speed (fpm): 17 to 50
☐Constant Speed ☒Variable Speed ☐Hand Operated

Motor hp: 1/2 (max)

Electric Conductors:
☐Bus Bar ☒Festoon ☐
☐Cable Reel

SPECIAL REQUIREMENTS

Accessories:
☒Central Lubrication System
☒OSHA operating and safety devices

Remote Controls:
☐Infrared, line-of-sight
☐Frequency modulated (FM)
Manufacturer:
☐Extended Grease Fittings

Special Electrical Requirements:

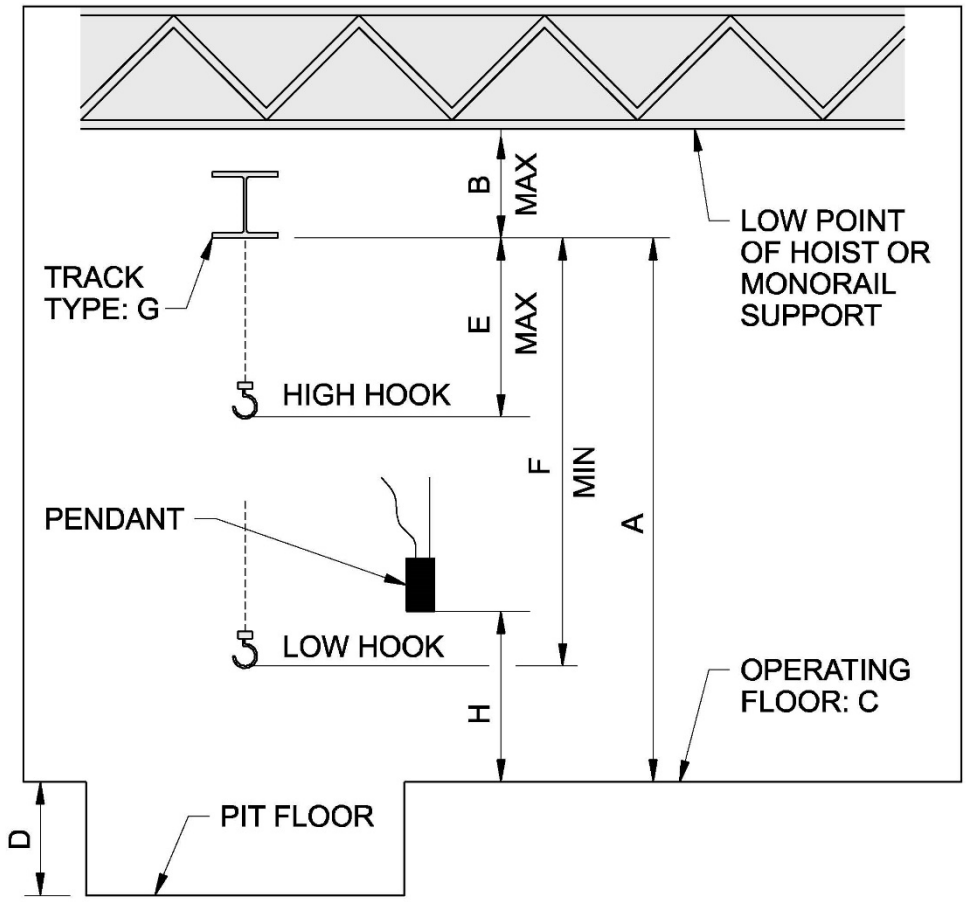
See Hoist/Monorail Dimension Sheet for clearances, lift distances, and details.

HOIST/MONORAIL DIMENSION SHEET
Building Clearances for Monorail Cranes

Project: A.B. Jewell WTP Clarifier 2 and 3 Improvements

Owner: Tulsa Metropolitan Utility Authority

Equipment Tag Number(s): M-0102



A: See drawing
B: See drawing
C: EL: 636.00 ft
D: N/A
E: 2’-0”
F: 16’-0”
G: See Drawings
H: 4’-0”

Notes:

1. Monorail Track Length: 18’-0”

INDUCTION MOTOR DATA SHEET

Project: A.B. Jewell WTP Clarifier 2 and 3 Improvements

Owner: Tulsa Metropolitan Utility Authority

Equipment Name: Sludge Pump Hoist

Equipment Tag Number(s): M-0102

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: 5 (max)

Voltage: 460

Phase: 3

Frequency: 60-Hz

Synchronous Speed: _____ rpm

☐ Thermal Protection: _____

☐ Space Heater: volts, single-phase

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Enclosure Type: _____

☒ Multispeed, Two-Speed: _____ / _____ rpm

Winding: ☐ One ☐ Two

Mounting Type: ☐ Horizontal ☐ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up _____ Down _____

☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: ☒ See Section 26 05 01, Electrical.

Special Features:

SECTION 43 22 56
RAPID MIXERS

PART 1 GENERAL

1.01 SUMMARY

A. This section covers the work necessary for furnishing and installing, complete with all accessories and appurtenances, four rapid mixers, M-10201, M-10202, M-10301, and M-10302.

1.02 REFERENCES

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

1. American Gear Manufacturers Association: AGMA Standard Practice 420.04.
2. National Electrical Manufacturer's Association: NEMA MG 1-78, Motor and Generators.

B. The following specification sections are to be used in conjunction with this specification, this section shall rule if any discrepancies are encountered:

1. Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
2. Section 40 90 01, Instrumentation and Control for Process Systems, and all associated Supplements for additional Instrumentation and Control Panel requirements.

1.03 SUBMITTALS

A. Shop Drawings:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Detailed calculations to substantiate all components of mixer selections are adequately sized to withstand hydraulic forces during operation.
4. Power and control wiring diagrams including terminals and numbers.
5. Control panel layout drawings, and control schematics.
6. Motor data in accordance with requirements of Section 26 05 01, Electrical.
7. Factory finish system.
8. 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. Special shipping, storage and protection, and handling, restrictions.
3. Manufacturer's printed installation instructions.
4. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
6. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
7. Provide warranty as specified in Specification Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturers:

1. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.
2. Mixers shall be furnished complete with speed reducer, electric motor drive connection through a flexible with guard, baseplate, agitator shaft, and impellers. Mixers shall be manufactured by Chemineer, Mixing Equipment Co., or Philadelphia Gear Co., "or-equal."
3. Safety Devices: The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other federal, state, and local health and safety regulations.

2.02 RAPID MIXERS

A. Provide four mechanical mixers suitable for installation in the rapid mix basins shown on Drawings.

B. The rapid mixer assembly shall consist of a vertical shaft, suspended impeller assembly; a right-angle, geared speed reducer suitable for continuous outdoor operation; variable frequency drive and an inverter duty energy efficient motor. The mechanism shall be designed to develop a high shear mixing environment for rapid mixing of aluminum chlorohydrate into raw water.

C. Speed Reducers:

1. The rapid mixer shall be furnished with a heavy-duty speed reducer of the right-angle type, or approved arrangement, with spiral bevel or helical gears, and combinations thereof specifically designed for continuous outdoor mixer service. Worm gearing is not acceptable. All gears must be contained in a single housing. Gears shall be AGMA Quality 10 minimum.
2. Drive housing shall be constructed of cast iron or welded steel. Fabricated housing must be stress relieved before machining. Housing shall be sufficient rigidity to prevent damaging misalignment when subjected to mixer assembly peak combined torsional, thrust, and bending forces.
3. The mixer gear drive shall be designed such that the gearing is isolated from unbalanced hydraulic loading on the mixing impeller by means of separate impeller shaft bearings located above and below the main drive bearings. The impeller shaft shall pass through the drive's hollow quill drive shaft and shall be connected to that drive shaft by means of a torsionally resilient flexible coupling.
4. The speed reducer shall be suitable for direct connection through a flexible coupling to the electric motor drive. Speed reducers shall be capable of continuous operation in the specified service and shall have a minimum AGMA service factor rating of 1.50 based on motor horsepower.
5. The thermal rating for each reducer must not exceed the design load or proper cooling shall be provided.
6. All shaft bearings shall be antifriction roller or ball bearing type. Output shafts shall be supported by tapered roller bearings. The output shafts antifriction bearings shall be designed for a rated B-10 life of 100,000 hours when operating at full nameplate horsepower. All other bearings in the speed reducer shall be designed for a rated life of 100,000 hours.
7. The basis for computation shall be the bearing manufacturer's published computation methods for determining bearing life for this application.
8. Bearings located outside the reducer's oil supply shall be grease-lubricated and shall be equipped with grease fittings and seals. Other bearings and the reducers' gears shall be lubricated by a constant flow of oil by splash lubrication, an oil slinger, or an oil pump.
9. General maintenance, including, but not limited to, motor changes, gear changes, replacement of all antifriction bearings (except the bearings supporting the output shaft), and the oil system maintenance, shall not require the removal of the speed reducer housing from its foundation.

10. Reducers shall include provisions, in the form of effective drywells, to prevent leakage of oil down output shafts. An oil dipstick or sight gauge shall be provided to all visual inspection of proper oil levels.
11. Speed reducer output shafts shall be constructed of sufficient size to carry the weight of the impeller shafts and impellers, and supported such that impeller shafts and impellers, and supported such that impeller shaft deflections caused by operating loads do not affect alignment of the antifriction bearings or cause misalignment of gearing during mixer operation.
12. The maximum speed of the output shaft when the drive motor is operating at full rated speed shall be 40 rpm.

D. Impeller Shaft:

1. Impeller shafts shall be Type 316 stainless steel construction. Each shaft shall be solid and shall be designed for a safety factor of 4 based on the yield strength of the particular metal. Minimum shaft diameter shall be 4 inches. Shafts shall be of the overhung design and use of bottom steady bearings will not be permitted. Each shaft shall be free of imperfections and inclusions which might affect the fatigue strength of the shaft or its corrosion resistance. Lower shaft straightness and rigid coupling squareness shall be such that a maximum runout at the lower end of the shaft is 1/8 inch for every 10 feet of overhung shaft, as measured when turning by hand.
2. Shaft keyways shall be designed to allow the impellers to be moved up or down 9 inches from the design setting. Shafts supporting the impellers shall be removable from the speed reducers without disturbing the internal gearing of the reducers.
3. Lower mixer shafts are to be connected to the output shafts with rigid, stainless steel flanged couplings. Welds shall be full penetration, blended, and stress relieved. Hubs shall be interface-fit with key and taper pin connections. Mating coupling faces shall be machined to provide accurate alignment and the coupling haves registered to assure concentricity. The drive-side half of the coupling may be carbon steel.
4. Shaft design shall limit operating speed to 65 percent of the first lateral harmonic vibration frequency (critical speed) without the use of stabilizing devise or guides. The critical speed and torsional and bending stress calculations shall include the mass and moment of inertia of the impeller and couplings.

E. Impellers:

1. The impeller shall be a radial flow, six-blade disk type turbine impeller. The impeller diameter shall be 36 inches. The disk diameter and hub design shall be determined by the manufacturer. Each of the mixer blades shall be approximately 12 inches in length and 9 inches high; actual dimensions shall be the manufacturer's standard for this impeller type.
2. The impeller shall be designed to invest a minimum of 3 hp into the liquid at 40 degrees F when turning at the full rated output speed of the speed reducer.
3. The positions of the impellers in relation to the basin shall be as shown on Drawings.
4. Impellers shall be attached to the shafts by means of keys and safety hooks. Impellers and associated hardware shall be constructed of Type 316 stainless steel.

F. Accessories:

1. Baseplate: The mixer shall be supplied with a steel baseplate with plan dimensions as shown on Drawings. The baseplate provided shall have the bolt pattern or as required by the manufacturer. The manufacturer shall determine the baseplate thickness, assuming it is rigidly supported on two sides as shown, to ensure it is adequately designed based on the static, dynamic, and vibrational loads associated with unit to be furnished. The minimum baseplate thickness shall be 1-1/2 inches. Clearly indicate the required baseplate thickness on submittal information.
2. Guards: All rotating parts above the mounting level must be provided with guards in accordance with applicable safety standards.
3. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
4. 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 engraved block type black enamel filled equipment identification number and letters indicated on Drawings.
5. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

G. Drive Motors:

1. Drive motors shall be designed, manufactured, and tested in accordance with the latest revised edition of NEMA MG 1. Provide motors as specified hereinafter. The motor nameplate horsepower rating shall not be exceeded at any operating condition. Each motor shall conform to the following:

    a. Type: Inverter duty energy-efficient, squirrel-cage, induction motor.
    b. Synchronous Speed: 1,750 rpm.
    c. Horsepower: 5.
    d. Voltage, Phase, and Frequency: 460 volts, three-phase, 60-Hz.
    e. Mounting: Vertical, solid shaft.
    f. Enclosure:
        1) TEFC.
        2) All motor windings shall be copper; aluminum windings are not acceptable.
    g. System Service Factor: 1.0.
    h. Guaranteed Minimum Full-Load Efficiency: 94 percent.
    i. Duty Cycle: Continuous.
    j. Ambient Temperature Rating: 40 degrees C.
    k. Starting Method: Full voltage.
    l. Starting Current: NEMA Code Letter F.
    m. Insulation: Class F.
    n. Temperature Rise: Class B.
    o. Bearing Lubrication: Manufacturer’s standard.
    p. Bearing Life: 100,000 hours B-10 rating life as defined by AFBMA standards.
    q. Coupling: Manufacturer’s standard design rated for 1.5 times motor horsepower.
2. Motor Accessories: Provide motor modification’s as follows:
    a. Space heaters to prevent moisture condensation, rated at 120 volts.
    b. Weep holes or drain plugs for moisture removal.
    c. Grounding terminal in conduit box.
3. Motor Test: See Section 26 05 01, Electrical.

H. Adjustable Frequency, Controlled Speed, Drive Mechanisms:

1. Adjustable Speed Control System:
    a. Provide speed control system capable of producing a continuously adjustable motor speed from 25 percent to 100 percent of motor full-load, rated speed.

b. Provide adjustable speed controllers suitable for top or bottom conduit entry.
c. Provide 120-volt power to motor thermal protector relay.
d. Coordinate sizing of adjustable frequency, controlled speed, drive systems with drive motors specified herein.

2. Refer to Section 26 29 23, Low-Voltage Adjustable Frequency Drive System, for additional requirements.

I. Instrumentation and Controls:

1. Instrumentation and controls work of this section shall be in accordance with requirements of Specification Section 40 90 01, Instrumentation and Control for Process Systems, and all associated Supplements. Provide all items, including items not specifically called out, which are required to implement the specified functions, and the functions required for proper system operation.
2. Drives for both rapid mixers shall be controlled from a local panel containing starters, controls, and indicators.
3. Furnish thermostatically controlled heating and cooling for each control panel furnish per the requirements of Section 40 90 01, Instrumentation and Control for Process Systems, and all associated Supplements.
4. Control Panels, General: Provide the following control panel(s):

Panel No.	Name	NEMA Rating	Mounting
MXR-CPN10201	Rapid Mixer	4X Stainless Steel	Rack
MXR-CPN10202	Rapid Mixer	4X Stainless Steel	Rack
MXR-CPN10301	Rapid Mixer	4X Stainless Steel	Rack
MXR-CPN10302	Rapid Mixer	4X Stainless Steel	Rack

5. Operator Controls and Indicators:
   a. As a minimum, provide the following functions on the face of the control panel for each rapid mixer:
      1) Hand Switches:
         a) RUN-OFF-REMOTE, 30.5 mm, NEMA 4X, black, three-position, maintained-contact selector switch.
         b) Manual Speed Setpoint Control, 30.5 mm, NEMA 4X, black, 0 percent to 100 percent (from minimum to maximum speed) potentiometer (impedance to match AFD requirements).
         c) RAPID MIXER RESET, 30.5 mm, NEMA 4X, black, flush-head, momentary-contact push button.

2) Status Indicating Lights:
   a) CONTROL POWER OK, 30.5 mm, NEMA 4X, white lens (for 120V ac or blue lens (for 24V dc), LED type, push-to-test pilot light.
   b) RUNNING, 30.5 mm, NEMA 4X, red lens, LED type, push-to-test pilot light.
   c) STOPPED, 30.5 mm, NEMA 4X, green lens, LED type, push-to-test pilot light.
   d) AFD FAULT, 30.5 mm, NEMA 4X, amber lens, LED type, push-to-test pilot light.

6. Functional Requirements:
   a. Rapid Mixer motor runs when switch is in RUN position.
   b. Rapid Mixer motor does not run when switch is in OFF position.
   c. Rapid Mixer accepts a dry contact remote RUN signal when switch is in REMOTE position.
7. External Interfaces: Provide the following external interfaces to other equipment not provided under this section:
   a. Discrete Outputs from Control Panel to Plant Control System PLC:
      1) Provide the following maintained dry contact outputs which shall be used as discrete inputs by PLC for each rapid mixer. Contacts shall be rated for 5 amps at 120V ac.
         A) IN REMOTE.
         b) RUNNING
         C) AFD FAULT.
         D) RAPID MIXER RESET DEPRESSED.
   b. Discrete inputs from plant control system PLC. Accept the following dry contact inputs to the control panel for each rapid mixer. Contacts shall be rated for 2 amps at 120V ac. Sensing voltage shall be 120V ac. Provide interposing relay if a contact rating greater than 2 amps is required.
      1) Remote RUN command.
   c. Analog outputs from control panel to plant control system PLC. Provide the following isolated 4 mA to 20 mA Analog Outputs:
      1) AFD SPEED feedback.
   d. Analog Inputs from plant control system PLC: Accept the following isolated 4 mA to20 mA Analog Inputs to the control panel.
      1) AFD Remote SPEED setpoint.

8. When the AFD FAULT contact changes states (indicating a FAULT), the AFD shall be locked out of operation via a hard-wired latching circuit and illuminate the AFD FAULT pilot light. The rapid mixer may be restored to operation when the fault has cleared and the RAPID MIXER RESET push button has been depressed.
9. Power Requirements: Each panel shall operate from a single 480-volt, three-phase power source. Provide separate branch circuits with branch circuit breakers for each rapid mixer. Provide a single main disconnect for each panel.
10. Adjustable Frequency Drive: Provide Adjustable Frequency Drive for each rapid mixer located in the control panel.

PART 3 EXECUTION

3.01 PAINTING, ASSEMBLY, AND DELIVERY

A. The equipment shall be supplied with the manufacturer's standard prime and finish paint. Field painting shall be as specified in Section 09 90 00, Painting and Coating, System No. 6.

B. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

C. All exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventative compound such as Kendall No. 5.

3.02 TESTING

A. Shop Test: Each reducer and motor shall be shop tested prior to shipment from the mixer manufacturer's factory.

B. Field Test: Prior to acceptance of each mixer installation, demonstrate proper operation at design conditions.

END OF SECTION

SECTION 44 42 28
STAINLESS STEEL BAFFLE SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Provide a complete Stainless Steel Baffle System as described herein and shown on Contract Drawings consisting of baffle planks, supports, rotating bottom plank and anchors for a complete working system.

B. The Contractor shall provide and install baffle walls including but not limited to baffle planks, supports, side wall mounting channels, rotating bottom plank, anchor bolts and related appurtenances. This equipment shall be provided as an integral package by a single manufacturer regularly engaged in the production of this equipment who shall take responsibility for coordination of all components to assure proper functioning of the flow control baffle walls.

1.02 REFERENCES

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

1. American Iron and Steel Institute (AISI): Material Specifications.
2. American Institute of Steel Construction (AISC): Guidelines for the Design of Steel Structures.
3. American Welding Society (AWS).
4. ASTM International (ASTM): Stainless Steel Material Specifications.
5. NSF International (NSF): Standard 61, Drinking Water Systems Components - Health Effects.

1.03 SUBMITTALS

A. Action Submittals:

1. Complete shop drawings describing the stainless steel baffle system including all ancillary items.
2. Manufacturer’s literature and cut sheets for all equipment.
3. List of spare parts which should be purchased and kept on hand.
4. Plan and section views of the basins, anchor bolt location and templates, dimensional tolerances required for installation. Typical details will include dimensions of components and their relationship to other items of supply and with respect to the basins and details for sling lifting.
5. A complete listing of materials.

6. Drawings will include controlling elevations (i.e., V-notch weir, wall openings, bottom of equipment, water surface elevations in the basin and along the effluent trough at minimum and maximum flows).
7. Head loss calculation through the baffles at maximum and design flow.
8. Connection locations and support attachment details.
9. Weights for major components and materials of construction.
10. Proof of NSF International (NSF) Standard 61 Certification for Use in Potable Water.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, with materials specifications will be submitted prior to shipment of the equipment. The certificate will certify that materials, manufacture, and final product conforms to or exceeds specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certificates as appropriate. The certificate may reflect recent or previous test results on material or product, acceptable to the Owner.
2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
3. Structural calculations of the baffle system design performed and stamped by a professional engineer registered in the State of Oklahoma.
4. Structural calculations for the anchorage of the baffle system to existing concrete structure performed and stamped by a professional engineer registered in the State of Oklahoma.
5. Manufacturer's Warranty.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Contractor will provide products required to complete the work under this section. Such products include, but are not limited to, inserts, anchor bolts, hangers and supports, specialties, and expendable materials, all as necessary to provide a complete and properly functioning system.

B. Manufacturer:

1. Meurer Research, Inc.
2. No "or-equal" or substitute product will be considered.

2.02 DESIGN SCOPE OF WORK

A. The work shall include supply, delivery, installation, inspection, and training in the use of flow control baffles.

B. The basins shall be in number and dimension as shown in the contract drawings and as specified herein.

C. The manufacturer shall provide a baffling system that will offers maximum flow control in accordance with the process design.

D. The baffle system shall be comprised of the following elements without exception:

1. Baffle planks formed to be assembled into a baffle wall.
2. Support channels and columns as required for complete assembly.
3. Rotating bottom baffle planks.
4. All wall mounted brackets and anchors as required.

2.03 DESIGN REQUIREMENTS

A. Number of Basins: One stainless steel baffle system for each of the two basins for both primary clarifiers will be provided. Refer to Contract Drawings for basin dimensions, baffle dimensions, and hydraulic wall design.

B. Flow Rates and Velocity:

1. Design: 20 million gallons per day (mgd) per basin.
2. Design Velocity: Less than 0.5 fps.

C. Design Loads:

1. The structural members will be designed to withstand hydrostatic loading and appurtenance loads.
2. Design will withstand all loads in submerged and non-submerged conditions.
3. Design shall consider the vibration of baffle.

D. Structural Support System Requirements:

1. The baffle wall shall be designed structurally for the following conditions:
   a. 2.5 inches of water differential.
   b. Free movement of rotating plank to minimize baffle wall loads during basin fill and drain operations.

2. Planks shall be stacked in between support channels and stainless columns to form a baffle wall. Bolting planks together to meet structural requirements is not allowed.

2.04 EQUIPMENT DESCRIPTION

A. Baffle Planks:

1. Baffle planks shall be formed of Type 304 stainless steel sheets, having a minimum thickness of 22 gauge (0.0293 inch) as determined by the manufacturer's structural load calculations. Manufacture planks from cold rolled, annealed, and pickled stainless sheet with standard mill finish.
2. Stainless steel shall have the following minimum properties
   a. Tensile Strength (psi): 80,000.
   b. Yield Strength (psi): 35,000.
   c. Modulus of Elasticity lb/in 2 by 106: 29.
   d. Hardness: 160.
3. Each plank shall be manufactured with an edge thickness of not less than 1.5 inches. Bolting or welding of planks together is not allowed.
4. Where required in the contract documents, the bottom plank shall be hinged at the top to allow the plank to "rotate" forward and back to equalize the head on either side of the baffle during filling and draining.
5. Where required in the contract drawings, baffles shall include flow distribution ports sized for the specified velocity. Include helical flow inlet diffusers as required to reduce exit velocity to 25 percent of the port velocity. Flow shall exit the diffuser in a spiraling motion to prevent floc damage and to minimize velocity currents.

B. Support Channels and Columns:

1. Where planks are attached to concrete columns or walls, support channels shall be provided for the purpose of securing planks to the concrete. Properly size and include all anchor bolts.
2. Support columns and base plates, channels and baffle planks shall be adequately sized to withstand a load of 2.5 inches of water differential.
3. The manufacturer shall be required to coordinate structural details of the design with the Engineer. This will be required to determine the final location of baffles and other design details which may affect the supply of structural support components.

C. Rotating Bottom Plank:

1. The bottom plank of each baffle in contact with the basin floor shall be hinged at the top so it can rotate to an 'open' position.
2. The rotating plank shall be designed to remain in the vertical position to obstruct the flow path during normal operating conditions.
3. The rotating bottom plank shall be capable of being propped 'open' to allow cleaning of the area behind the baffle when the basin is drained.

D. Access Door:

1. A 3 foot-0 inch by 7 foot-6 inch hinged door, one per diffuser wall, shall be constructed from the same material as the baffles with diffuser cutouts as shown on Contract Drawings.
2. A 4 inch by 4 inch stainless steel angle shall provide stiffening.
3. Provide hinges and door latch as described on Contract Drawings.

2.05 MATERIALS OF CONSTRUCTION

A. All components of the plate settler system shall be fabricated of stainless-steel materials.

1. Baffle Planks: ASTM A240, AISI Type 304 stainless steel.
2. Bolts, Nuts, Fasteners: IFI-104, Grade 304.

B. All fabricated stainless-steel components shall be properly treated to prevent future corrosion. All welds shall be bead blasted or mechanically cleaned per ASTM A380. Nitric acid or other hazardous chemicals shall not be allowed for cleaning. Nonwelded parts shall be supplied with standard mill finish.

C. To ensure public safety, baffles shall be certified by NSF to ANSI Standard 61. Systems that are not NSF 61 certified by NSF will not be allowed. Other agencies or certificates are not acceptable.

D. If free chlorine is present at concentrations to allow corrosion of Type 304 stainless steel, then planks at the air-water interface shall be constructed of Type 316 stainless steel.

PART 3 EXECUTION

3.01 Delivery, Storage and Handling

A. Baffles and supports shall be shipped on flatbed truck to allow access by crane provided by the Contractor.

B. Equipment shall be stored and protected in accordance with the manufacturer's recommendations.

3.02 INSTALLATION

A. Equipment shall be covered and stored in a dry area protected from environmental extremes, iron contamination and highly concentrated loads in strict accordance with the manufacturer's recommendations prior to installation.

B. Install baffle equipment as indicated on the contract drawings and in accordance with the shop drawings, manufacturer's recommendations, and local codes.

C. For Flow Control Baffles:

1. Install wall channel brackets straight and true as shown on Drawings.
2. Install planks into the support channels to form a baffle wall.
3. Install rotating bottom plank and level plank to assure free movement.

3.03 MANUFACTURERS' SERVICES

A. A manufacturer's technical representative for the equipment specified herein will 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 installing contractor on proper installation procedures.
3. 1 person-day for functional testing.

Note: Manufacturer's representative will be present at the Job Site for a duration necessary to assure proper assembly, installation, testing, startup and certification of the equipment specified herein.

B. Startup and assistance services will 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 will 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 will be at such times as requested by the Owner. Training services will consist of pre-startup classroom training and site training.

3.04 FUNCTIONAL TESTING

A. Functional Test: Prior to plant startup, all equipment described in this Specification will be inspected for proper alignment and connection and satisfactory performance by means of a functional test as performed by Contractor.

3.05 SPARE PARTS

A. Furnish one spare baffle plank of each size and type.

3.06 MANUFACTURER'S CERTIFICATE

A. The following certificates will be provided:

1. Certification of Proper Installation.
2. Certification of Materials Compliance.

END OF SECTION

SECTION 44 42 56.09
NON-CLOG DRY-PIT 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):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Rating and Fatigue Life for Roller Bearings.
2. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   b. B106.1, Design of Transmission Shafting.
3. ASTM International (ASTM): A48/A48M, Standard Specification for Gray Iron Castings.
4. Department of Defense (DoD) Test Method Standard: MIL STD 167, Mechanical Vibrations of Shipboard Equipment.
5. Hydraulic Institute Standards (HIS):
   a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
   b. 11.6, Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
6. International Standards for Organization: ISO 1940, Balance Quality Requirements of Rigid Rotors.
7. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
8. Occupational Safety and Health Administration (OSHA).

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each pump assembly.

b. Complete pump and motor catalog information, descriptive literature, specifications, and identification of materials of construction.
c. Plan and section dimensional outline drawings of the pumps and motors identifying all components, anchor bolts, external connections, and appurtenances.
    1) Include all components identified with quantity, part name and corresponding materials of construction complete with ASTM designation on sectional drawings.
d. Performance data curves showing head, capacity, horsepower demand, net positive suction head required (NPSH3), and pump efficiency over entire operating range of pump, from shutoff to maximum capacity.
    1) Include the pump's preferred operating range (POR) and the manufacturer's defined maximum allowable operating range (AOR) for continuous steady state service on performance curves.
    2) Indicate separately head, capacity, horsepower demand, NPSH3, and overall efficiency required at the AOR's minimum and maximum continuous stable flow conditions and at the Rated Conditions and at Secondary Conditions (if applicable).
e. For variable speed motors, provide performance data curves for 50, 60, 70, 80, and 90 percent of nominal speed.
f. Certified detail structural, mechanical, and electrical drawings showing equipment dimensions, arrangement, assembly, including locations and type of connections and weights of major equipment and components.
g. Lateral and torsional critical speed analysis.
h. Structural response frequency analysis.
i. Power and control wiring diagrams, including terminals and numbers.
j. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
k. Factory finish system.
l. Bearing life calculation confirming compliance with L10 bearing life requirement.
m. 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 design analyst qualifications.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. 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.
6. Factory Functional and Performance Test Reports and Log.
7. Field Vibration and Performance Test Reports and Log.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
9. Suggested spare parts list to maintain equipment in service for period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. One complete set(s) packing.
2. One complete set(s) bearings.
3. One complete set(s) gaskets and O-ring seals.
4. One complete set(s) of shaft sleeves.
5. One complete set(s) keys, dowels, pins, etc.
6. One complete mechanical seal(s).
7. Impeller.
8. Impeller shaft.
9. One set of impeller and casing wear rings.
10. Head shaft.
11. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide a complete, coordinated, and fully functional operating system.

B. Coordinate pump requirements with motor manufacturer and be responsible for pump and motor requirements.

C. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, motor, and adjustable speed controller. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

D. Pumps supplied under this section to be a standard product of manufacturer and to have proven reliability.

E. Provide a complete lateral and torsional critical speed analysis of each pump-coupling-motor rotating assembly including extension shaft assembly, and structural analysis of complete pump and motor assembly performed by pump manufacturer or qualified third party.

1. Analyst Qualifications: Experienced in performing analyses for pump and motor units of comparable size and complexity.
2. Prepare a written report for each completed analysis documenting analysis and calculation procedures.
3. Submit results of each analysis for review and acceptance prior to pump and motor fabrication.

F. Lateral Analysis:

1. Identify lateral critical speeds for both pump and motor shafts and extension shaft assembly.
2. Include both dry and wet impeller cases.
3. Provide a critical speed map demonstrating that a critical speed does not occur below 1.25 times the maximum rated speed of the pump and motor and does not occur between 0.75 times the blade pass frequency associated with the minimum speed of the pump and 1.25 times the blade pass frequency associated with the maximum specified speed of the pump.
4. Calculate the damped vibration response to unbalance for the shafts and compare to applicable specified requirements to verify acceptable vibration amplitudes.

G. Torsional Analysis:

1. Calculate system torsional natural frequencies, corresponding mode shapes, and steady-state and transient torsional response.
2. Include extension shaft assembly in analysis, if applicable.
3. Provide an interference diagram demonstrating the following:
   a. No critical speeds occur between 0.80 times the minimum specified operating speed and 1.20 times the maximum rated speed of the pump and motor.

b. No critical speed associated with the mechanical running speed (one times shaft speed) excitation frequency occurs below 1.20 times the maximum rated operating speed.

4. Forced Response Analysis:
   a. Perform a forced response analysis for all critical speeds determined to occur below 1.20 times the maximum rated operating speed.
   b. Expected excitation frequencies for steady-state operation include as a minimum, but not limited to, electrical line frequency, two times electrical line frequency, current modulating frequencies produced by the variable frequency drive, mechanical running speed (one times shaft speed), two times mechanical running speed (two times shaft speed), and blade pass frequency.
   c. Confirm that calculated steady-state and transient dynamic torsional shaft stresses and coupling torques are below allowable levels, such that the motor shaft, pump shaft, and associated drive train components are capable of an unlimited number of startup and shutdown cycles associated with 0 rpm up to the maximum rated speed.
   d. Determine allowable stresses (endurance limits) for the pump and motor shafts in accordance with ASME B106.1 (Design of Transmission Shafting) or MIL STD 167, whichever is lower.
   e. Include a factor of safety of at least two in the allowable stress levels and demonstrate stresses on a Modified Goodman Diagram.
   f. Confirm that dynamic torque in the couplings is in accordance with coupling manufacturer's requirements.

H. Structural Response Frequency Analysis:

1. Perform a structural response frequency analysis for the pump and motor assembly.
2. At a minimum, model the motor, pump, and fabricated support, including any other critical components based upon mounting details shown on Drawings.
3. Confirm that the minimum structural natural frequency of the complete pump and motor assembly is a minimum of 1.25 times the maximum rated pump and motor speed, and does not occur between 0.75 times the blade pass frequency associated with the minimum speed of the pump and 1.25 times the blade pass frequency associated with the maximum specified speed of the pump.
4. Verification of calculated natural frequencies of the pump and motor assembly shall be performed by pump manufacturer, or pump manufacturer's authorized representative, when unit is fully installed at the Project Site.

2.02 SUPPLEMENTS

A. Specific service, performance, and design requirements are attached to this section as supplements.

B. No “or-equal” or substitute products will be considered.

2.03 EQUIPMENT

A. Pump:

1. Heavy-duty, solids handling, nonclog, dry pit design.
2. Configuration: See Supplements.
3. See Drawings for pump orientation and rotation.
4. Continuously rising head-capacity curve from runout to shutoff.
5. Designed to operate continuously at any point on specified operating range of performance curve without cavitation, overheating, or excessive vibration.
6. Motor nameplate horsepower rating not to be exceeded by pump brake horsepower required at any point on nominal pump performance curve.

B. Casing:

1. Back pullout design allowing for removal of rotating element without disturbing piping connections.
2. Heavy wall, one-piece volute construction with integral flanged discharge flange and smooth fluid passages. Provide drilled and tapped volute priming and drain connections.
3. Wear ring securely fastened to casing (or suction cover) with recessed stainless steel screws.
4. Provide handhole for cleanout purposes at volute centerline located to provide access to interior of pump.
5. Flanges:
   a. Conform to ASME B16.1, Class 125-pound, flat face standard.
   b. Provide 1/2-inch gauge connection drilled and tapped in discharge flange.
6. Diffusion vanes or stationary guides are not allowed.

C. Suction Cover (Fronthead):

1. Single-piece construction designed to provide even flow to impeller eye.
2. Flanged connection conforming to ASME B16.1, Class 125-pound, flat face standard.
3. Machine register fitted to casing.

D. Suction Elbow:

1. ASME B16.1, Class 125-pound flat face standard, flanged suction elbow with contoured handhole cleanout and cover.
2. Provide 1/2-inch gauge connection.

E. Stuffing Box Cover (Backhead):

1. Single-piece construction designed with integral stuffing box suitable for use of either conventional packing or mechanical seal. Drilled and tapped 3/4-inch drain connection and large openings to allow easy access to stuffing box.
2. Designed for installation of a minimum of five rings of packing and a split type lantern ring and a split type gland follower. Provide stuffing box with 1/4-inch minimum drilled and tapped connection for injection or venting of the stuffing box.
3. Machine register fitted to casing.

F. Bearing Frame and Bearings:

1. Removable, single-piece construction.
2. Machined for accurate bearing alignment and completely enclosing shaft between bearings.
3. Provide with retainer covers on inboard and outboard ends of frame equipped with lip-type grease seals to prevent entrance of contaminants.
4. Single or double row bearings at inboard and outboard ends designed to take radial, weight, and thrust loads of pump and associated shafting loads. Bearings to be designed for an L10 life per ABMA at best efficiency point.
5. Provide jacking screws for adjustment of impeller.
6. Grease packed at factory and provided with grease fittings for bearing lubrication.

G. Impeller:

1. Single suction, enclosed, nonclogging type design with extremely smooth passageways to prevent clogging.
2. Single-piece construction.
3. Secure to shaft with stainless steel bolt, washer, and key to prevent loosening from either forward or reverse rotation.
4. Dynamically balanced to assure vibration limits for pump are not exceeded.
5. Wear ring securely fastened to impeller with recessed stainless steel screws. Impeller wear ring to be a minimum of 50 Brinell softer than suction head wear ring.

H. Shaft:

1. Accurately machined over entire length and precision ground at bearing locations.
2. Designed to transmit full motor horsepower with a liberal safety factor to carry maximum loads imposed and to meet pump vibration requirements.
3. Provide keyways at both ends.
4. Provide renewable, hooked shaft sleeve positively secured to shaft to prevent leakage.

I. Pump Base: Rugged, heavy duty, with ample strength for support of entire pump and imposed static and operational loads.

J. Coupling:

1. Designed to provide flexible connection between pump and motor.
2. Flexible coupling to be designed to carry maximum horsepower of motor, including service factor, and additional forces imposed by rotating assembly.
3. Flexible coupling selection to take into account torsional analysis of complete pump and motor drive system. There is to be no torsional critical speed within 15 percent above or below specified speed range. Number of vanes times the rpm are part of this speed range.
4. Provide fabricated coupling guard to comply with OSHA safety standards.

K. High Ring Base:

1. Cast iron or fabricated steel of adequate height to allow access to flexible coupling and designed to carry weight of motor without undue vibration to pump assembly.
2. Provide with shaft guard to comply with OSHA safety standards.

L. Extension Shaft Assembly:

1. Constructed of sufficient diameter and properties to transmit 1.25 times full motor horsepower including service factor.
2. Complete with self-leveling, self-aligning universal joint at pump end, and coupled to meet motor connection requirements at motor end.
3. Complete with self-aligning, single-row, pillow block type steady bearings with means of connection to a rigid support. Provide means of grease lubrication at each steady bearing.

4. Pump thrust bearing to be designed to carry weight of lower portion of universal joint assembly and any imposed lateral loads plus loads from pump rotating assembly and hydraulic thrust to meet required L10 bearing life.
5. Motor thrust bearing to be designed to carry weight of universal joint extended shaft assembly and motor coupling to meet required L10 bearing life.
6. Designed to allow lower shaft to be disconnected to swing to the side for removal of rotating assembly.
7. Provide shaft guard to conform to OSHA safety requirements; complete with banded openings to allow access to shaft lubrication fittings.

2.04 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 engraved block type equipment identification number and letters indicated in this Specification and as shown.

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.

2.05 FACTORY FINISHING

A. Manufacturer to prepare, prime and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Manufacturer’s standard enamel finish.

2.06 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments:

1. Factory testing to be in accordance with the standards of the Hydraulic Institute, latest edition.
   a. Pump Test Acceptance Grade: 1U.
2. Test all pumps actually furnished. Use actual motor to be provided for factory tests.

3. Factory tests to include the following:
   a. Hydrostatic testing of pump pressure containing components, to include as a minimum, pump volute, suction cover, and stuffing box cover. Test pressure to be the greater of 150 percent of rated condition or 125 percent of pressure at rated speed with discharge valve closed. Test for 10 minutes.
   b. Performance testing of fully assembled pump, per Hydraulic Institute Standard 1.6. Performance testing to be at rated speed.
   c. Dynamically balance rotating assembly to ISO 1940 Grade G6.3 or better prior to final assembly.
   d. Vibration testing of fully assembled pump with the Project motor at full rated speed.
      1) Limits of Vibration of Fully Assembled Pump: Less than 90 percent of those established in standards of the Hydraulic Institute.
   e. Include complete test records and performance curves certified correct by an authorized representative of the pump manufacturer for each test performed.
   f. Motor Test: See Section 26 05 01, Electrical.
   g. Make necessary adjustments, realignments, and retest to bring pumps into compliance.
   h. Witnessing of factory testing shown on supplements at end of this section.

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 such that driving units are properly aligned, plumb, and level with driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of pump pedestals 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. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests:

1. Conduct on each pump, system, and subsystem as specified in Section 01 91 14, Equipment Testing and Facility Startup.
2. Alignment:
   a. Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   b. Verify alignment of complete extended shaft assembly, including angularity of pump and motor shafts, meets requirements of shafting manufacturer.
   c. Shafting manufacturer's authorized representative shall verify installation alignment and prepare and submit a report confirming compliance.
3. Flow Output: Measure using plant instrumentation and storage volumes.
4. Operating Temperatures and Vibration: Monitor bearing areas on pump and motor and on extension shafting for abnormally high temperatures or vibrations.
5. Vibration Test:
   a. Test with units installed and in normal operation, and discharging to connected piping systems at rates at 20 percent speed increments over the anticipated operating speed range of the pump and with actual building structures and foundations provided.
      1) Confirm vibration is below 90 percent of limits specified in HIS 9.6.4.
   b. If units exhibit vibration in excess of the limits specified adjust as necessary to bring units into compliance. Units that cannot be adjusted or modified to conform as specified shall be replaced.
   c. Provide instrumentation in current calibration to measure pump vibration at locations outlined in the Hydraulic Standards.
   d. Prepare test report, including test records for each pump.

6. Performance Test: Conduct on each pump as specified in Section 01 91 14, Equipment Testing and Facility Startup.
7. Test in accordance with Hydraulic Institute Standard 1.6, Centrifugal Pump Test.
8. Perform under simulated operating conditions at full rated speed.
9. Test for a continuous 3-hour period without malfunction.
10. Test Records and Report: Prepare and submit a complete test report along with the test records in accordance with Hydraulic Institute Standard 1.6.
11. Use of plant instrumentation is allowed for tests. Provide additional instrumentation required to obtain required test data per the Hydraulic Institute.

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 and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for classroom or Site training.
4. 1 person-day for facility startup.

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

3.05 SUPPLEMENT

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

1. Sludge Pump Nonclog Dry-Pit Centrifugal Pump Data Sheet.

END OF SECTION

SLUDGE PUMP NONCLOG DRY-PIT CENTRIFUGAL PUMP DATA SHEET

Tag Numbers: PMP-10301, PMP-10302

Pump Name: Sludge Pumps

Manufacturer and Model Number: (1) Yeomans, 4310LC-1C

(2) _____

(3) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Clarifier sludge, <1% solids

Pumping Temperature (Fahrenheit): Normal: 65 Max: 85 Min: 40

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: _____

Vapor Pressure at 60 Degrees F: _____ pH: _____

Abrasive (Y/N) Y caused by sludge

Possible Scale Buildup (Y/N): N caused by _____

Corrosive caused by _____

Total Suspended Solids (mg/L) _____

Min. NPSH Available (Ft. Absolute): _____

Area Classification: _____

Ambient Temperature (F): 70

Location Indoor/Outdoor: Indoor

Altitude: 640

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 150 Secondary: 300

Total Dynamic Head (Ft): Rated: 5 Secondary: 15

BHP at Rated Point: 1.7

NPSH Required, Max. (Ft Absolute) at Rated Point: 2.0

Maximum Shutoff Pressure (Ft): 30

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 55

Max. Pump Speed at Rated Capacity (rpm): 900

Constant Speed: _____

Adjustable Speed: Y Minimum Speed: 50%

Maximum Head, Rated Impeller (ft): _____

Maximum Power, Rated Impeller (BHP): _____

Sphere Size Required (to pass through impeller), Min. (in): 3.0

PUMP CONSTRUCTION DETAILS

Configuration:	Horizontal, Frame Mounted: _____
	Vertical, Close-Coupled: _____
	Vertical, Extension Shafting: Y
Size:	Suction (in.): 4 Discharge (in.): 4
Casing:	Single Volute: _____
	Tangential Discharge: _____ Centerline Discharge: Y
Impeller:	Enclosed: Y Two Vane: _____ Three Vane: _____ Bladeless: _____
Wear Rings:	Suction Cover: _____ Impeller: _____
	Axial Type: _____ Radial Type: _____ L Type: _____
Bearings L10 Life: 100,000 Hr: X	50,000 Hr: Y 25,000 Hr: _____
Shaft Sleeve:	Yes Y No _____
Pump Base:	Heavy Duty Fabricated Steel: X
	Cast Iron Combination Base Elbow: _____
	Cast Mounting Pads Integral With Casing: _____
Suction Elbow:	Yes Y No _____ Type: _____
	Material: Cast Iron, ASTM A48 Class 30: Y With 3% Nickel: _____
Coupling:	Standard Flexible Type: Y Spacer Type: _____
	Manufacturer: _____ Manufacturers Standard: _____
Seal:	Packing: _____
	Mechanical Seal: X Single: _____ Double: X
	Mechanical Seal Manufacturer/Model: _____
	Lubrication: Seal water

Extension:	Solid Type: _____ Tubular Type: _____
Shafting:	No of Segments: _____
	Max Drive Shaft Segment Length (in): _____
Materials:	Pump Castings (includes casing, suction cover, stuffing box cover, bearing frame):
	Cast Iron, ASTM A48/A48M Class 30 ___ With 3% Nickel ___
	Cast Iron, ASTM A48/A48M Class 35 ___ With 3% Nickel ___
Impeller:	Cast Iron, ASTM A48/A48M Class 30 ___ With 3% Nickel ___
Pump Shaft:	High Strength Steel _____ AISI 1045 Steel, HR _____
	Type 4140 Alloy Steel _X_ Type 304 Stainless Steel _____
Shaft Sleeve:	Hardened Stainless Steel X Corrosion-Resistant Bronze _____
Wear Rings:	Bronze SAE660, SST AISI 420 _____
Packing:	Graphite Impregnated Braided Synthetic _____
Lantern Ring:	Bronze _____ Teflon _____
Follower Gland:	Bronze _____ Cast Iron _____ Steel _____
Mechanical Seal:	Buna N _____ Viton _____ EPT _____
	Carbon _____ Tungsten Carbide _____ Silicone Carbide _____
	18-8 Stainless Steel _____ Type 316 Stainless Steel _____
Extension Steel: Shafting:	_____ Fiber Reinforced Composite _____

DRIVE MOTOR (See Section 26 05 01, Electrical.)

Horsepower: _3_ Voltage: _460_ Phase: _3_ Hertz: 60

Synchronous Speed (rpm): 875

Service Factor (at max. ambient temp.): 1.15

Insulation Class: _F_ Temperature Rise: _F_

Inverter Duty Rated (Y/N): Y Thermal Protection: _____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _Y_ CISD-TEFC _____

TENV _____ WPI _____ WPII _____ SUBM _____

Mounting Type: Horizontal _____ Vertical Solid Shaft: __Y__

Adjustable Speed Drive: 50% min to 100% max. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

REMARKS_____

_____

_____

_____

_____

SECTION 44 42 63
HOSE-LESS SOLIDS COLLECTION SYSTEM

PART 1 GENERAL

1.01 SCOPE AND RESPONSIBILITIES

A. Traveling submerged solids collection systems shall be furnished and installed in clarifier/basin as shown on Contract Drawings and as described herein.

B. Each solids collector system shall include collector assemblies, electric drive assemblies, drive cables, rigid conduit for settled solids discharge, cable pulleys, control system for fully automatic operation, and all other miscellaneous accessories and hardware as required for a complete installation. This equipment shall be provided as an integral package, manufactured by a single manufacturer.

C. Each solids collector shall remove the settled solids from basin/tank floors by means of differential head. The collected solids shall be discharged through rigid solids conduits. Flexible hoses shall not be used for solids removal. Unit shall be capable of operation on a longitudinally sloped floor surface of up to 1/8-inch per foot.

1.02 GENERAL

A. It is the intent of the Owner that the traveling solids equipment manufacturer shall furnish a complete and engineered system suitable for removal of coagulated solids settled onto basin floors.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings shall be submitted for review and approval by Engineer. Shop Drawings shall include, at a minimum, the following:
   a. Engineering drawings showing dimensional data, equipment details, materials of construction, weights, and component connections.
   b. Scaled plan view drawings of the aforementioned basins and tank showing basin/tank features (e.g., dimensions, walls, curb, etc.) and proposed equipment.
   c. Catalog cut sheets and specifications.

d. Data and design computations upon which the design is based, including hydraulic calculations used to determine head loss through equipment at flow rates of 200, 250, and 300 gallons per minute (gpm).
e. Recommended solids removal flowrate for each unit.

2. Drive assembly details and traveling speeds.
3. Recommended control panel dimensional data, layouts, component descriptions, functional descriptions, ladder logic, and interface with Plant Process Control System (PICS) and Adjustable Frequency Drive Unit.
4. Sunshield fabrication drawings.
5. Power and control wiring diagrams, including terminals and numbers per Section 40 90 01, Instrumentation and Control for Process Systems, requirements.
6. Electrical and instrumentation submittals as per Section 40 90 01, Instrumentation and Control for Process Systems, requirements.
7. Control panel layout drawings, and control schematics per Section 40 90 01, Instrumentation and Control for Process Systems, requirements.
8. See Section 40 90 01, Instrumentation and Control for Process Systems, for additional submittal requirements.
9. Sequence of Operation.
10. Test procedure for unwitnessed factory test (UFT), in accordance with Section 40 90 01, Instrumentation and Control for Process Systems, requirements.
11. Operational readiness test (ORT) procedure, in accordance with Section 40 90 01, Instrumentation and Control for Process Systems, requirements.
12. Performance acceptance test (PAT) procedure, in accordance with Section 40 90 01, Instrumentation and Control for Process Systems, requirements.
13. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
14. Motor data sheet.
15. Certification that submerged materials are compatible with the settled solids.

B. Informational Submittals:

1. Storage, handling, and installation instructions.
2. Field installation and testing procedures.
3. Functional test results.

4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data, including routine maintenance requirement prior to startup and Operation and Maintenance Data in accordance with Section 40 90 01, Instrumentation and Control for Process Systems.
5. UFT, ORT and PAT testing results per Section 40 90 01, Instrumentation and Control for Process Systems, and all associated Supplements.
6. Manufacturer's Certificate of Compliance for each flocculation mechanism installed, in accordance with Section 01 43 33, Manufacturers' Field Services.
7. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.

C. Quality Control Submittals:

1. Operation and Maintenance Manual, in accordance with Section 01 33 00, Submittal Procedures.
2. Manufacturer's Warranty.
3. Certificate of Proper Installation.

1.04 STORAGE AND PROTECTION

A. Equipment and accessories shall be stored and protected in accordance with the manufacturer's recommendations.

1.05 WARRANTY

A. Provide 1-year warranty. Warranty period shall begin at Substantial Completion.

PART 2 PRODUCTS

2.01 SYSTEM REQUIREMENTS

A. Each traveling solids collection system shall be designed to uniformly collect settled solids from basin/tank floor.

B. Coagulated settled solids will be approximately 1.5 percent dry solids (maximum).

C. The equipment shall be designed to operate intermittently or continuously.

D. Chemical doses to the water in sedimentation basins will be up to 60 mg/L of aluminum sulfate and 1.25 mg/L of chlorine dioxide. Submerged components of the solids collector systems may be exposed to different doses than those listed above due to the settled solids. Submerged components shall be suitable for water with 15 mg/L of aluminum and 15 mg/L of iron.

2.02 MANUFACTURERS AND PRODUCTS

A. Manufacturer and Product:

1. Meurer Research Inc.; Hoseless Cable-Vac.
2. No “or equal” or substitute products will be considered.

2.03 DESIGN REQUIREMENTS

A. Basin/Tank Configuration and Dimensions: As shown on Drawings.

B. Maximum Flow from Each Collector System: 300 gpm (typical flow per manufacturer’s recommendation). Flow will be controlled by an electrically-actuated plug valve dedicated for each collector (provided by others).

C. Minimum Available Driving Head (from Water Surface to Connection of Rigid Solids Discharge Conduits to Fixed Piping):

1. Sedimentation Basins: 11.0 feet.

D. Water Temperature: 40 degrees F to 90 degrees F.

2.04 EQUIPMENT DESCRIPTION

A. General:

1. Each traveling solids collection system shall consist of a drive mechanism, solids removal suction header piping, guide rail when necessary, rigid conduit for settled solids, end scrapers, local control panel and appurtenances.
2. Solids collectors shall be of a hose-less design. Equipment with hoses will not be considered.
3. Each traveling solids collection system shall be designed, constructed, and installed in the aforementioned basins and tank for the collection and removal of settled solids accumulated during the settling process.

B. Each traveling solids collection system shall be programmable to accomplish, at the operator's option, all of the following:

1. Variation of traveling speed. Traveling speeds shall be defined per manufacturer's recommendation.
2. One way travel for the full length of the basin/tank.
3. Operator flexibility feature to allow programming capability for specific collection mechanism distance.

2.05 DRIVE ASSEMBLY

A. Drive System: Each solids collection system shall be towed along the longitudinal length of the basin/tank by a Type 304 stainless steel multiple stranded wire cable.

B. Shared Reel Drive:

1. Each drive assembly shall consist of a variable speed electric AC motor, which shall be coupled to a single rotating drum for manipulation of the cable attached to the tandem solids collector assembly. Motor drive shall be housed in a box located above each solids collector on top of the facility. Each motor shall be 1/4 hp rated for 230 volts and powered from control panel as specified by Manufacturer.
2. Cable shall be firmly attached to rotating drum to prevent slippage. Tensioning the cable between multiple pulleys to prevent slippage will not be allowed.
3. Drive enclosure shall provide a visual indication of the relative position of the collector assembly in the basin/tank.
4. Drive cable shall be stored on the reel in a single layer, the placement of which shall be organized by the drive mechanism.
5. Complete drive mechanism shall be provided with a powder coated aluminum safety enclosure.
6. Drive assembly shall include a mechanical overload protection device (shear pin) that will not allow excessive loads to be transmitted to the drive cable.
7. Drive cable shall be Type 304 stainless steel with a minimum diameter of 1/4 inch.
8. Drive assembly shall be capable of enduring an indefinite stall without damage, and without the need to replace sheer pins or other replacement devices. Upon removal of the obstruction or excessive load, the drive mechanism shall automatically resume full operation.

9. Drive assembly shall have integral position sensors, which determine the collector location within the basin/tank. No external or under-water position sensors shall be required or allowed.
10. Drive shall have an emergency stop button, which shall be a large, red palm operated single button.

2.06 TANDEM SOLIDS COLLECTOR ASSEMBLY

A. Solids Removal Header Pipe:

1. Each tandem solids collector assembly shall be manufactured entirely of Type 316 stainless steel, with the exception of non-metallic parts such as casters, bushings, orifices, etc., which shall be manufactured of plastic, nonmetallic materials.
2. Each tandem solids collector assembly shall consist of two solids collection pipes with helical flow orifices which shall be, in turn, connected to a center pipe which shall carry the solids to the horizontal telescoping pipe solids conduit. End caps shall be used to seal the ends of the solids collection pipes. These shall be easily removed for internal inspections, should the need arise.
3. Orifices on each solids collector shall be designed to allow the flow to enter tangentially into the solids collection pipes for efficient solids removal.
4. Flow through each solids collector shall be controlled by an electrically actuated plug valve (V405) (furnished by others) as directed by main control panel furnished under this Section. Actual collector flow shall be determined by adjusting the speed on the sludge pumps. Valves, actuators, and valve stems shall be furnished by others and located as shown on Drawings.
5. Manufacturer shall determine the proper number, spacing and angle of the orifices for the most efficient removal of solids from aforementioned basin/tank.
6. Each solids collector assembly shall be complete with polyurethane rolling casters, side casters, and all necessary mounting hardware.
7. All welds shall be continuous and brushed clean.
8. All underwater bearings shall be specifically designed for underwater use.
9. The header pipe shall be fitted at the ends of the pipe with antirocking casters, manufactured from urethane. These casters shall be designed to minimize motion of the header pipe in the vertical plane.

2.07 ELECTRICAL AND INSTRUMENTATION

A. General:

1. Provide control devices, instrumentation, panels, electrical components and wiring, Loop Specifications for overall operation and requirements and all ancillary devices for a complete functional system in accordance with general control requirements specified in Section 40 90 01 Instrumentation and Control for Process Systems, and all supplemental/appendixes.
2. The minimum functional requirements of control system are specified herein. Provide items not specifically identified which are required to implement a complete and functional system including interface with plant SCADA system.
3. UL Listing Mark for Enclosures: Mark station “Listed Enclosed Industrial Control Panel” per UL 508A.
4. I&C and electrical components, terminals, wires, and enclosures U recognized or UL listed.
5. Control panels shall be Type 316 stainless steel, NEMA 4X, powder coated white with a pad lockable three-point latch.
6. Outdoor control panels shall be shrouded by a powder coated white aluminum sunshield with hinged glare shield and shall be fabricated as indicated on Detail 4091-384.
7. Control panel shall contain as a minimum, the following components:
   a. 120V ac Incoming Power Type SS-1 surge suppressor.
   b. Copper ground bus.
   c. Copper ground bus for signal shield ground.
   d. Interior lights in the control panel shall be wired to intrusion type door switches mounted toward the hinge of each door in the control panel.
   e. Courtesy GFCI receptacle.
   f. Each outdoor panel shall be temperature controlled per the requirements as defined in per Section 40 90 01, Instrumentation and Control for Process Systems.
   g. UPS per the requirements of Section 40 90 01, Instrumentation and Control for Process Systems.
      1) Each UPS furnished on the Project shall be sized to power the entire control panel and field devices (less the panel heater and/or the panel air conditioner, the panel interior lights and courtesy receptacle) for 30 minutes (minimum) at full load (all devices energized).
   h. UPS bypass switch per the requirements of Section 40 90 01, Instrumentation and Control for Process Systems.

i. PLC as indicated per Section 40 90 01, Instrumentation and Control for Process Systems, and ancillary documentation.
j. Industrial hardened Ethernet switch with SFP modules per the requirements of Section 40 90 01, Instrumentation and Control for Process Systems.
k. Operator Interface Unit (OIU) as defined within these Contract Documents.
l. Furnish fiber optic patch panel sized to terminate all fiber optic cables entering and leaving the enclosure with a minimum of six spare fiber optic ports. Fiber optic terminations shall be LC type connectors. All active and dark fibers entering and exiting the enclosure shall be terminated.

8. All equipment safeties and interlocks shall be hardwired.

B. Furnish the following operator interface devices on the face of each enclosure:

1. UTILITY POWER OK: 30.5 mm, NEMA 4X, White, Push-to-Test, LED type, pilot light. Illuminates when incoming power to control panel is present.
2. DC POWER OK: 30.5 mm, NEMA 4X, Blue, Push-to-Test, LED type, pilot light. Illuminates when DC power (used within the control circuits of the control panel) is present. (Only if power supplies are present within the control panel.) [One for each type of DC voltage if multiple DC voltages are used within the enclosure.]
3. ETHERNET SWITCH OK: 30.5 mm, NEMA 4X, Blue, Push-to-Test, LED type, pilot light. Illuminates when Ethernet switch is not faulted. (Only if an Ethernet Switch is present within the control panel.)
4. UPS OK: 30.5 mm, NEMA 4X, Blue, Push-to-Test, LED type, pilot light. Illuminates when the UPS is not in an alarm state. (Only if a UPS is present within the control panel.)

C. Motors: Cable drive motor shall be a 1/4 hp motor.

D. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make necessary modifications to the electrical wiring and documentation as part of the lump sum price. All wiring shall meet the requirements of Section 26 05 01, Electrical, and NFPA 70. All insulation shall be rated 600 volts, minimum.

E. Control Panels and Instrumentation:

1. Provide control panels and instruments with power supply, external interfaces, and operator controls and indicators as shown on the P&ID and described herein. Field panels and instruments that are provided

under this section are identified on the P&ID either with an asterisk, noted as such, or are shown within Package Equipment boundaries. Construct panels in accordance with Section 40 90 01, Instrumentation and Control for Process Systems, and all associate supplements, its supplementary figures, and as follows:

Panel Tag	Panel Name	NEMA Rating	Enclosure Materials	Power Supply
CPN-10212	Clarifier No. 2 Solids Collection System 1-1	4X	316 SST	120-volt ac
CPN-10213	Clarifier No. 2 Solids Collection System 1-2	4X	316 SST	120-volt ac
CPN-10214	Clarifier No. 2 Solids Collection System 1-3	4X	316 SST	120-volt ac
CPN-10215	Clarifier No. 2 Solids Collection System 2-1	4X	316 SST	120-volt ac
CPN-10216	Clarifier No. 2 Solids Collection System 2-2	4X	316 SST	120-volt ac
CPN-10217	Clarifier No. 2 Solids Collection System 2-3	4X	316 SST	120-volt ac
CPN-10218	Clarifier 2 Solids Collection System PLC Panel	4X	316 SST	120-volt ac
CPN-10312	Clarifier No. 3 Solids Collection System 1-1	4X	316 SST	120-volt ac
CPN-10313	Clarifier No. 3 Solids Collection System 1-2	4X	316 SST	120-volt ac
CPN-10314	Clarifier No. 3 Solids Collection System 1-3	4X	316 SST	120-volt ac
CPN-10315	Clarifier No. 3 Solids Collection System 2-1	4X	316 SST	120-volt ac
CPN-10316	Clarifier No. 3 Solids Collection System 2-2	4X	316 SST	120-volt ac
CPN-10317	Clarifier No. 3 Solids Collection System 2-3	4X	316 SST	120-volt ac
CPN-10318	Clarifier 3 Solids Collection System PLC Panel	4X	316 SST	120-volt ac

F. Supplier shall provide a single panel mounted OIU for local monitoring, alarming, and control functions for each Collection System PLC Panel.

1. Touch screen operator interface shall be an industrial graphic workstation as specified in Section 40 90 01, Instrumentation and Control Process Systems, and with the following features as a minimum:
   a. Full color LCD touch screen.
   b. Duel Ethernet communication ports.
   c. Suitable for outdoor installation.

2. Touch screen operator interface, as a minimum, shall be provided with the following:
   a. Overview screen displaying equipment run status, valve status, solids operations status and sludge pump station status.
   b. Alarm summary display.

G. Plant SCADA System Interface: The following signals shall interface with Plant SCADA system via the existing Plant Fiber Optic Cable network (Ethernet IP). Vendor to coordinate with PICS subcontractor for communication data exchange requirements. See Section 40 90 01, Instrumentation and Control for Process Systems.

1. System LOCAL-REMOTE status.
2. Operational mode selection.
3. Solids collector FORWARD-REVERSE status.
4. Solids collector Position (“Home” and “End of Travel”).
5. Isolation valve OPEN-CLOSED status.
6. EMERGENCY STOP status.
7. General FAIL alarm.

H. The Plant SCADA System shall serve to initiate and control sequencing as well monitor the status of the collection systems. All control logic (as described herein) shall reside within the PLC.

I. Accept remote collector RUN COMMAND via Ethernet interface.

J. The Clarifier 2 Solids Collection System PLC Panel (CPN-10218) shall be provided with necessary means of fiber termination and distribution.

1. Hardened Industrial Grade multi-mode Fiber Optic switch suitable for interfacing with both the Fiber Optic Plant network and Ethernet ports suitable for Category 6 cables (RJ-45 connectors) for interface with the local HMI and the local PLC. Switch shall per requirements shown in Section 40 90 01, Instrumentation and Control for Process Systems.

K. The control panel shall be provided with necessary means of cooling to maintain internal temperature within the recommended limits of all components mounted inside the panel.

L. Functional Requirements:

1. Adjustable Frequency Drive Unit Interface: Solids control panels shall function with Adjustable Frequency Drives (AFDs) providing a RUN signal when the AFD is selected for either REMOTE or LOCAL operation. Operators shall have the ability to vary solids collector speed locally. When the AFD is selected for REMOTE operation, it is intended that solids collector drive control panel shall be selected for AUTOMATIC mode and function on a timed cycle at operator set speed. When the AFD is selected for LOCAL operation it is intended that solids collector panel shall be selected for MANUAL mode and function based on operator selected FORWARD or REVERSE control and RUN at selected speed.
2. Provide both MANUAL and AUTOMATIC control functions.
   a. See "SEQUENCE OF OPERATION – SOLIDS COLLECTION SYSTEM" below.
3. Provide EMERGENCY STOP control that shall function whether in MANUAL or AUTOMATIC mode.
4. Preset Operational Mode: Six pre-set operation cycles shall be programmed by Manufacturer at startup. These programs shall cover various modes of operation (based on water quality and chemical doses) and can be re-programmed as operational requirements change in the future.
5. Hand operation shall be independent of the Programmable Logic Controller (PLC) furnished in the panel. If the PLC is out-of-service, the solids collector can still run in hand via Manual Start on drive.

M. Special Requirements for Clarifier 2 Solids Collection System PLC Panel (CPN-10218):

1. Within panel, provide a surge suppressor on the incoming 120-volt power.
2. Provide a surge suppressor on each 4 mA to 20 mA signal entering or leaving the panel.
3. Provide a 120-volt ac powered thermostatically controlled (set at 50 degrees F, field adjustable setpoint) panel heater (minimum 100 watts). Furnish with temperature calculations to ensure adequate heating for winter conditions.
4. Provide door actuated 120V ac powered LED lighting for the panel interior.
5. Provide an inner door within the three-point lockable latch NEMA 4X panel in which to mount the local HMI.

6. Provide a sunshade as show in the instrument details. Vendor may submit for approval an alternative sunshade that meets the requirements of the detail provided.
7. Use of an Allen-Bradley PLC ControlLogix 1756-L73 (Owner-supplied to Vendor) with Ethernet/IP communications shall be required.
8. Provide an Allen-Bradley 1756-EN2T ethernet communication card for the Device Level Ring (DLR).
9. Furnish the capability to accept the following existing Clarifier No. 1 I/O for retransmission to the Plant SCADA system:
    a. East Effluent Turbidity Signal (4 mA dc to 20 mA dc Analog Input).
    b. East Effluent “Turbidity High” Alarm (Discrete Input).
    c. East Effluent “pH” Signal (4 mA dc to 20 mA dc Analog Input).
    d. East Effluent “Low pH” Alarm (Discrete Input).
    e. West Effluent Turbidity Signal (4 mA dc to 20 mA dc Analog Input).
    f. West Effluent “Turbidity High” Alarm (Discrete Input).
    g. West Effluent “pH” Signal (4 mA dc to 20 mA dc Analog Input).
    h. West Effluent “Low pH” Alarm (Discrete Input).
    i. East Effluent Gate “Fully Closed” (Discrete Input).
    j. East Effluent Gate “Fully Opened” (Discrete Input).
    k. West Effluent Gate “Fully Closed” (Discrete Input).
    l. West Effluent Gate “Fully Opened” (Discrete Input).
10. Furnish 120V ac fused power terminals for powering the two existing Hach sc200 Turbidity / pH East and West Analyzers.

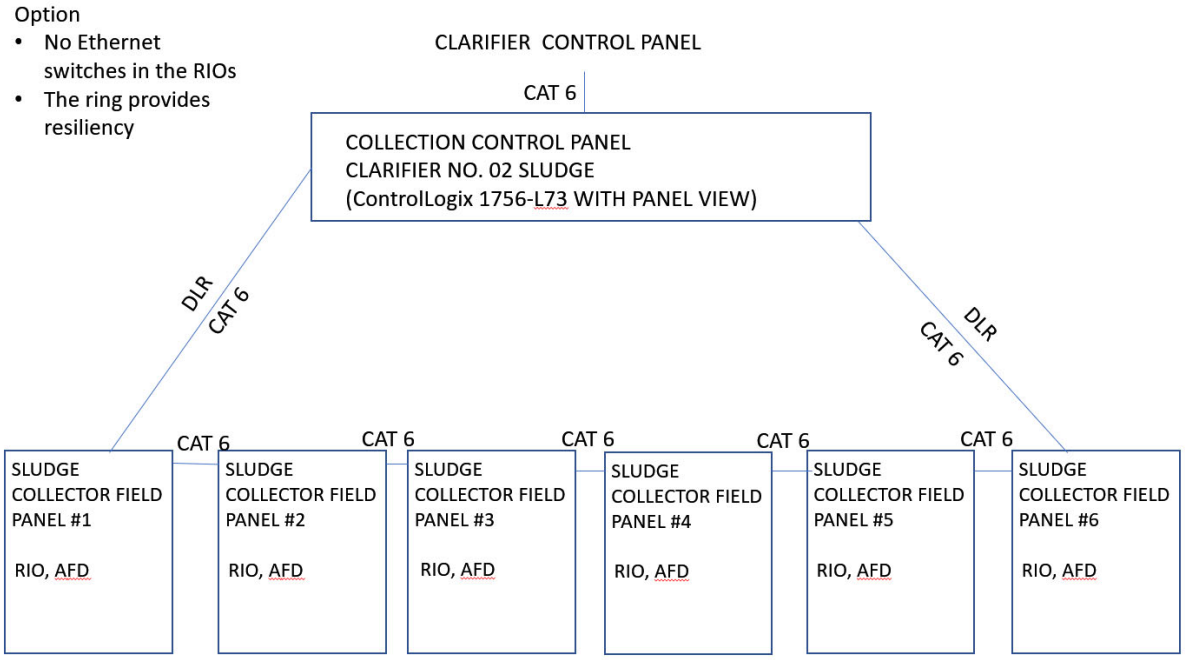
N. Special Requirements for Local Solids Collection Panels (CPN 1020X (01-07) and CPN 1030X (01-07)):

1. Each Local Solids Collector Control Station shall contain a mushroom head, NEMA 4/13, maintained-contact, twist-to-release EMERGENCY STOP pushbutton.
2. Provide UPS system per requirements specified in Section 40 90 01, Instrumentation and Control for Process System.
3. Provide a 120V ac powered thermostatically controlled (set at 50 degrees F, field adjustable setpoint) panel heater (minimum 100 Watts). Furnish with temperature calculations to ensure adequate heating for winter conditions.
4. The following signals (for each Solids Collection Drive) shall interface these Field Panels:
    a. Home Position Limit Switch.
    b. Full Travel Limit Switch.
    c. Emergency Stop Switch Activated.
    d. Line Voltage Failure.

e. UPS Trouble.

O. Control System:

1. Vendor to provide Remote I/O and AFD in each sludge collection control panel and connected to main panel through dual redundant ethernet cables (one used as cold spare). CPN-10207/CPN 10307 shall house the PLC (Control Logix 1756-L73) and communicate to remote I/Os and Plant SCADA.
2. Vendor to provide an ethernet card to communicate with SCADA and a another ethernet card to communicate with the RIO field collector panels.
3. Vendor to provide detailed design with make/model numbers for this option. All operations, monitoring and controls details remains same only system architecture and communication varies for this option.
4. Client has two each re-usable PLC processors (1756-L73). Vendor shall use them in the design. Vendor will need to coordinate with General Contractor on how to receive the processors from the Owner.
5. See below draft version of anticipated system architecture for control system. This is for information purpose only. Vendor to develop detailed system architecture during design development if this option is selected.



2.08 PROGRAMMING REQUIREMENTS

A. See Section 40 90 01, Instrumentation and Control for Process Systems, and all associated Supplements for programming requirements.

B. Coordinate with the PICS Contractor for duplication of all Panel PC screens on the Plant SCADA System.

2.09 SEQUENCE OF OPERATION – SOLIDS COLLECTION SYSTEM

A. Manual Mode of Operation (Solids Collection System):

1. Forward Mode of Operation:
   a. The three-position, maintained-contact LOCAL-OFF-REMOTE selector switch (located at the local Solids Collector Operating Station) must be placed in the LOCAL position.
   b. The Solids Collection System may be started in the FORWARD MODE OF OPERATION by the operator depressing the momentary contact RUN FORWARD pushbutton.
   c. This shall initiate the Solids Collection System to run / cycle continuously at last speed value enter at the AFD.
   d. The Solids Collection System shall start operation from any position (other than the END OF TRAVEL position) and operate in the FORWARD RUNNING mode until its END OF TRAVEL limit has been reached (when the corresponding END OF TRAVEL limit switch changes states).
   e. Once the Solids Collector's corresponding END OF TRAVEL limit switch changes states, the Solids Collection System motor shall stop operating in the forward direction and start operating in the REVERSE direction.
   f. The Solids Collection System shall start operation from the END OF TRAVEL position and operate in the REVERSE RUNNING mode until its HOME position limit has been reached (when the corresponding HOME position limit switch changes states).
   g. Once the Solids Collector's corresponding HOME position limit switch changes states, the Solids Collection System motor shall stop operating in the reverse direction and start operating in the FORWARD direction.
   h. While in the MANUAL MODE OF OPERATION, the system shall operate in this manner indefinitely, until stopped by the operator depressing the momentary-contact STOP pushbutton or by the operator depressing the maintained-contact EMERGENCY STOP pushbutton.

i. If the Solids Collector is stopped at the END OF TRAVEL position and the operator depresses the momentary contact RUN FORWARD pushbutton, the Solids Collection System shall not start since it cannot move in the FORWARD direction.

2. REVERSE MODE OF OPERATION:
   a. The three-position, maintained-contact LOCAL-OFF-REMOTE selector switch (located at the local Solids Collector Operating Station) must be placed in the LOCAL position.
   b. The Solids Collection System may be started in the REVERSE MODE OF OPERATION by the operator depressing the momentary contact RUN REVERSE pushbutton.
   c. This shall initiate the Solids Collection System to run/cycle continuously at last speed value enter at AFD.
   d. The Solids Collection System shall start operation from any position (other than the HOME position) and operate in the REVERSE RUNNING mode until its HOME position limit has been reached (when the corresponding HOME position limit switch changes states).
   e. Once the Solids Collector's corresponding HOME position limit switch changes states, the Solids Collection System motor shall stop operating in the reverse direction and start operating in the FORWARD direction.
   f. The Solids Collection System shall start operation from the HOME position and operate in the Forward Running mode until its END OF TRAVEL position limit has been reached (when the corresponding END OF TRAVEL position limit switch changes states).
   g. While in the MANUAL MODE OF OPERATION, the system shall operate in this manner indefinitely, until stopped by the operator depressing the momentary-contact STOP pushbutton or by the operator depressing the maintained-contact EMERGENCY STOP pushbutton.
   h. If the Solids Collector is stopped at the HOME position and the operator depresses the momentary contact RUN REVERSE pushbutton, the Solids Collection System shall not start since it cannot move in the REVERSE direction.

B. Remote Mode of Operation (Solids Collection System):

1. A graphic shall be provided on the Plant SCADA HMI which shall allow an operator to select a Solids Collection Cell MODE OF OPERATION.

2. A graphic shall be provided on the Plant SCADA HMI which shall allow the operator to select either REMOTE-MANUAL or REMOTE-AUTO modes of operation.
3. REMOTE-MANUAL Mode of Operation:
    a. The three-position, maintained-contact LOCAL-OFF-REMOTE selector switch (at the local Solids Collector operator station) must be placed in the REMOTE position.
    b. If the REMOTE-MANUAL Mode of Operation has been selected by the operator via the Plant SCADA HMI, a graphic shall be furnished which shall allow the operator to enter the following:
        1) The speed at which the selected Solids Collector is to operate (Minimum Solids Collector Operating Speed – 100 percent).
        2) The percentage of the Solids Collector is to travel in the basin (0 percent to 100 percent).
        3) A Solids Collector RUN and STOP HMI pushbutton icons for the selected Solids Collector.
    c. Upon the above information being entered by the operator, the operator shall initiate the system by depressing the Solids Collector RUN HMI graphic icon.
    d. This shall send the Solids Collector to its HOME position (if it is in any other position other than HOME).
    e. Once the Solids Collector has proven that it is in the HOME position (via its corresponding HOME position limit switch), the following shall occur:
        1) If the corresponding Sludge Collector Flow Valve is in the AUTO mode of operation, the Sludge Collector Flow Valve shall be commanded open via the PLC. If the corresponding Sludge Collector Flow Valve is in the LOCAL position, it must be proven that it is in its FULLY OPENED position.
        2) If the LEAD Sludge Pump is in the AUTO mode of operation, LEAD Sludge Pump shall be commanded to start via the PLC (through the SCADA system). If the Sludge Pumps are running in the MANUAL mode of operation, one of the Sludge Pumps must prove that it is RUNNING.
        3) Once the corresponding Sludge Collector Flow Valve is proven to be in its FULLY OPENED position and the LEAD pump has proven that it is RUNNING, the Solids Collection System shall start and operate at the speed as set by the Operator.

f. For a complete forward cycle (the percentage of the Solids Collector is to travel in the basin set to 100 percent):
   1) Once the Solids Collector's corresponding END OF TRAVEL limit switch changes states, the Solids Collection System motor shall stop operating in the forward direction, the LEAD Sludge Pump shall be commanded to STOP (if in the AUTO mode) and the corresponding Sludge Collection Flow Valve shall be commanded to close (if in the AUTO mode) and the Solids Collector shall return to its HOME position.
   2) The cycle time shall be monitored by the PLC. If a full cycle was selected by the operator and the END OF TRAVEL limit switch does not change states within the calculated time to complete its forward cycle plus 20 percent (field adjustable), a warning shall be sent to the Plant SCADA HMI and the system shall be shut down (as indicated above) by the PLC.

g. For a partial forward cycle (the percentage of the Solids Collector is to travel in the basin set below 100 percent):
   1) Once the Solids Collector's calculated time (to complete the entered partial forward cycle) times out, the Solids Collection System motor shall stop operating in the forward direction, the LEAD Sludge Pump shall be commanded to STOP (if in the AUTO mode) and the corresponding Sludge Collection Flow Valve shall be commanded to close (if in the AUTO mode) and the Solids Collector shall return to its HOME position.
   2) If the END OF TRAVEL limit switch changes states prior to the timer timing out, the Solids Collection System motor shall stop operating in the forward direction, the LEAD Sludge Pump shall be commanded to STOP (if in the AUTO mode) and the corresponding Sludge Collection Flow Valve shall be commanded to close (if in the AUTO mode) and the Solids Collector shall return to its HOME position.

4. REMOTE-AUTOMATIC Mode of Operation:
   a. Solids Collection System Sequencing:
      1) The three-position, maintained-contact LOCAL-OFF-REMOTE selector switch (located at the local Solids Collector operator station) must be placed in the REMOTE position.
      2) All Solids Collection Systems which are placed in the REMOTE Mode of Operation shall be placed in sequential order (1-1, 1-2, 1-3, 2-1, 2-2 and 2-3).

3) If any of the above Solids Collection Systems is placed in the OFF position, it shall be skipped in the sequence.
4) If one of the Solids Collectors is being run in the MANUAL MODE or REMOTE MANUAL MODE of operation and has been proven RUNNING, its corresponding Sludge Collection Flow Valve has been proven FULLY OPENED and one of the Sludge Pumps has been proven RUNNING, the Solids Collection System shall not operate in the AUTOMATIC Mode of Operation until all Solids Collectors are not RUNNING, all of the Sludge Collection Flow Valves are in their FULLY CLOSED positions and both Sludge Pumps are proven not to be RUNNING.
5) If the above permissive are met, the system shall operate in the AUTOMATIC Mode of Operation.

b. A graphic shall be furnished which shall allow the operator to enter the following information on the SCADA HMI prior to initiating this system in the "Automatic" mode of operation.
1) Speed at which the selected Solids collector is to operate (Minimum Solids Collector Operating Speed: 100 percent).
2) Percentage of the Solids Collector is to travel in the basin (0 percent to 100 percent).

c. A graphic shall be furnished for the overall Solids Collection system which shall allow the operator to do the following:
1) Enter a time to initiate a "Total System Cycle Interval" (example: Initiate a Clarifier No. 1 Solids Collection Cycle every 24 hours - Repeat Cycle Timer – Operator adjustable).
2) Initiate a "Solids Collection System Start" by depressing an HMI pushbutton icon.
3) Initiate a "Solids Collection System Stop" by depressing an HMI pushbutton icon.

d. Once this information has been entered for each Solids Collector for Clarifier No. 1 the operator may initiate a "Solids Collection System Start" by depressing the corresponding HMI SCADA icon.

e. The first Solids Collector shall initiate operation. This shall include the following:
1) Each Solids Collector shall start from the "Home" position. If the Solids Collector is in any position other than the "Home" position, the PLC shall command the Solids Collector to return to "Home" position prior to beginning its "Automatic" Solids Collection cycle.
2) With the Solids Collector starting in the “Home” position (via its corresponding “Home” position limit switch), the

PLC shall send a remote "Run Forward" command to the first Solids Collector in the sequence.

3) The PLC shall send a remote Sludge Collector Flow Valve "Open" command to the Sludge Collectors corresponding Flow Valve.

4) Once the valve is proven "Fully Opened", the PLC shall send a remote "Lead" Sludge Pump "Start" command to the "Lead" Sludge Pump at Pump Station No. 1 (via the Plant SCADA System).

f. When the "End of Travel" limit switch changes states, for the Solids Collector in operation, the following shall occur:

1) Send a remote "Run Reverse" command, for the Solids Collector in operation, this Solids Collector shall return to the "Home" position.

2) Send a remote Sludge Collector Flow Valve "Close" command to the Solids Collectors corresponding Flow Valve.

3) Send a remote "Lead" Sludge Pump "Stop" command to the "Lead" Sludge Pump at Pump Station No. 1 (via the Plant SCADA System).

g. Once the Sludge Flow Valve has been proven "Fully Closed" and the "Lead" Sludge Pump confirmed not "Running", the following shall occur:

1) Send a remote "Run Forward" command to the next Solids Collector in the sequence.

2) Send a remote Sludge Collector Flow Valve "Open" command to the next Solids Collector in the sequence corresponding Sludge Collector Flow Valve.

3) Once the valve is proven "Fully Opened", the PLC shall send a remote "Lead" Sludge Pump "Start" command to the "Lead" Sludge Pump at Pump Station No. 1 (via the Plant SCADA System).

h. This shall continue until all of the Solids Collectors in the system have run through a complete Solids Collecting Cycle.

i. Once the final Solids Collector has completed its Solids Collecting Cycle, it shall return to "Home" position and the Solids Collection System shall await the Automatic Solids Collection System Start command initiated by the completion of the “Total System Cycle Interval” timer to time out and reset.

2.10 SAFETIES AND INTERLOCKS – SOLIDS COLLECTION SYSTEM

A. If a Sludge Collection Flow Valve is commanded to open by the PLC and the valve’s “Fully Opened” limit switch does not change states within 45 seconds

(field adjustable), the valve shall be considered failed by the PLC and lock both the Sludge Collection Flow Valve and the Solids Collector out for "Automatic" operation (the corresponding Solids Collector shall be taken out of the Solids Collector Sequencing until reset by the operator via the Solids Collector "Reset" HMI and OIU graphic icon push button).

B. If a Sludge Collection Flow Valve is commanded to close by the PLC and the valve's "Fully Closed" limit switch does not change states within 45 seconds (field adjustable), the valve shall be considered failed by the PLC and lock both the Sludge Collection Flow Valve and the Solids Collector out for "Automatic" operation (the corresponding Solids Collector shall be taken out of the Solids Collector Sequencing until reset by the operator via the Solids Collector "Reset" HMI and OIU graphic icon push button).

C. If a Solids Collector is called to run by the PLC and the "Lead" Sludge Pump (located at Sludge Pumping Station No. 1) has not proven that it is "Running" within 90 seconds (field adjustable), the Solids Collection system shall be placed in a "Standby" mode of operation and an alarm shall be initiated indicating "Solids Collection System Fault" which shall be displayed at the Plant SCADA HMI.

D. If any of the local Solids Collector Emergency Stop Push Buttons are depressed, the associated Solids Collector AFD shall be shut off (via a "hard-wired" interlock), and the associated Sludge Collection Flow Valve shall be commanded to close via the PLC and the "Lead" Sludge Pump shall be commanded "Off" via the PLC. The Solids Collection System shall be locked out from operation by the PLC. An alarm shall be initiated and recorded and displayed on the Plant SCADA HMI. Once the emergency has been cleared and the Emergency Push Button restored to its normal state (by the operator twisting and releasing the Emergency Push Button), the Solids Collection System shall be able to resume operation in the "Automatic" Mode once the Solids Collection System "Reset" HMI and OIU graphic icon push-button has been depressed by the operator.

2.11 ACCESSORIES

A. Provide Home Position and End of Travel limit switches and wire back to the local control panels. Provide one set of these switches for each mechanism.

B. Anchors: Anchors shall be sized and provided by Manufacturer and shall be constructed of Type 316 stainless steel and at least 3/8 inch in diameter in accordance with Section 05 50 00, Metal Fabrications. Contact of anchors with concrete reinforcing steel will not be accepted.

C. Supports for drive assemblies and control panels shall be designed and provided by Manufacturer, and shall be Type 316 stainless steel.

2.12 SOURCE QUALITY CONTROL

A. Unwitnessed Factory Tests (UFT) and Adjustments:

1. Hose-less collection system components shall be factory tested at point of manufacture. Test each equipment assembly to ensure proper operation of mechanical equipment, electrical equipment, controls, protective devices, and override controls.
2. Run equipment and test for minimum 2 hours.
3. Testing shall be done in factory with unit oriented in its installed position.
4. Engineer reserves right to be present during factory testing. Engineer shall be notified at least 6 weeks prior to estimated test date.
5. Control panels shall be tested in accordance with Section 40 90 01, Instrumentation and Control for Process Systems, requirements.
6. Testing procedures (UFT) shall be submitted and approved prior to testing per Section 40 90 01, Instrumentation and Control for Process Systems, requirements. Test reports verifying successful passing of testing shall be submitted prior to the control panels being shipped to the Site.
7. Test each screen assembly to ensure operation of protective devices and override controls.

PART 3 EXECUTION

3.01 GENERAL

A. All parts of the solids collection system shall be amply proportioned for all stresses that may occur during fabrication, shipment, erection, and intermittent or continuous operation.

3.02 ASSEMBLY AND DELIVERY

A. All drive assemblies shall be shop tested prior to shipment.

B. All parts and components shall be factory-assembled in sections convenient for field handling and installation but requiring the minimum amount of work for field assembly. Any field assembly work shall be bolted. No cutting or welding should be required on either field assembly or erection, except for welding of telescoping pipe sections.

C. All assembled parts and components ready for shipment shall be securely bundled, coiled, or crated and adequately protected from damage and corrosion during shipment and storage.

D. Equipment should be stored indoors in a dry area prior to installation.

3.03 INSTALLATION

A. Solids collection equipment shall be installed as indicated on the Contract Drawings and in accordance with the manufacturer's recommendations.

B. Provide factory certified service technician to inspect the installation, and supervise startup and initial operation of the solids collector system.

C. Factory certified service technician to provide field support certifying that the equipment is properly installed, fully operational and ready for to the Engineer.

3.04 FIELD QUALITY CONTROL

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for the minimum person-days listed for the services herein under, travel time excluded:

1. 4 person-days for installation assistance, inspection, and certification of the installation.
2. 4 person-days for functional testing.
3. 1 person-day for prestart up classroom or jobsite training.
4. 1 person-day for post-startup training of Owner’s personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Engineer.

B. Functional Test: Inspect for proper alignment, quiet operation, excessive vibration, proper connection, proper control system function, and satisfactory performance by means of a functional test.

C. Startup services and training of Owner's personnel shall be at such times as requested by the Owner.

D. In the event of unforeseen installation difficulty or problems. Manufacturer shall provide a qualified technical representative to the jobsite within 48 hours notification that such a situation exists.

3.05 ADDITIONAL SERVICES

A. After the facilities have been accepted by both the Owner and the Engineer (after substantial completion) for 12 months, provide an additional 12 hours of programming time to make adjustments to the PLC and/or OIU programming as required by the Owner. This time shall not include travel to and from the project site for implementation of the programming changes. If the package system supplier is not local to the plant, the time listed shall be done during one continuous trip.

3.06 MANUFACTURER'S CERTIFICATE

A. The following certificates shall be provided:

1. Certificate of Proper Installation.

3.07 SUPPLEMENT

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

1. Hose-Less Solids Collection System Data Sheet.

END OF SECTION

HOSE-LESS SOLIDS COLLECTION SYSTEM DATA SHEET					
Equipment Tag No.	**Location**	**Collector Width**	**Travel Length**	**Manufacturer-Supplied Curb Required**	**Remarks**
M-03-35-1-1	Clarifier No. 1 Basin 1	26’-6” (1)	178’-6”	No	
M-03-35-1-2	Clarifier No. 1 Basin 1	26’-6” (1)	178’-6”	No	
M-03-35-1-3	Clarifier No. 1 Basin 1	26’-6” (1)	178’-6”	No	
M-03-35-2-1	Clarifier No. 1 Basin 2	26’-6” (1)	178’-6”	No	
M-03-35-2-2	Clarifier No. 1 Basin 2	26’-6” (1)	178’-6”	No	
M-03-35-2-3	Clarifier No. 1 Basin 2	26’-6” (1)	178’-6”	No	
(1) Inside of curb to inside of curb (or wall).					

SECTION 44 44 36
HORIZONTAL PADDLE FLOCCULATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. American Gear Manufacturers Association (AGMA):
   a. 2004-B89, Gear Materials and Heat Treatment Manual.
   b. 6001-D97, Design and Selection of Components for Enclosed Gear Drives.
   c. 6010-F97, Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives.
3. American Iron and Steel Institute (AISI).
4. American Society of Mechanical Engineers (ASME):
   a. B1.20.1, Pipe Threads, General Purpose (Inch).
   b. B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   c. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24.
5. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
6. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
7. The Society for Protective Coatings (SSPC).

B. The following specification sections are to be used in conjunction with this specification, this section shall rule if any discrepancies are encountered:

1. Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
2. Section 40 90 01, Instrumentation and Control for Process Systems, and all associated Supplements for additional Instrumentation and Control Panel requirements.

1.02 SUBMITTALS

A. Action Submittals:

1. Complete information required by data sheets attached at end of Specification.
2. Make, model, weight, and horsepower of each component.
3. Manufacturer's catalog information, descriptive literature, specifications, and materials of construction.
4. Data and design computations upon which design of paddle wheels are based, including mixing intensity (G), tip speed, power input, and structural calculations. Calculations shall also include feed water force against flocculation paddle wheel.
5. Data and design computations upon which design of drive mechanism's supports are based including maximum pullout and torque forces.
6. Current limit set point requirements for high- or over-torque safety.
7. Detailed structural, mechanical, and electrical drawings showing equipment fabrications and interface with other items. Include dimensions, size, and details of anchorages and of connections to other work, and weights of associated equipment.
8. Template for anchor bolts and other connections.
9. External utility requirements such as air, water, power, drain etc., for each component.
10. Motor nameplate data, in accordance with NEMA MG1, motor manufacturer, and any motor modifications.
11. Power and control wiring diagrams, including terminals and numbers.
12. Control panel layout drawings, and control schematics.
13. Information on proposed factory-applied coating system.
14. Method of chain tightening of drive chains.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Storage, handling, and installation instructions.
3. Field installation and testing procedures.
4. Functional test results.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer's Certificate of Compliance for each flocculation mechanism installed in accordance with Section 01 61 00, Common Product Requirements.
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.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Designer: Registered Professional Engineer.

1.04 EXTRA MATERIALS:

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools as recommended by manufacturer.

Item	Quantity
Drive Chain	Four complete sets
Special tools required to maintain or dismantle	Four complete sets for each different sized unit

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 the section shall be products of:

1. Meurer Research, Inc.
2. No “or-equal” or substitute product will be considered.

2.02 SERVICE CONDITIONS

A. Process Description: The horizontal paddle flocculators will be installed outdoors.

B. Water Description: 40 degrees F, viscosity 2.7 cP by 10.5 lbs/sec/ft^2.

C. Basin Dimensions and Water Depths: All stages, 74.5 feet long by 12.5 feet wide by 13 feet deep.

D. Design Mixing Intensity (G, sec^{-1}) per Compartment:

1. Stage 1 80 $^{S-1}$.
2. Stage 2 60 $^{S-1}$.
3. Stage 3 40 $^{S-1}$.
4. Stage 4 20 $^{S-1}$.

E. System Flow Rates: 20 mgd per basin.

2.03 SHAFT SYSTEM

A. General:

1. Furnish each shaft in sections connected by ANSI flanges to facilitate installation and removal.
2. Each shaft shall support five paddle assemblies.
3. Shafts shall be aligned parallel to direction of flow.
4. Each settling tank shall contain four shafts that shall be rotating clockwise for the south basin and counter-clockwise for the north basin.
5. Each flocculator shaft shall be driven by an individual drive.
6. Maximum Combined Shear Stress: 6,000 psi at any point in shaft, determined by combining bending and torsional stresses under full operating load using Mohr's circle stress convention.
7. Yield Stress: Minimum of 5X the Maximum Combined Shear Stress.
8. Maximum Vertical Deflection: 1/360 inch per foot between support reactions, under dry load.
9. Maximum Total Torsional Deflection: 5 degrees, each shaft.
10. Construction:
    a. Fabricate shaft and accessories from ASTM A276, AISI Type 316 stainless steel, unless noted otherwise.
    b. Either solid or hollow/solid are considered acceptable subject to design constraints specified:
    c. Solid:
        1) Solid, cold-finished, straight and true, held in alignment with set-screwed collars.
        2) Coupling: Rigid compression type; firmly keyed to shaft and designed to transmit torque and axial thrust loads applied to shaft.
        3) Hubs for mounting paddle arm assemblies: Firmly keyed (or shop-welded) to shaft, minimum 1/2 inch thickness, to transmit maximum torque.

d. Hollow/Solid:
   1) System shall consist of hollow pipe sections with solid sections at bearing supports, held in alignment with set-screwed collars.
   2) Hollow Sections: Minimum Schedule 80 pipe.
   3) Solid Sections: Cold-rolled, machined.
   4) Each section end shall be counter-bored for locating machined blind flange, minimum 3/4 inch thick, which shall be shop welded in place.
   5) Flange faces shall be machined after fabrication to assure perpendicularity to the shaft centerline.
   6) Paddle arm mounting flanges, minimum 1/2 inch thick, shall be shop welded to each section.
   7) Intermediate sections shall have a machined flange shop-welded in place on each end; end sections shall have a machined flange shop-welded on one end. Flange faces shall be machined after fabrication to assure perpendicularity to shaft centerline.

e. Solid shaft at drive end shall have a keyway for drive sprocket mounting. Shaft shall be supported and aligned to minimize loading to drive mechanism.

f. Weld procedures for solid shafting shall minimize internal stress created by stress relief procedures. Multiple pass rather than single pass weld technique shall be used in order to minimize internal stress and heat build-up. Base metal, outside 1 inch of base weld, shall not exceed 400 degrees F.

B. Bearings:

1. Cast iron, split pillow block type.
2. Bearing Length to Shaft Diameter Ratio: Greater than 2.0.
3. Submerged bearings shall be designed for water lubrication and equipped with wearing-resistant bearing liners and felt seals. Provide grease fitting and grease groove for auxiliary lubrication to be used in dry operation. Bearing caps and bases shall be doweled to assure proper mating orientation. Liner shall be thermoplastic or nonmetallic composite.
4. Furnish with slotted bolt holes and minimum 1/2 inch thick ASTM A276, AISI Type 316L stainless steel baseplate to allow for shaft alignment and maintenance.
5. Furnish with adhesive stainless steel anchor bolts. Refer to Section 05 50 00, Metal Fabrications, for additional requirements.

C. Wall Penetrations: Provide seal for each solid stainless steel shaft extending through a basin wall. Each shall be designed per manufacturer's recommendation. Each assembly shall include drip well with drain connection designed to direct leakage. Drain connection shall be piped to floor drain at floor.

D. Paddle Wheels:

1. Approximately 10.5 feet in diameter and installed horizontally as shown on Drawings. Paddle cross-sectional area shall not exceed 25 percent of basin cross-sectional area. Paddles shall provide for uniform flocculation.
2. Each paddle wheel shall have a minimum of three structural arms bolted to shaft assembly by ASTM A276, AISI Type 316 stainless steel bolts, nuts, and lockwashers. Paddles shall cover full width and depth of basins and shall provide specified mixing intensity. Paddle lengths shall be varied as required to clear chain drives and supports. Paddles shall be made of 16-gauge, Type 316 stainless steel, 2 inches by 6 inches and bolted to structural ASTM A276, AISI Type 316L stainless steel arms with ASTM A276, AISI Type 304 stainless steel bolts, locknuts, washers.
3. Minimum thickness of all steel structural members shall be 1/4 inch.
4. Size structural stainless steel arms such that tip deflection of arm is less than 1/360 of the arm length under full operating load.
5. Direction of rotation of paddle wheels shall be as shown on Drawings.

E. Flanges and Pipe Threads:

1. Flanges on equipment shall comply with ANSI B16.1, Class 125; or ANSI B16.5, Class 150, unless otherwise indicated.
2. Threaded flanges and fittings shall have standard taper pipe threads complying with ASME B1.20.1.

2.04 DRIVE SYSTEM

A. Mechanism:

1. Electrical variable speed, with motor and gear reducer and shear pin device mounted in a compact unit on a common structural pedestal type steel base.
2. Speed Reducer: Helical or cycloidal gear, in-line type, rated AGMA 6010-F97 Class II for 24-hour, continuous duty, moderate shock load including a 1.5 service factor based upon motor nameplate horsepower. Anti-friction bearings and gearing shall run in a totally submerged oil bath. The bearings shall have a minimum B10 rating of

100,000 hours. Housings for the speed reducers shall be constructed of cast iron.

3. Operate with a minimum four to one variable output speed.
4. Motor and variable speed mechanism/speed reducer shall be bolted and doweled in accurate alignment on machined surfaces of cast iron or stainless steel.
5. Provide one Type 316L stainless steel support for each drive. Support shall be sized to accommodate maximum pullout and torque forces. Support shall transmit forces from drive mechanism to dry pit wall.

B. Gears and Gear Drive:

1. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA 6010-F97, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used.
2. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape, but keep dust and dirt out. Casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. Provide oil level sight glass and oil flow indicator, installed for easy reading.
3. Material selections shall comply with AGMA 2004-B89 and AGMA 6001-D97 values and the manufacturer's recommendations. Input and output shafts shall be properly designed for service and load requirements. Gears shall be computer-matched for minimum tolerance variation. Output shall have two positive seals to prevent oil leakage.
4. Oil level and drain location shall be readily accessible. Oil coolers or heat exchangers with all required appurtenances shall be included where indicated.
5. Where gear drive input to output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.

C. Bearings:

1. Bearings shall conform to ABMA 9 and ABMA 11.
2. Except where otherwise indicated, bearings of process equipment shall have a minimum L-10 life expectancy of 100,000 hours.

D. Chain and Sprocket Drive Assembly:

1. Drive Sprocket Assembly: One sprocket wheel manufactured from UHMW polymer. Tooth number and pitch shall be designed by flocculation equipment manufacturer. Hub to be bored, keyseated, and set-screwed for reducer output shaft.
2. Driven Sprocket: One split design, shear pin type, Class 35 cast iron body segmented for appropriate chain. Sprocket tooth number and pitch shall be designed by flocculation equipment manufacturer. Rim teeth to be made from UHMW polymer. All hardware to be Type 316 stainless steel. Hub to be bored, keyseated and setscrewed for shaft. Cast iron components shall be coated per manufacturer's recommendation for the service conditions.
3. All sprockets shall be of the same manufacturer.
4. Sprocket teeth to be cut for the appropriate chain.
5. Drive Chain: Sized by manufacturer with appropriate safety factor. Chains shall be H-78 type stainless steel. The chain shall have a design working load of not less than 1/10 of the ultimate strength based on both strength and wear considerations. Connecting pins of 300 Series stainless steel shall be snap-in construction. Pins shall be pressed into link sidebars to exclude abrasives. Chain barrel shall have a diameter along its full working length that allows proper engagement with 1-inch maximum face width of sprocket.
6. Chain Tightener: Provide chain tighteners for each drive chain.
7. Chain Guard: Chain drives above operating platform shall be covered with removable metal guard of 16-gauge, ASTM A276, AISI Type 316L stainless steel or aluminum Type 6061-T-6.
8. Set collars: Two split collars, one provided against each submerged head and tail shaft bearing to prevent lateral movement.

E. Powder Coated Aluminum Enclosures:

1. Provide for each unit to contain all equipment (e.g., motor, drive, chain guard, etc.) on operating level.
2. Provide access doors to inspect and maintain equipment or total hinged cover.
3. Designed to protect motor and drive equipment for year-round operation in outdoor installation. Provide adequate heat dissipation to prevent motor from overheating in summer conditions.
4. Fasten enclosure to operating deck as recommended by manufacturer. Fastening hardware shall be as specified in Section 05 50 00, Metal Fabrications.
5. Easily removable to access equipment.

2.05 MOTORS

A. Squirrel-Cage AC Induction Type:

1. Motor Horsepower: 5 maximum (horsepower as required based on load requirements, velocity gradients, drive efficiencies and safety factor).
2. Nominal Speed: 1,750 rpm, 230/460 volt, three-phase, 60-Hz.
3. Application: Variable Speed, Inverter Duty.
4. Enclosure Type: Chemical industry severe duty TEFC enclosure.
5. Drive: Direct-drive with flexible couplings and guard.
6. Motor Efficiency: Premium efficiency.

2.06 ADJUSTABLE FREQUENCY, CONTROLLED SPEED, DRIVE MECHANISMS

A. Adjustable Speed Control System:

1. Provide speed control system capable of producing a continuously adjustable motor speed from 25 percent to 100 percent of motor full-load, rated speed.
2. Provide adjustable speed controllers suitable for top or bottom conduit entry.
3. Provide 120-volt power to motor thermal protector relay.
4. Coordinate sizing of adjustable frequency, controlled speed, drive systems with drive motors specified herein.

B. Refer to Section 26 29 23, Low-Voltage Adjustable Frequency Drive System, for additional requirements.

2.07 INSTRUMENTATION AND CONTROLS

A. Instrumentation and controls work of this section shall be in accordance with requirements of Section 40 90 01, Instrumentation and Control for Process Systems. Provide all items, including items not specifically called out, which are required to implement the specified functions, and the functions required for proper system operation.

B. Drives for a single settling tank shall be controlled from a local panel containing starters, controls, and indicators.

C. Control Panels, General:

1. Provide the following control panel(s):

Panel No.	Name	NEMA Rating	Mounting
FLOC-CPN10201	Flocculator 10201	4X Stainless Steel (Powder Coated White Finish)	Handrail
FLOC-CPN10202	Flocculator 10202		
FLOC-CPN10203	Flocculator 10203		
FLOC-CPN10204	Flocculator 10204		
FLOC-CPN10205	Flocculator 10205		
FLOC-CPN10206	Flocculator 10206		
FLOC-CPN10301	Flocculator 10301		
FLOC-CPN10302	Flocculator 10302		
FLOC-CPN10303	Flocculator 10303		
FLOC-CPN10304	Flocculator 10304		
FLOC-CPN10305	Flocculator 10305		
FLOC-CPN10306	Flocculator 10306		

D. Operator Controls and Indicators:

1. As a minimum, provide the following functions on the face of each control panel:
   a. Hand Switches:
      1) "Run-Off-Remote."
      2) Manual Speed Setpoint Control.
      3) Emergency Stop.
   b. Status Indicating Lights:
      1) "Running."
      2) "Fault."

E. Functional Requirements:

1. Paddle flocculator motor runs when switch is in "Run" position.
2. Paddle flocculator motor does not run when switch is in "Off" position.
3. Paddle flocculator accepts a dry contact remote "Run" signal when switch is in "Remote" position.

F. External Interfaces:

1. Provide the following external interfaces to other equipment not provided under this section:
   a. Discrete outputs from control panel to plant control system PLC: Provide the following maintained dry contact outputs which shall be used as discrete inputs by PLC. Contacts shall be rated for 5 amps at 120V ac.
      1) "In Remote."
      2) "Running."
      3) "VFD Fault."
      4) "Emergency Stop Depressed."
      5) "High Winding Temperature."
      6) "Reset Depressed."
   b. Discrete inputs from plant control system PLC: Accept the following dry contact inputs to the control panel. Contacts shall be rated for 2 amps at 120V ac. Sensing voltage shall be 120V ac. Provide interposing relay if a contact rating greater than 2 amps is required.
      1) Remote "Start."
      2) Remote "Stop."
   c. Analog Outputs from control panel to plant control system PLC: Provide the following 4 mA to 20 mA Analog Outputs.
      1) VFD Remote "Speed" setpoint.
   d. Analog Inputs from VFD to Plant Control System PLC: Provide the following 4 mA to 20 mA Analog Input:
      1) VFD Remote "Speed feedback."

G. Power Requirements: Each panel shall operate from a single 480-volt, three-phase power source. Provide separate branch circuits with branch circuit breakers for each flocculator. Provide a single main disconnect for each panel.

H. Adjustable Frequency Drive: Provide Adjustable Frequency Drive for each flocculator located in the control panel.

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 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

engraved block type enamel filled equipment identification number and letters indicated on Drawings.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.09 FABRICATION

A. Shop Assembly:

1. All parts and components shall be factory-assembled in sections convenient for field handling and installation but requiring the minimum amount of work for field assembly. Any field assembly work shall be bolted. No cutting or welding should be required on either field assembly or erection.
2. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
3. All assembled parts and components ready for shipment shall be securely bundled, coiled, or crated and adequately protected from damage and corrosion during shipment and storage.

B. Shop/Factory Finishing: Shop prepare and prime surfaces described herein in accordance with primer manufacturer's recommendations, Steel Structures Painting Council (SSPC) standards, and all applicable federal, state, and local codes. See Section 09 90 00, Painting and Coating, for further information.

2.10 SOURCE QUALITY CONTROL

A. Functional Tests:

1. Test all components including control panels and electrical equipment. All variable speed and gear-reduction assemblies shall be shop tested prior to shipment. The speed reduction assemblies shall be run with rust-inhibiting oil.
2. Motors: Short commercial test.
3. Functional Test: Perform manufacturer's standard, test on equipment. Include vibration test, as follows:
    a. Dynamically balance rotating parts of each drive unit before final assembly.
    b. Driving Unit Limits: Less than 80 percent of NEMA MG1 limits.

PART 3 EXECUTION

3.01 EXAMINATION

A. Manufacturer's representative shall verify the following conditions prior to assembly:

1. All existing structures dimensions shall be verified before submittals are submitted to the Engineer.

3.02 INSTALLATION

A. In accordance with manufacturer's written instructions and drawings, and as shown on Contract Drawings.

B. Anchor Bolts: Accurately place using templates furnished by equipment name manufacturer and as specified in Section 05 50 00, Metal Fabrications.

3.03 FIELD QUALITY CONTROL

A. Functional Tests:

1. Conduct on each flocculator as follows:
   a. Alignment: Prior to facility startup, test complete assemblies for correct rotation, proper alignment and connection, quiet operation, excessive vibration, and satisfactory specified performance.
   b. Manufacturer shall verify proper installation of flocculator system. Acceptance and approval of equipment installation and operation by manufacturer is required prior to startup. Submit documentation to Engineer.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's representative shall assist in supervision of installation, in startup and testing equipment, and in training Owner's staff in proper operation and maintenance of the equipment.

B. Manufacturer's Representative:

1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 4 person-days for installation assistance and inspection.
   b. 1 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for prestartup classroom or Site training.

d. 1 person-day for facility startup.
e. 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.

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

3.05 SUPPLEMENT

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

1. Flocculation Equipment Data Sheets (to be completed by manufacturer and submitted).

END OF SECTION

FLOCCULATION EQUIPMENT
DATA SHEET

EQUIPMENT MANUFACTURER:

Name: _____

Address: _____

Telephone: _____

EQUIPMENT DATA (Note: Fill one figure only if item common to all stages):

	1st Stage	**2nd Stage**
Paddle Wheels Diameter		
Tip Speed		
Number of Arms		
Number of Paddles		
Paddle Size		
Paddle Material		
Shaft Diameter		
Shaft Material		

	3rd Stage	**4th Stage**
Paddle Wheels Diameter		
Tip Speed		
Number of Arms		
Number of Paddles		
Paddle Size		
Paddle Material		
Shaft Diameter		
Shaft Material		

FLOCCULATION EQUIPMENT
DATA SHEET

DRIVE MECHANISM (Note: Fill one figure only if item common to all stages):

SHAFT BEARING TYPE AND LUBRICANT	
Intermediate	
Supporting End	
Driven End	
VARIABLE-SPEED DRIVE	
Motor Type	
Speed Ratio	
GEAR REDUCER	
Type	
Speed Ratio	
Rating (AGMA)	
Minimum Speed at Flocculators (rpm)	
PERFORMANCE DATA	
Stage 1 Min G (sec-1) at 10 degrees C	
Stage 2 Min G (sec-1) at 10 degrees C	
Stage 3 Min G (sec-1) at 10 degrees C	
Stage 4 Min G (sec-1) at 10 degrees C	

SECTION 44 44 57
PARALLEL PLATE SETTLER SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section covers the design, manufacture, delivery, site storage, installation, testing and placement into operation of parallel plate settling equipment.

B. Parallel plate settler system includes, but is not limited to, plate packs consisting of plates, frames, effluent troughs and weirs, effluent trough connections/extensions, influent baffles, spacers/stiffeners, gaskets, lifting attachments, anchoring systems, and all appurtenances necessary for a complete and operating system.

C. Conform to other related work specified elsewhere.

1.02 GENERAL

A. The parallel plate settler equipment manufacturer shall furnish an engineered system suitable for clarification of coagulated and flocculated water.

B. Details such as sizing of openings from distribution inlet flumes into space between plates, size and spacing of outlet orifices or weirs from plates into the settled water collection flumes, etc., shall be defined by and be responsibility of Contractor and shall be consistent with all requirements imposed in this section.

C. The manufacturer of the parallel plate settler system shall utilize a fabrication facility regularly engaged in the manufacturing of parallel plate clarification equipment.

D. The Contractor will, at his expense, remove any equipment requiring repairs, replacements, and/or refurbishment necessitated by defects in materials or workmanship, or caused by long-term exposure to the environment (process water or atmosphere) within the warranty period. The Contractor shall be responsible for all transportation associated with removal and replacement of equipment or materials for repair, replacement, or refurbishment of this equipment.

1.03 SUBMITTALS

A. Action Submittals:

1. Complete description of the parallel plate settler system, including plate pack support frames, plates, inlet baffles and flumes, outlet weirs and flumes, embedded metal wall connectors, fasteners, and other ancillary items.
2. Plan and section views of the basins, anchor bolt location and templates, dimensional tolerances required for installation. Typical details will include dimensions of components and their relationship to other items of supply and with respect to the basins and details for sling lifting.
3. A complete listing of materials.
4. Drawings will include controlling elevations (i.e., V-notch weir, wall openings, bottom of equipment, water surface elevations in the basin and along the effluent trough at minimum and maximum flows).
5. Hydraulic calculations including headloss and velocity through the inclined plate system at minimum and maximum flows.
6. Embedment design details.
7. The manufacturer will submit equipment structural support requirements.
8. Proof of NSF International (NSF) Standard 61 Certification for Use in Potable Water.

B. Informational Submittals:

1. Structural calculations including seismic anchorage and brace shall be performed and stamped by a professional engineer registered in the State of Oklahoma.
2. Installation List: Manufacturer will submit a list of parallel plate settler systems installed within the last 5 years.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, with materials specifications will be submitted prior to shipment of the equipment. The certificate will certify that materials, manufacture, and final product conforms to or exceeds specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certificates as appropriate. The certificate may reflect recent or previous test results on material or product, acceptable to the Owner.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
5. Manufacturer’s Warranty.
6. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

C. Administrative Submittal:

1. The manufacturer will provide the following patent warranty and authorization:
   a. Provide a warranty that the proposed use of the parallel plate settler process and equipment is the use for which the system has been expressly designed and sold by the manufacturer. The warranty will further state that the use will not infringe on any U.S. or foreign patents, and that the necessary licenses have been obtained and are included in the bid price.
   b. Provide written authorization granting the right to use this process and equipment in perpetuity to Owner, and its assigned heirs. This right will not be subject to any licensing fees, franchising fees, or any other conceivable charge, presented at this time or in the future, that are not included in Contractor's bid price as stated in Bid. Declare in writing that in the event manufacturer ceases to do business under its current registered name, or in the event the manufacturer ceases to be the sole direct licenser of this process and equipment, or in the event this equipment is not available by any reasonable means, Owner, and its assigned heirs have the right and authorization to use the process and equipment for unspecified future expansions at the Water Treatment Plant site, but not at any other location, without prejudice or claim as regards applicable patents or licenses.

1.04 SPECIAL GUARANTEE

A. Warranty: Manufacturer will furnish a 5-year warranty protecting the Owner against equipment failure. Warranty period will commence from the date of substantial completion of the Project.

PART 2 PRODUCTS

2.01 GENERAL

A. Contractor will provide products required to complete the work under this section. Such products include, but are not limited to, inserts, anchor bolts, hangers and supports, specialties, and expendable materials, all as necessary to provide a complete and properly functioning system.

B. Manufacturer:

1. Meurer Research, Inc.
2. No "or-equal" or substitute product will be considered.

2.02 OPERATIONAL DESCRIPTION

A. The feed to the basin is admitted from the flocculation basin through openings in the sedimentation basin wall. Opening size and location to be coordinated by Contractor and Engineer.

B. The feed enters the parallel settler plates through specially sized baffle openings in the sides of the plate packs. The flow, together with suspended matter, travels up the plates with the solids settling out and sliding down the surface of the plates. The flow passes out of the space between the plates, over weirs and into the settled water collection flumes.

C. The settled water exits the flumes and flows into a common channel at the outlet end of the sedimentation basin.

2.03 DESIGN REQUIREMENTS

A. Efficiency Factor: 95 percent.

B. Number of Basins: One plate settler system for each of the two basins will be provided. Refer to Contract Drawings for basin dimensions.

C. Flow Rates: Maximum: 20 million gallons per day (mgd) per basin.

D. Influent Water Quality:

1. Clarifier Turbidity Performance Criteria:

Effluent Turbidity	Influent Turbidity
< 0.5 NTU	< 10 NTU
< 1.0 NTU	10 - 20 NTU
< 2.0 NTU	> 20 NTU

2. Temperature Range: 40 degrees F to 85 degrees F.
3. Chlorine Dioxide Dosage: 0.4 mg/L to 1.5 mg/L.
4. pH Range: 7.0 to 9.0.
5. Alkalinity Range: 90 mg/L to 140 mg/L.

E. Primary Coagulant: ACH (average dose, 20 mg/L).

F. Hydraulic Loading Rate: Maximum: 0.3 gallons per minute per square foot of projected horizontal plate area.

G. Design Loads:

1. See General Structural Notes on Drawings for structural design criteria.

2. The structural members will be designed to withstand hydrostatic loading and appurtenance loads.
3. Design will withstand all loads in submerged and non-submerged conditions.
4. Frames will be designed with a 50 psf live load and the plates will be capable of withstanding a 50 psf live load with a 4 feet by 8 feet plywood board laid on top of the trough.

H. Plate Angle: 55 degrees to 60 degrees from horizontal.

I. Plate Spacing: The perpendicular distance between parallel plates shall not be less than 2 inches.

2.04 EQUIPMENT DESCRIPTION

A. Plate Pack Frames:

1. Plate pack frames will be constructed of Type 304L stainless steel. Structural members will be suitable for long-term service with continuous immersion in the process water.
2. Plate pack frames will be designed with anchorage baseplates at each end of the plate pack frame modules. Anchorage at one end of the frame will be designed for fixed end conditions, and the other anchorage will provide for movement that may result from contraction/expansion of the plate pack frame and/or the concrete structure housing the parallel plate settlers. Frames will be designed to span end to end without intermediate support.
3. Each frame will be factory fabricated and will be delivered to the Site in one piece. No field fabrication of frames will be permitted. Contractor will furnish accessories required for mounting of frames on concrete walls.
4. Frames will be structurally designed to span between the concrete supporting walls, as indicated on Drawings and will support the weight of the plates and water/sludge loads expected. Frame deflection will be limited to 1/360th of the span. Frames will be designed to withstand hydrostatic uplift created when filling the sedimentation basin and will support live loads of 50 psf.
5. Provide support beams, column supports, and braces as required.

B. Inlet Feed Baffles:

1. Inlet feed baffles and flumes will be constructed of Type 304L stainless steel suitable for long-term service with continuous immersion in the process water and exposure to the atmosphere.

2. Inlet feed baffles will be hydraulically designed to equally distribute influent flow to all plates. Properly sized openings in the side walls of the plates will introduce the flocculated water near the bottom of the plates from both sides, and minimize floc destruction.

C. Parallel Plates:

1. Parallel plate assemblies will be fabricated from Type 304L stainless steel with a minimum thickness of, 0.024 inch, and stiffened at top and bottom with structural bend and crimp.
2. Parallel plate assemblies will be secured in the plate pack frames in accordance with the manufacturer's standards.
3. Parallel plates will be easily removable.

D. Outlet Weirs/Flumes:

1. Outlet weirs and flumes will be straight-edged weirs constructed of Type 316L stainless steel.
2. Outlet flumes will be sized for a flow velocity of 2 fps at maximum design flow.
3. Provide a means of effluent flow balancing to ensure even flow distribution through the plates.

E. Access Walkway:

1. Provide a 36-inch wide access walkway along the entire width of the plate settlers on the basin side for access during washdown.
2. Walkway supports shall be part of and designed as part of the plate settler package and be constructed of Type 316L stainless steel.
3. Walkways shall be provided with aluminum grating and handrail as specified in Section 05 52 16, Aluminum Railings, and Section 05 53 00, Metal Gratings.
4. Provide stairs on each end as required for access to the walkway from the basin walkways.

2.05 MATERIALS OF CONSTRUCTION

A. Fasteners: Will conform to ASTM A193 and ASTM A194, Type 304 stainless steel B8MN, B8m2, or B8m3. Fasteners will be threaded in accordance with ANSI B1.1 for screw threads, coarse-thread series. Stainless steel fasteners lubricant (antiseizing) will be applied to the threads prior to making up the connections.

B. Welding:

1. Welding will be done in accordance with the recommendations of the American Welding Society.
2. Welding will be done by a process suitable for the materials to be welded.
3. Welds will be free of porosity, cracks, holes, and flux.
4. Welds will be ground smooth and will have a uniform appearance.
5. Field welds will be passivated prior to equipment being placed in service.

C. Passivation: Fabricated stainless steel components will be passivated using a combination of citric acid and mechanical passivation, adhering to ASTM A380 and NSF-61 standards.

D. Stainless Steel:

1. Swedish Steel Institute SS 2333 is equal to AISI 304L stainless steel.
2. Swedish Steel Institute SS 2343 is equal to AISI 316L stainless steel.

2.06 MISCELLANEOUS PRODUCTS

A. General:

1. Furnish incidental products, such as gaskets, supports, bolts, and lubricants, as required for proper operation of equipment installed under this section.
2. Products will 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., will be Type 316 stainless steel to match connecting component. Fasteners will be threaded in accordance with ANSI B1.1 for screw threads, coarse-thread series. Stainless steel fasteners lubricant (anti-seizing) will 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 will be shipped assembled, ready for installation at the Site. Parts and assemblies that are, of necessity, shipped unassembled will be trial assembled at the factory and marked in a manner to facilitate final assembly in the field. The equipment and materials will be packaged in a manner that will protect the equipment from damage during shipment.

B. Contractor will have a manufacturer's representative at the Job Site during receipt of equipment and materials. This representative together with a representative of Contractor and Owner 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 PARALLEL PLATE SETTLERS

A. Contractor and plate settling equipment manufacturer will determine Site access during installation during the Bid phase.

B. A detailed description of the various items of work and precaution in handling the plate settling units will be provided by the manufacturer to Contractor prior to delivery and installation.

C. Provide a specially fabricated sling for use with individual plate settling units before installation commences. Sling will be the property of Owner at the end of the installation time, for plant maintenance usage.

D. Installation work will conform to manufacturer's recommended procedures, instructions, and shop drawings.

E. Inspect, receive, unload, transport to its place of installation, store, handle, and protect equipment.

F. Provide supervision, labor, tools, construction equipment, incidental materials, and necessary services required in install equipment.

G. Installation of the parallel plate settlers will not begin prior to satisfactory completion of supporting structures. Support structure columns, beams, walls or slabs will not be used to move the equipment into position.

3.03 MANUFACTURERS' SERVICES

A. A manufacturer's technical representative for the equipment specified herein will 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 installing contractor on proper installation procedures.
3. 1 person-day for functional testing.

Note: Manufacturer's representative will be present at the Job Site for a duration necessary to assure proper assembly, installation, testing, startup and certification of the equipment specified herein.

B. Startup and assistance services will 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 will 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 will be at such times as requested by the Owner. Training services will consist of pre-startup classroom training and site training.

3.04 FUNCTIONAL TESTING

A. Functional Test: Prior to plant startup, all equipment described in this Specification will be inspected for proper alignment and connection and satisfactory performance by means of a functional test as performed by Contractor.

3.05 SPARE PARTS

A. Furnish a minimum of two extra plates for every five plate packs.

B. Furnish ten additional fasteners of each type.

3.06 MANUFACTURER'S CERTIFICATE

A. The following certificates will be provided:

1. Certification of Proper Installation.
2. Certification of Materials Compliance.

END OF SECTION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